GR-23-03 – IBR Transient Response Improvements To Transmission Faults

1. Company or University Name, as well as partnering organizations

University of Wisconsin, Milwaukee, AECC, SPP

2. Project Title

GR-23-03- IBR Transient Response Improvements to Transmission Faults

3. Project PI/Contact

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4. Technology Roadmap Target Area

Distributed Energy Resources, Protection and Management

5. Project Summary

Due to their inherent current-limiting features, Inverter Based Resources (IBRs) may not activate overcurrent-dependent algorithms during faults, impacting fault impedance measurements and distance relaying accuracy. IBRs also force balance fault current behavior, which complicates directional supervision in protection schemes relying on negative-sequence currents. Additionally, IBR control behavior also introduces errors in protection schemes that rely upon impedance measurements and phase angle comparisons. This project offers an XG-Boost machine learning based relaying approach to overcome these limitations in zonal protection schemes for transmission lines with one or more IBR-based feed.

6. Technology Gap/Market Need

This work will provide solution alternatives to conventional Distance relays, that are proven to be unreliable for transmission line fault location. We will also the outcomes of this work to networked microgrids as a means for increasing the resilience of critical installations, such as military bases .

8. Target Application (where does it fit in?)

Transmission, Distribution, Protection

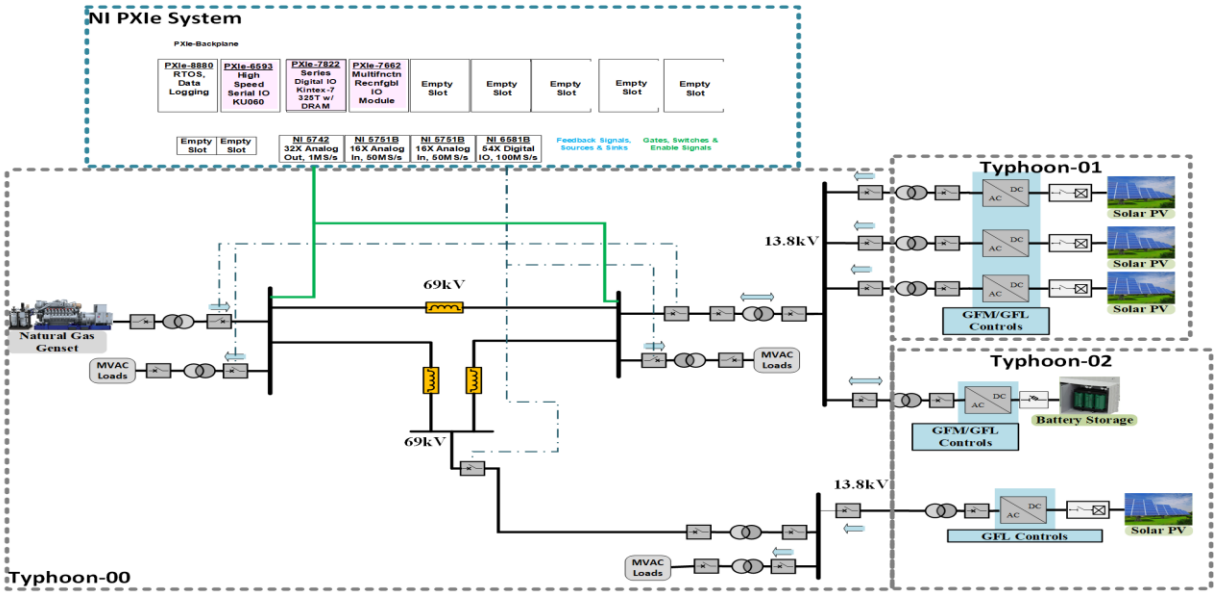
9. Accomplishments/Deliverables:

- *Implemented a Typhoon HiL Control Hardware-in-the-Loop 3 bus model of an 69kV AC With input from industry partners, determined a finite number of transmission line ratings and distances and points of fault application and Power Line Carrier (PLC) communication info to use in the generation of training use cases.*
- *Compared XGBoost approach to Support Vector Model*
- *Utilizing an NI PXIe-based system with Kintex 7 FPGA plug-ins, in conjunction with Typhoon HiL models, to demonstrate protection schemes, performance will be compared to emulation of a conventional distance relaying approach using emulated PMU data*

10. Impact/Benefits

This project aims to address the uncertainties and vulnerabilities introduced by the increasing presence of Inverter-Based Resources (IBRs) in power systems, which can compromise grid resiliency.

11. Images



3-bus 69kV transmission system