Study Committee B5

Protection and Automation

10119_2022

IMPACT OF RENEWABLE GENERATION ON THE DISTANCE PROTECTION AND SOLUTIONS

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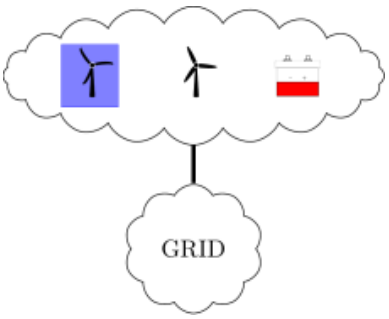
Motivation

Increasing contribution from renewable generation presents new challenges to line protection.



Overview Of The Problem

Lack of deterministic fault signature

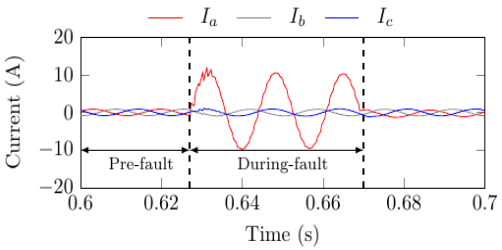


Figure: Real world conventional generator response for AG fault

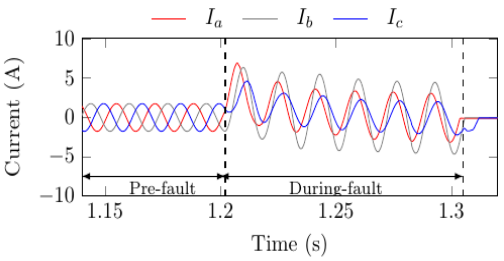


Figure: IBR response for AG fault with Real Controller

Impacts on Distance Protection

1. Varying source impedance results in uncontrolled MHO behavior

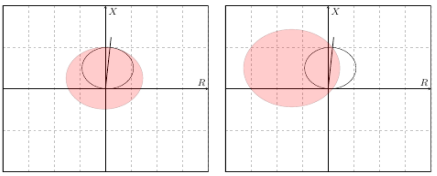


Figure: Response of Ground MHO with conventional generation (left) and with renewables (right)

2. Issues with top-reactance line polarisation due to unreliable negative sequence current

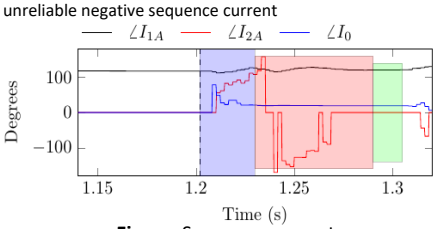
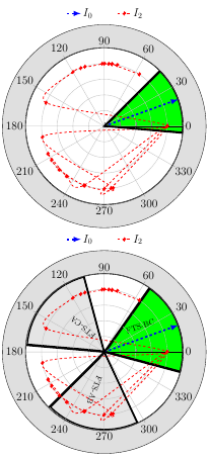


Figure: Sequence currents

3. Unreliable negative sequence current also causes security and dependability issues with phase selector



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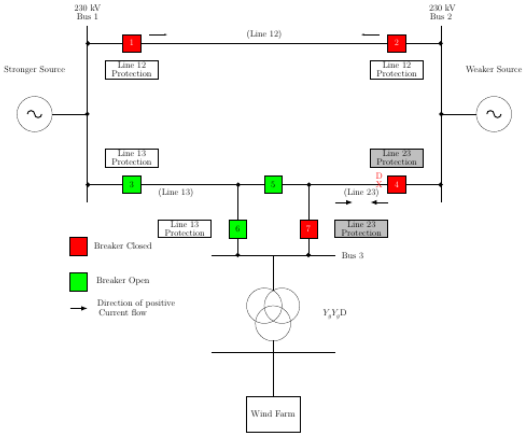
Power System Model with Real Controllers

- Power system model which incorporates IBR models from four different original equipment manufacturers.



Best Polarization - Inbuilt Intelligence

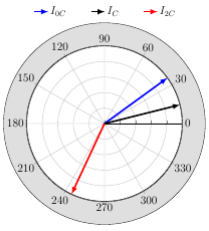


Figure: Real world case: I_0 was reliable compared to I_2. Relay automatically switches to I_0

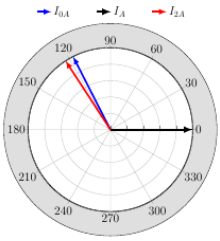


Figure: Real world case: both I_0 and I_2 are not reliable. Relay automatically switches to MHO

Controlled Dynamic MHO

- Varying source impedance results in MHO swings

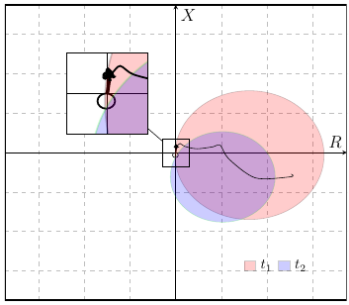


Figure: Uncontrolled MHO causing reverse Zone to operate for remote end forward fault

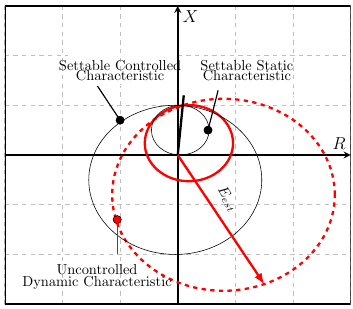


Figure: Controlled Dynamic MHO

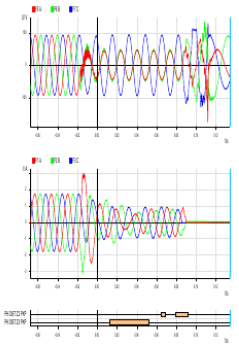


Figure: Uncontrolled MHO

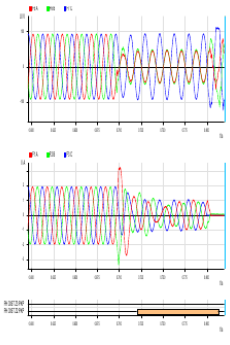


Figure: Controlled MHO

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New Phase Selector

Phase selector giving priority to voltage and uses current as and when requrired.

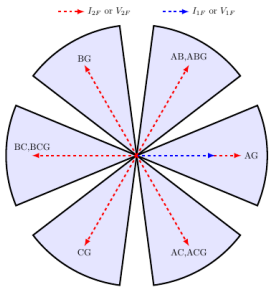


Figure: Pos. Vs Neg. Seq.

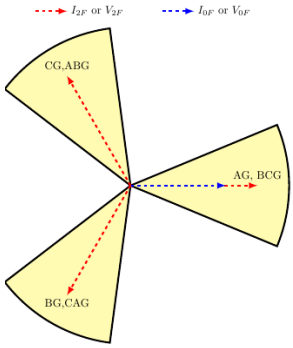


Figure: Zero Vs Neg. Seq.

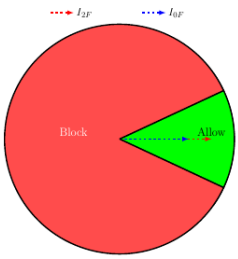
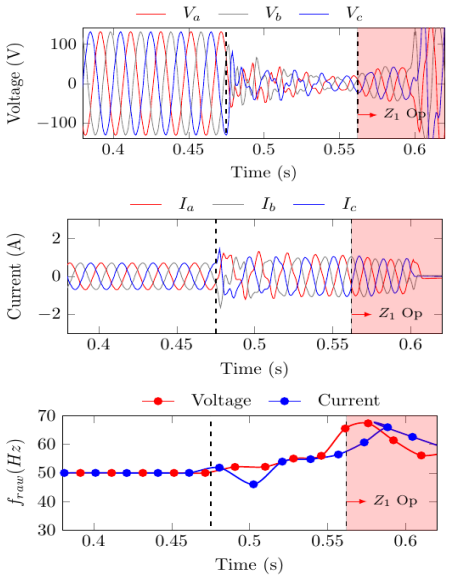


Figure: Adaptive angle

Frequency Excursion



Conclusion