POST-COMMISSIONING MODEL VALIDATION OF IBR PLANTS

ppourbeik@peace-pllc.com
www.peace-pllc.com

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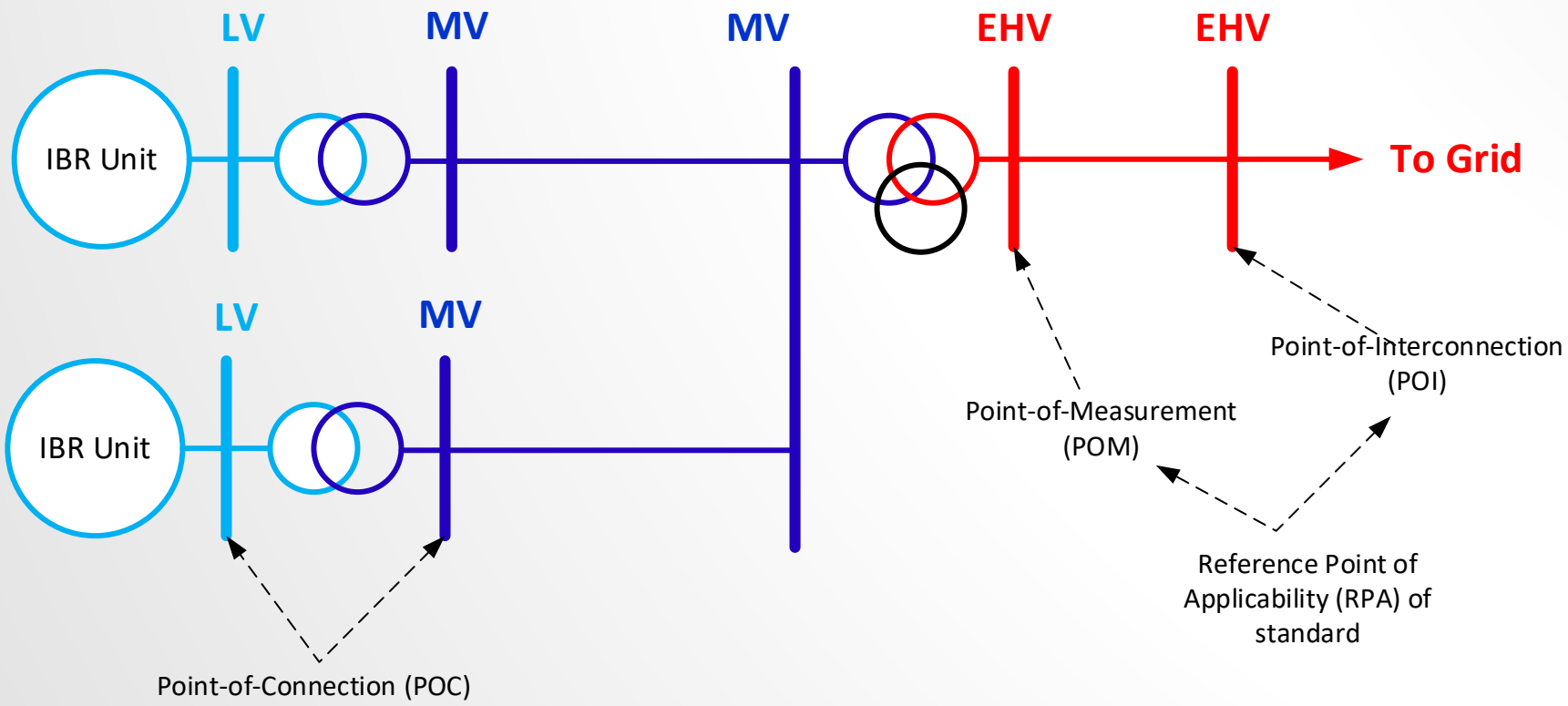
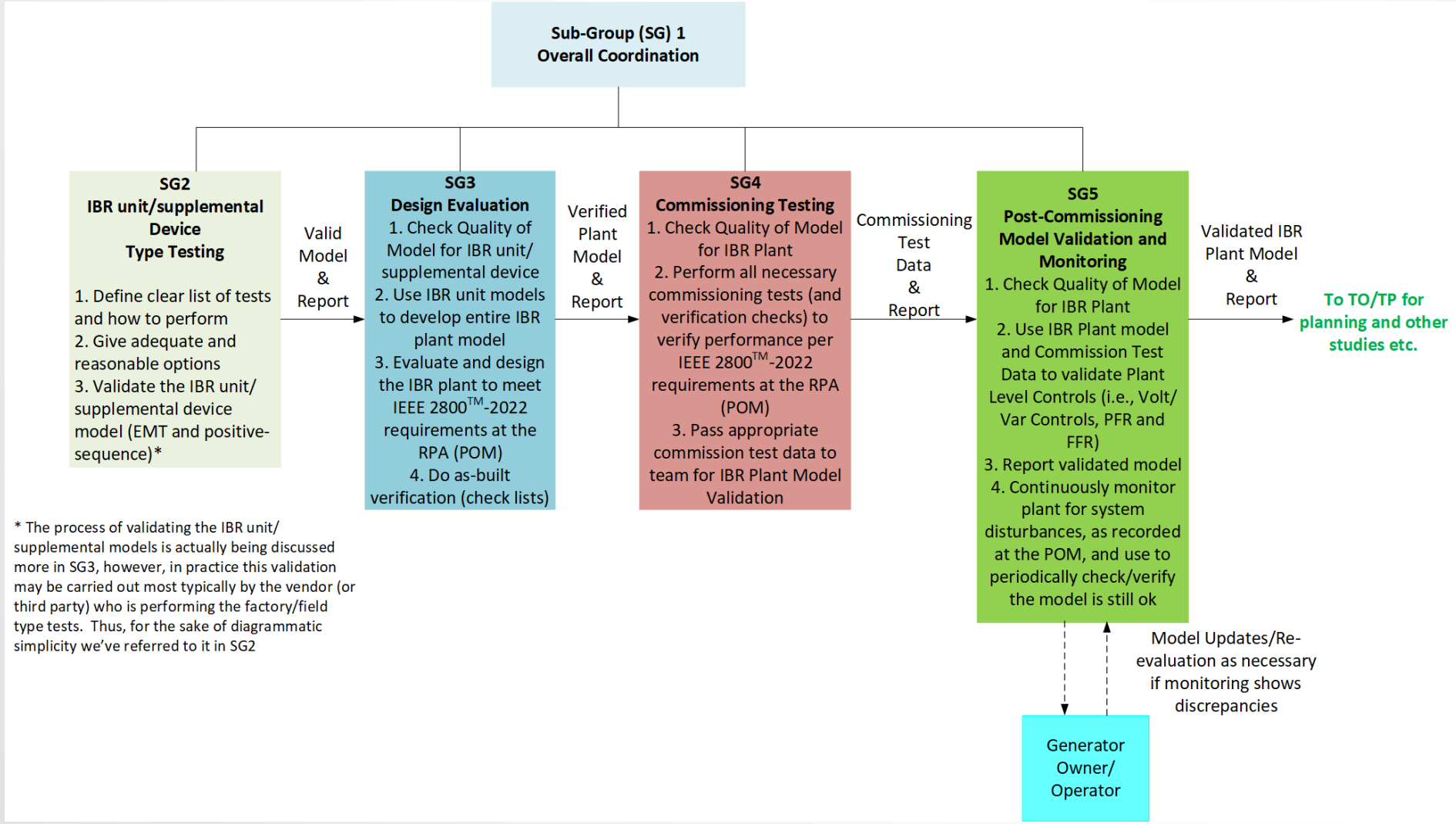
IBR PLANT MODEL



HIGH LEVEL OVERVIEW OF IEEE P2800.2

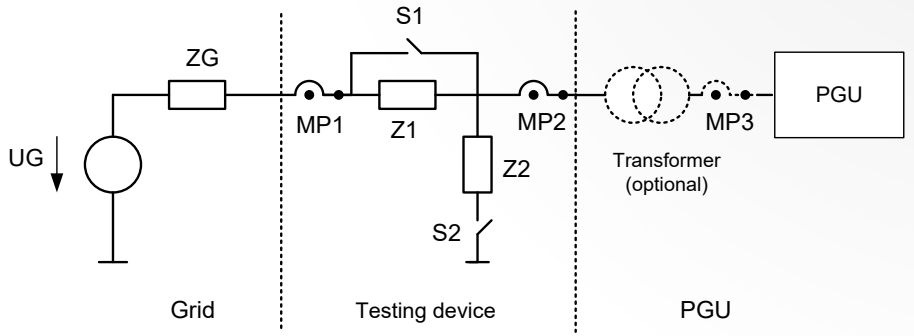


HIGH-LEVEL PREMISE

- The individual IBR units (and supplemental devices) are OEM type tested and their models validated
  - Electromagnetic Transient (EMT) user-defined model (UDM) by OEM
  - Phasor-Domain fundamental-frequency Transient stability tools (PDT) UDM by OEM
  - OEM parameterized standard-library ("generic") PDT models
- The collector system and major electrical equipment are all modeled per nameplate data
  - Collector system is typically aggregated for the most part
  - Substation equipment is explicitly modeled
- **Once the entire plant model is developed, and carried through the design evaluation phase, it will need to be validated against field measurements from commissioning**
- **Post-commissioning monitoring can be quite helpful too – next presentation**

WHAT DOES TYPE TESTING VALIDATION LOOK LIKE – INDIVIDUAL IBR UNIT

- Tests include:
  - Reactive power capability
  - Active power controls
  - Primary Frequency Response (if applicable at IBR unit level)
  - Fast Frequency Response (if applicable at the IBR unit level)
  - Rate-of-change of frequency
  - Voltage and Frequency disturbance ride-through
  - Phase jump
  - Protection
  - Power Quality Testing
  - Documentation of many other factors (e.g. priority of response, TOV capability, etc.)



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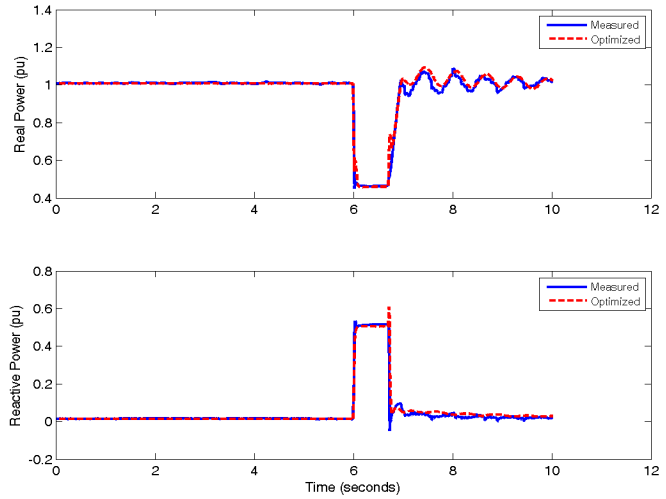

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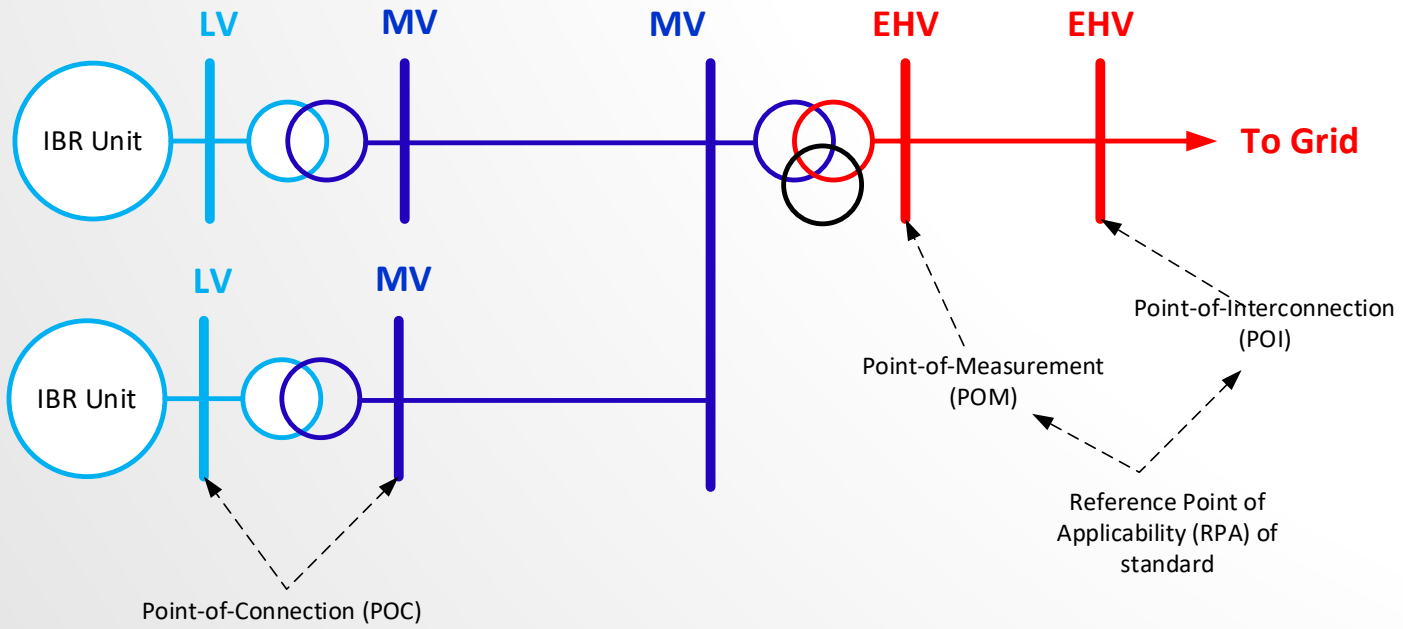
COMMISSIONING TESTS

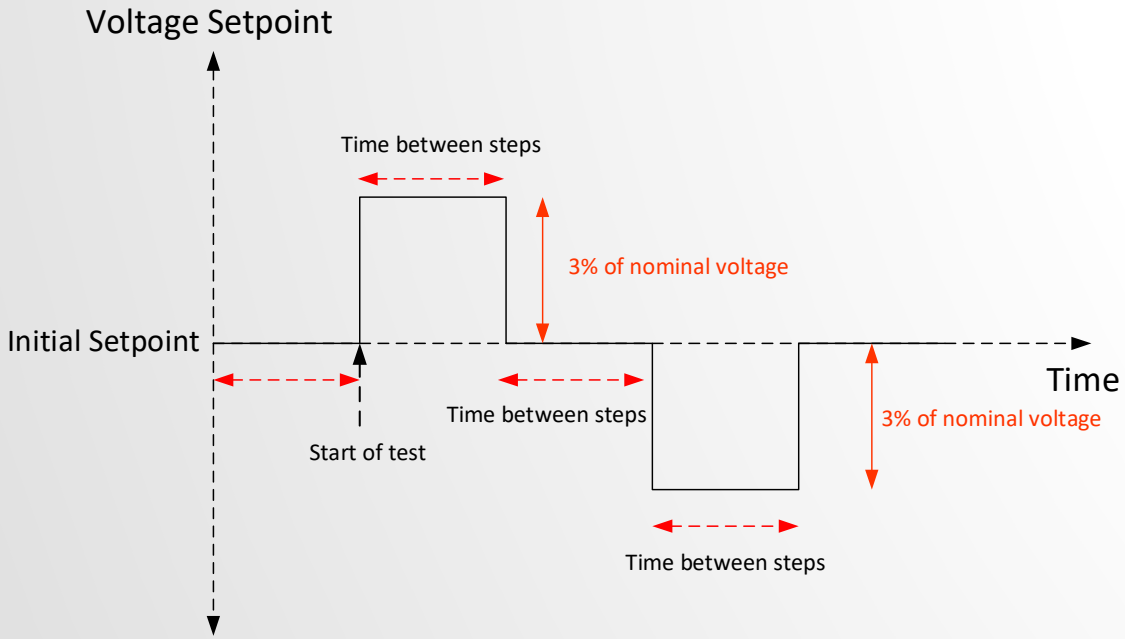
- There are many tests, and detailed documentation review, that will be done to verify field setting and conformity to expected IEEE 2800™-2022 requirements
- In addition, some of the tests can also be specifically used for model validation of the entire plant model

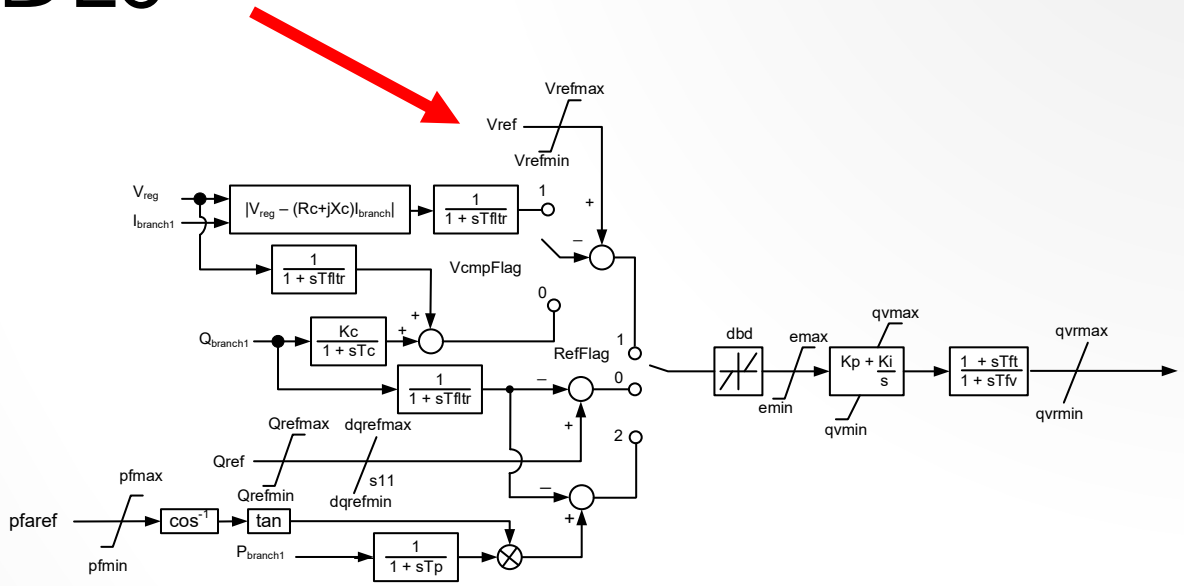


COMMISSIONING TESTS

- Execution of Mode or Parameter Changes
- Reactive power capability
- Voltage and reactive power control modes
- Primary frequency response
- Fast frequency response
- Harmonic/PQ
- Many other verification items

VOLTAGE AND REACTIVE POWER CONTROL MODES

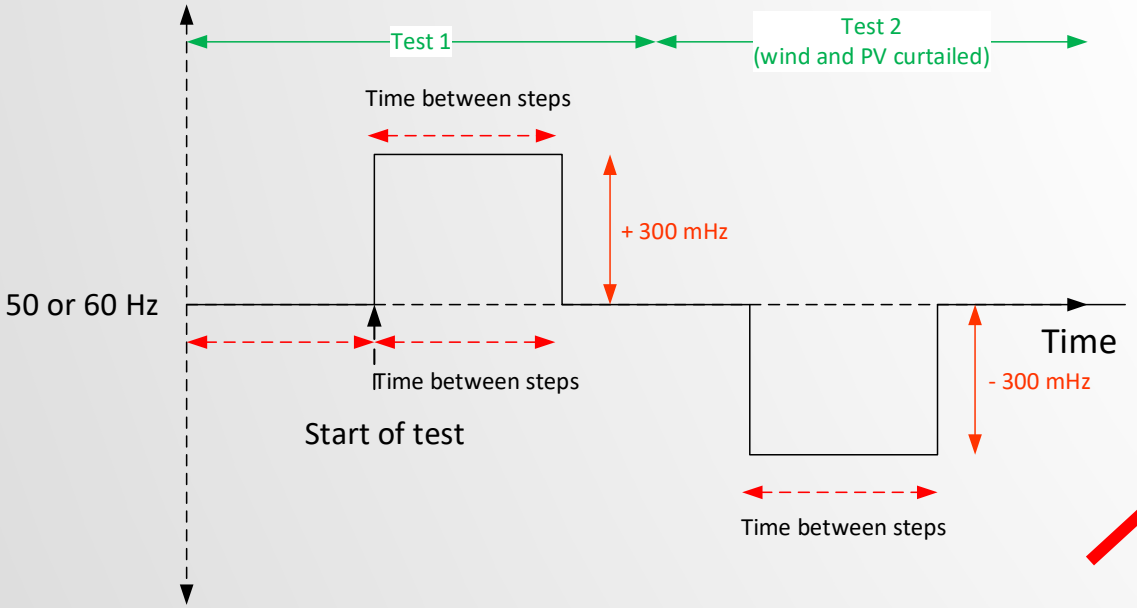


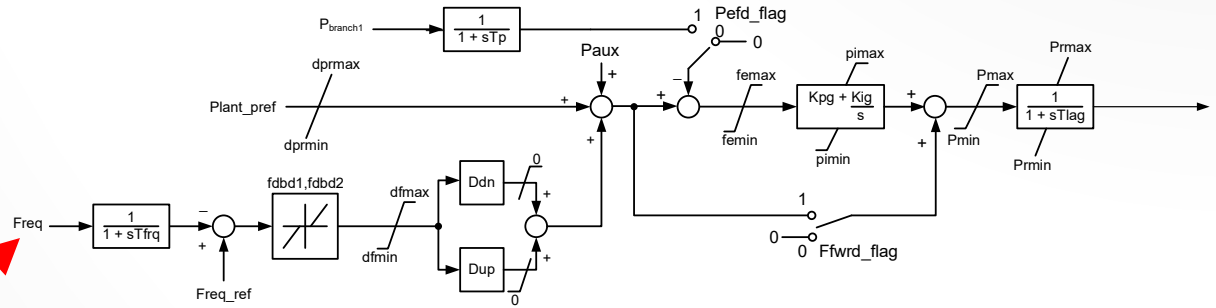


PPC – Reactive Power Control

Alternative test – switch a shunt device, if available, to cause a voltage change at the POM

PFR AND FFR TESTING





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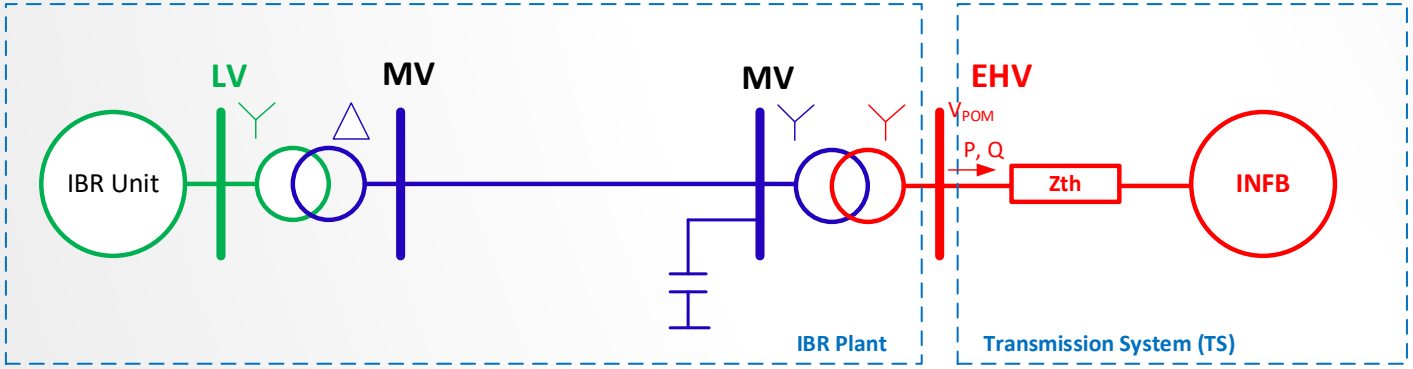
PPC – Active Power Control

For FFR Δf = 500 mHz typically

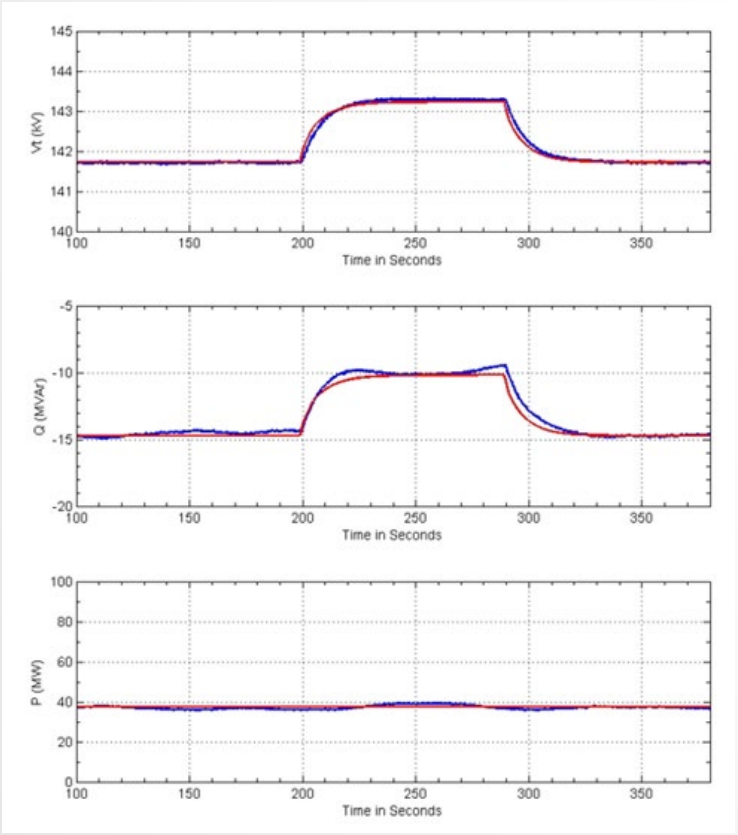
METHODS FOR VALIDATION

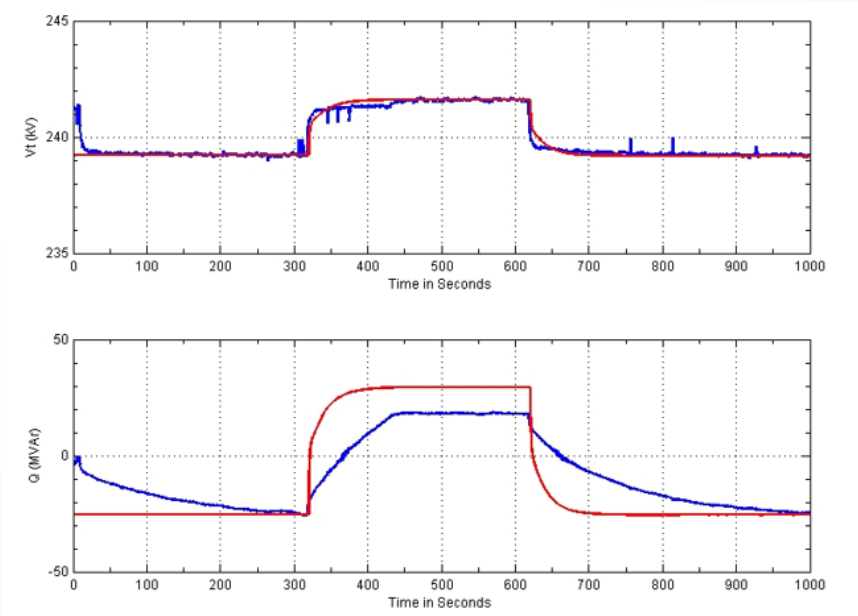


- INFB + source impedance
- Play back model
- Full (or partial) grid model – requires data from TP/TO

EXAMPLES

Simple INFB + source impedance model





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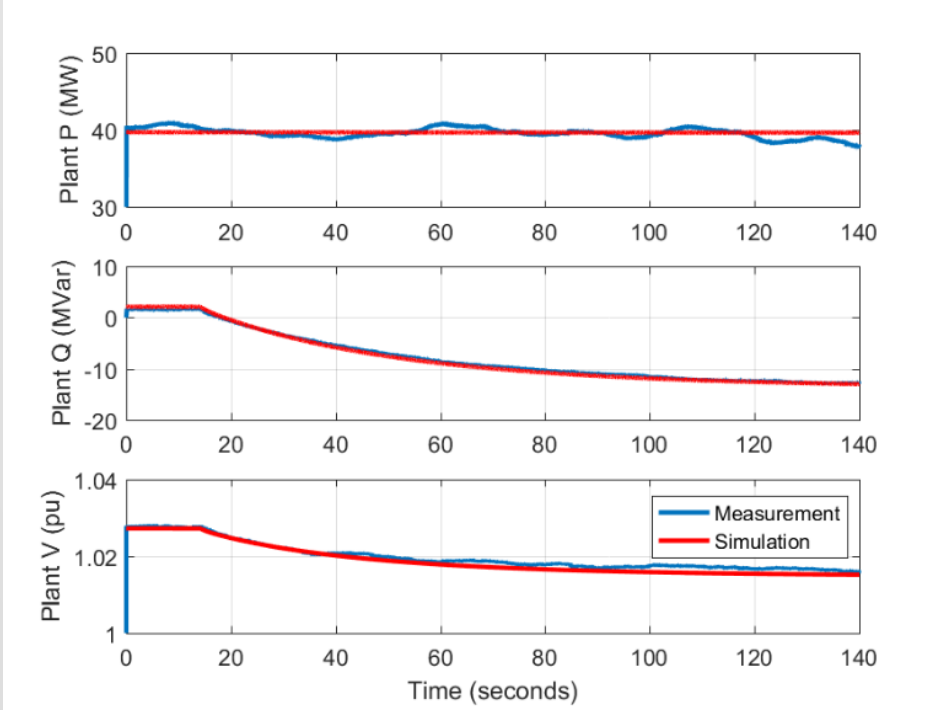
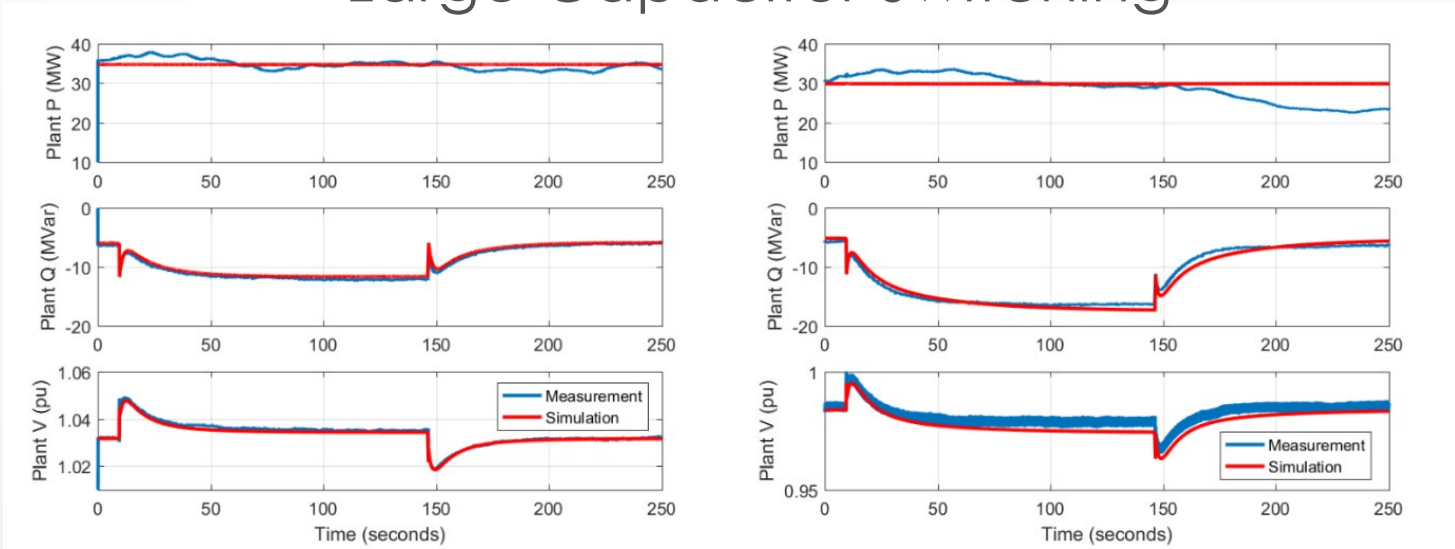
EXAMPLES

Grid Modeled in Detail

Reference Step

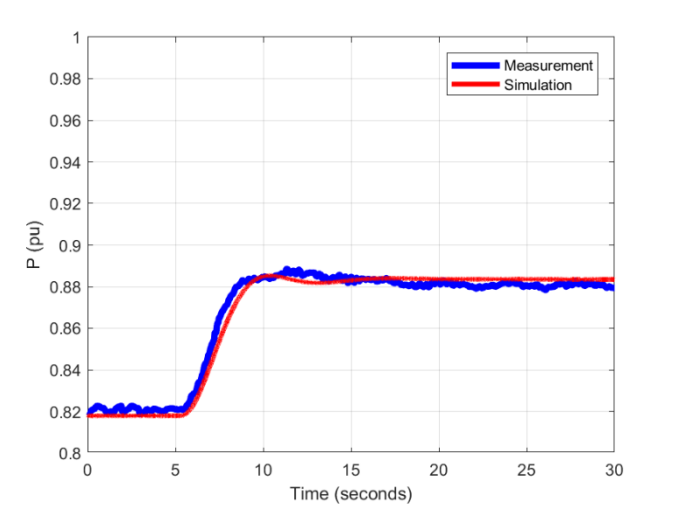


Large Capacitor Switching



EXAMPLES

Frequency reference step-test



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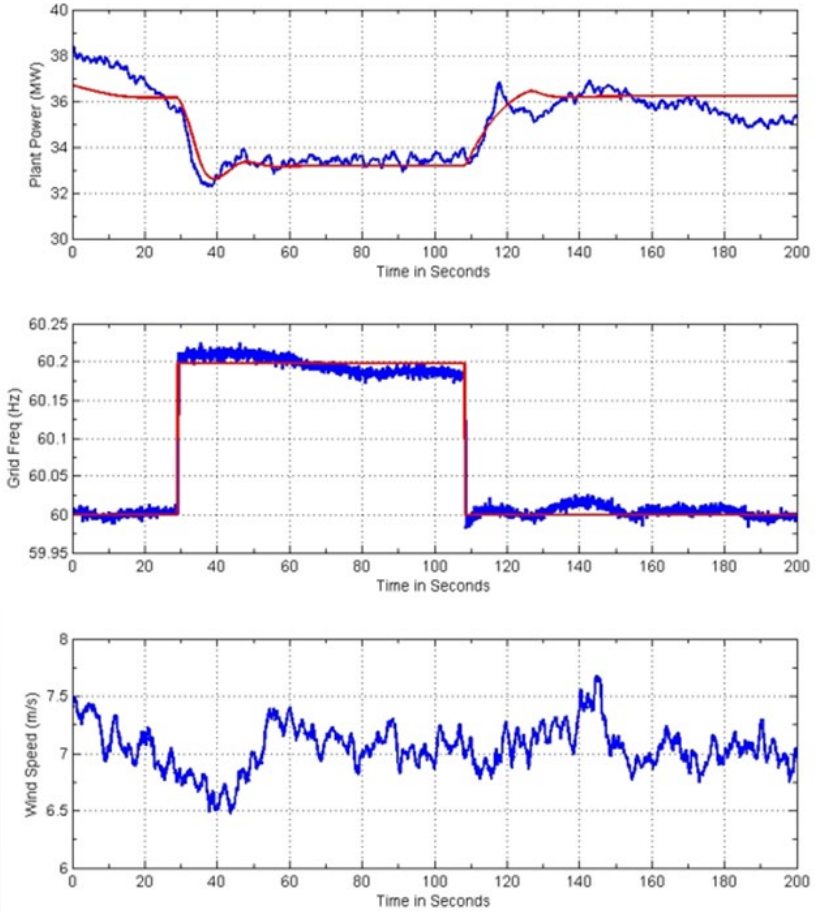
Frequency signal step-test



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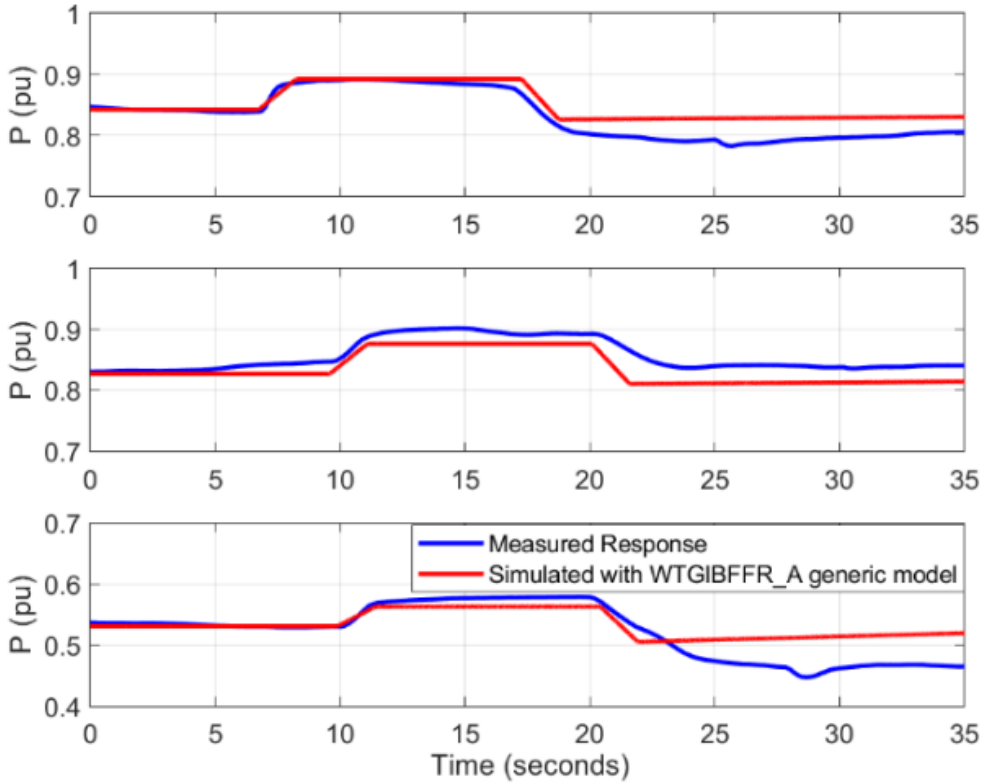
EXAMPLES

FFR test on a Wind Power Plant



- Cannot capture wind fluctuations in aggregated stability model
- Aggregated model cannot capture nuances of wind speed at each turbine in plant (nor is this necessary for power systems analyses)

SUMMARY

- IBR Unit Type Testing and Model Validation → Good and reliable IBR Unit models
- Develop the IBR Plant model based on nameplate data of the electrical components, aggregating the collector system appropriately, and explicitly modeling substation equipment
- Verify all equipment match actual filed settings
- Do post-commissioning tests (Volt/Var + PFR/FFR) and validate the IBR Plant Model

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