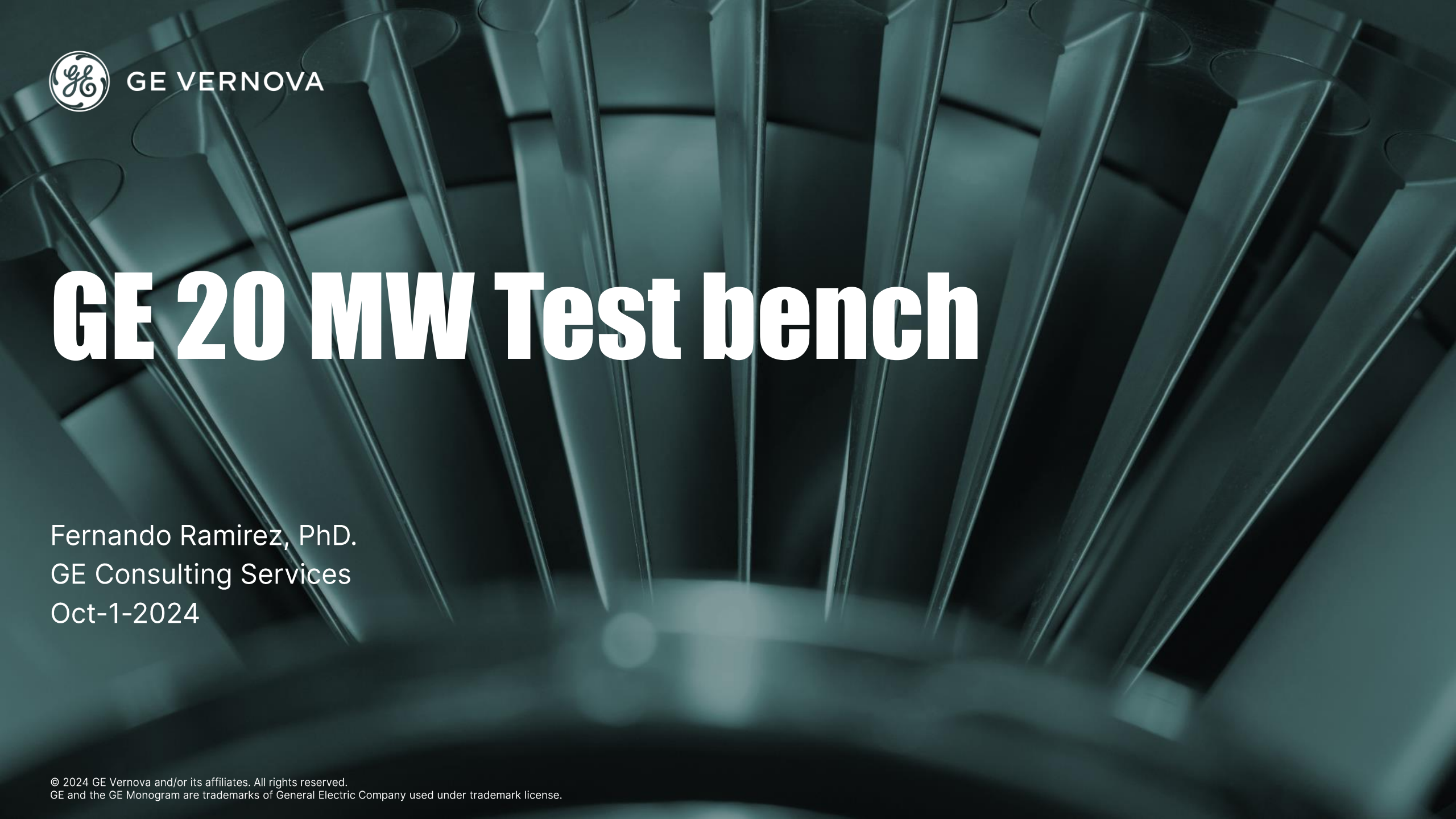

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GE 20 MW Test bench

Fernando Ramirez, PhD.
GE Consulting Services
Oct-1-2024

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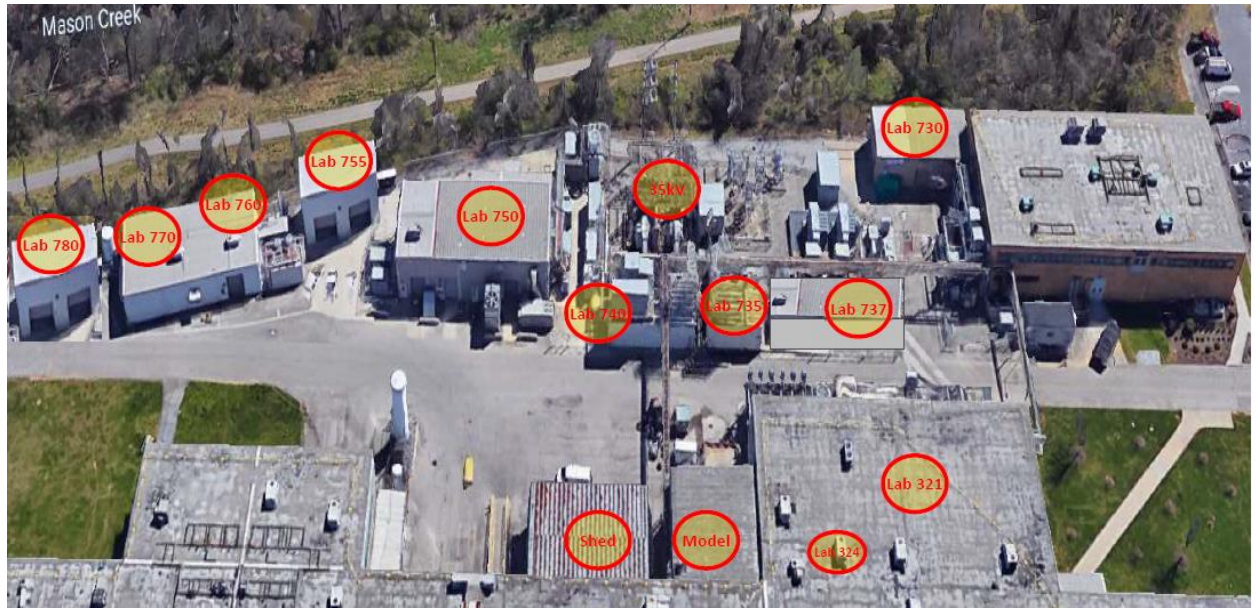
GE Renewable Energy Electrical Engineering Lab



Located in Salem Va. US, Salem Labs are dedicated to the test validation of different electrical power systems.

Lab equipment:

-20 MVA grid simulator, commissioned in 2020

-2 passive yard grid fault simulators

-4 Large Dynamometers (2-9 MW)

-3 Pump-back, current circulation systems (>3 kA)

-1 Thermal chamber

-Semiconductor thermal characterization testbench

-Multiple small dynamometers (below 100 kW)

-2 PHIL Hub simulators

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Pickup Truck (for size comparison)

Grid Simulator Building

DFIG lab– Control Room, Generator, Converter, Prime Mover

Passive Testbed

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6.1 MW DFIG lab Prime mover, Grid simulator, Passive inductors

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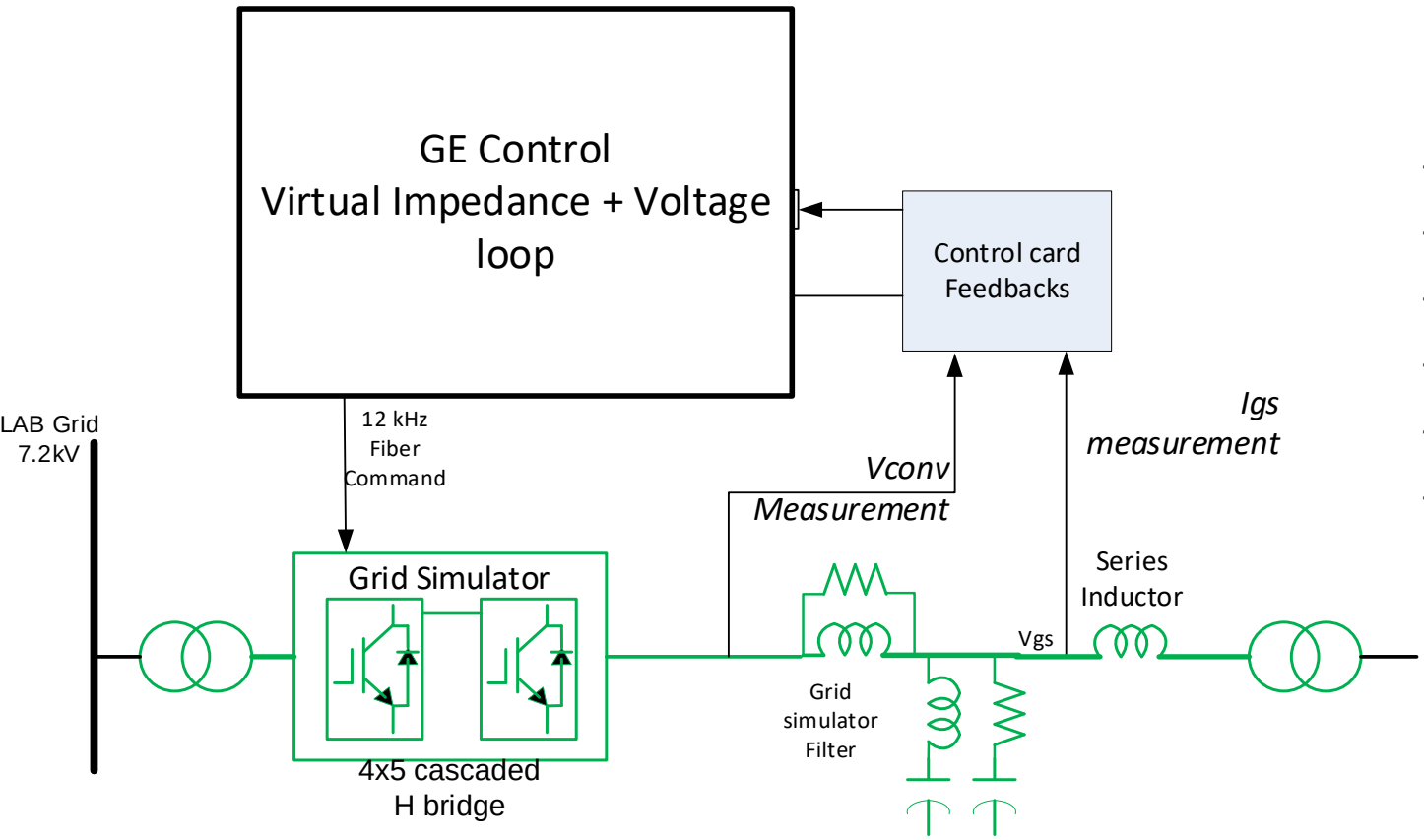
20 MVA Test bench



- GE Grid simulator spec:
  - Cascaded H bridge configuration
    - TECO Westinghouse power state
    - GE Control (Mk Vie controller)
  - Max voltage 14 kV
  - THD <2% at steady state
  - Selectable switching frequency
  - Real Impedance: Up to 12 mH
  - Virtual impedance: From 60 -1.0 SCR
  - Some typical tests:
    - LVRT, 3Ph and LL
    - HVRT
    - ROCOF
    - Series Comp tests
    - Harmonic injection
    - FMEA tests
    - Imbalances
    - Very weak Grid validation

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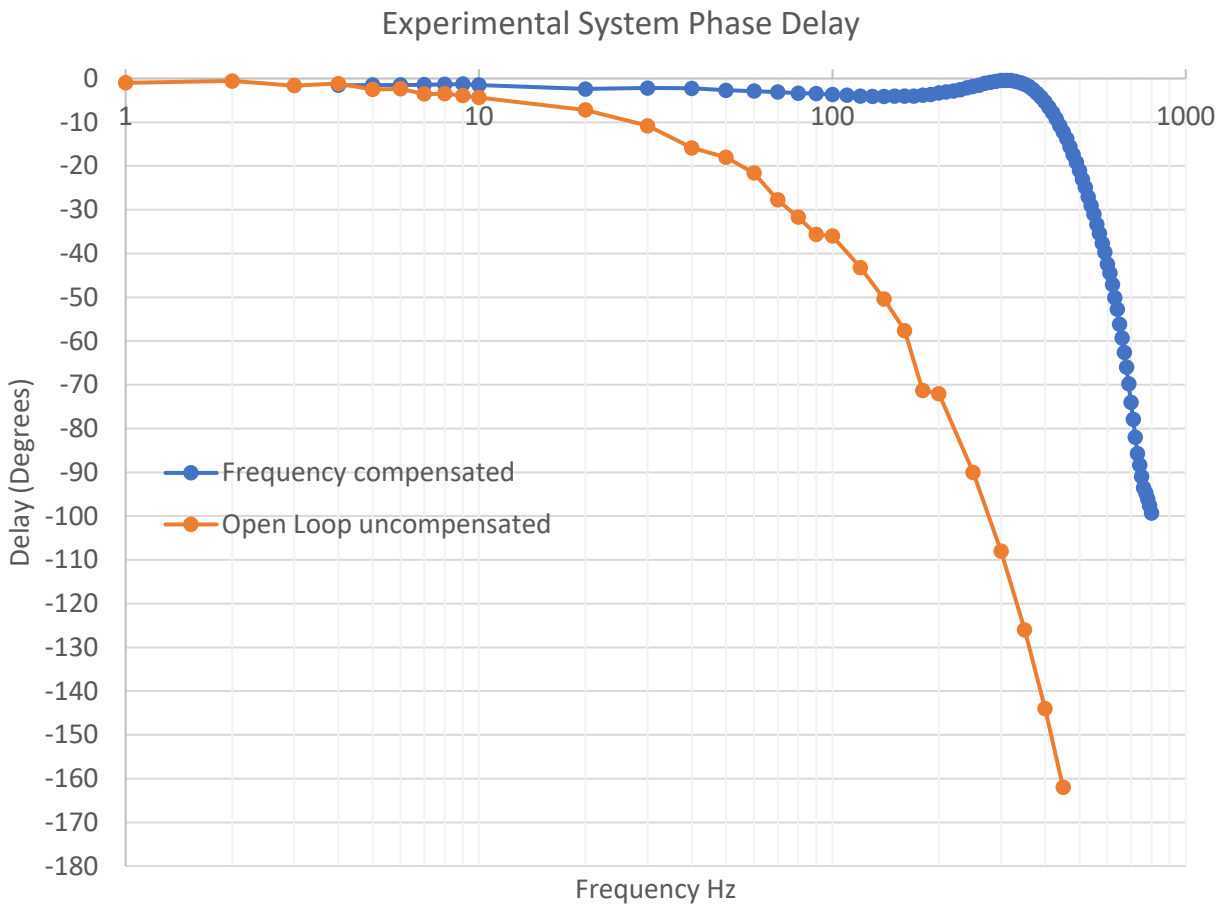
Control Response

Bandwidth



- Different control loops available (based on desired test/scenario)
  - Open Loop
  - Closed Loop (modified PR loop)
  - Frequency compensated (Lag compensation)

350 Hz range within required delay time (5 degrees max)

  - Control scheme is selected based on SCR, test and desired bandwidth
- Real impedance available in place for cases where no bandwidth limitations are desired.

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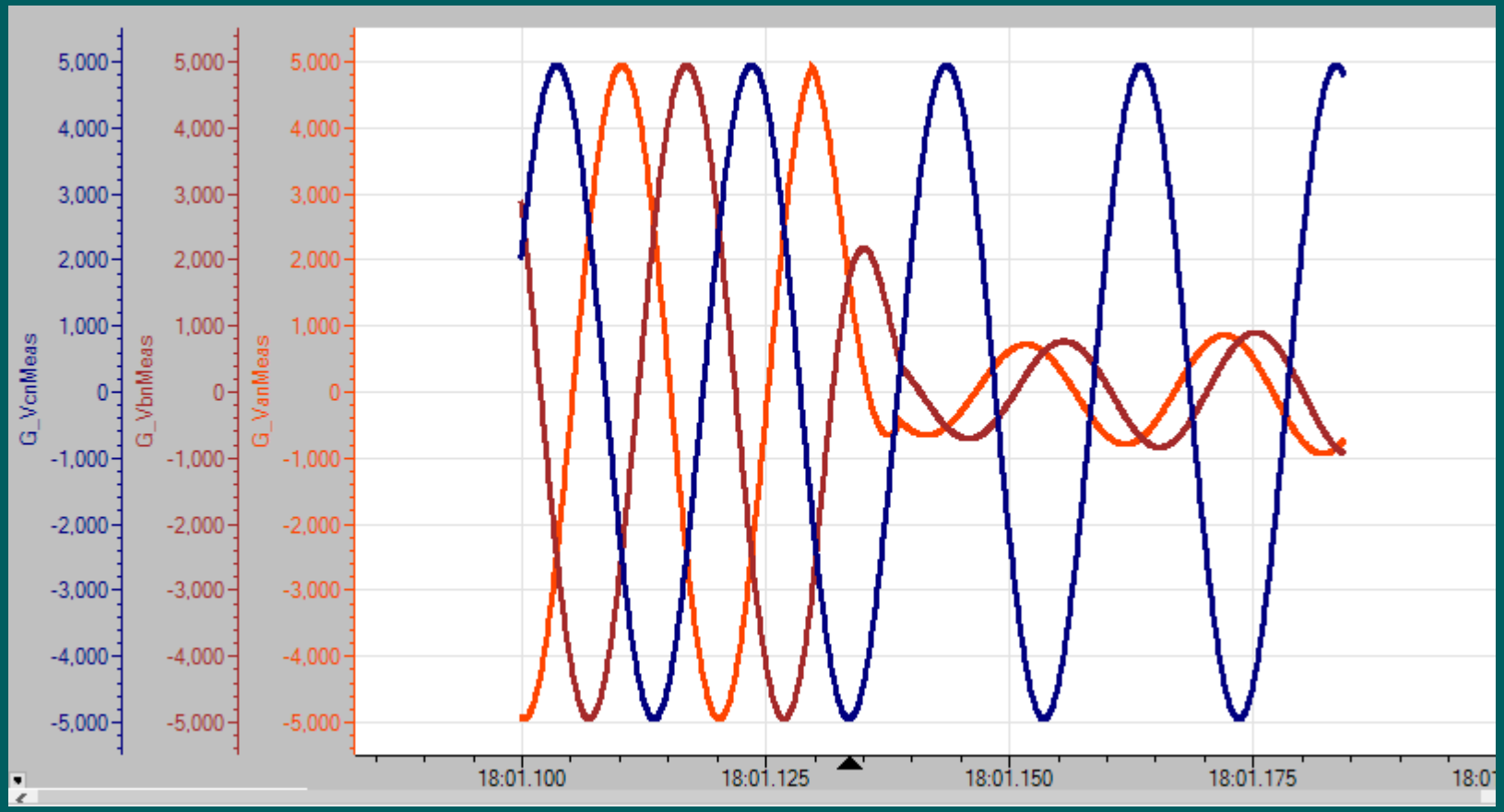
Transient events, experimental examples



Line to line fault example:

6 kV base system, 50 HZ

5.5 MW DFIG load

Phase displacement as expected

10% LL residual voltage

Voltages show are line to Neutral voltages at the Grid simulator output.

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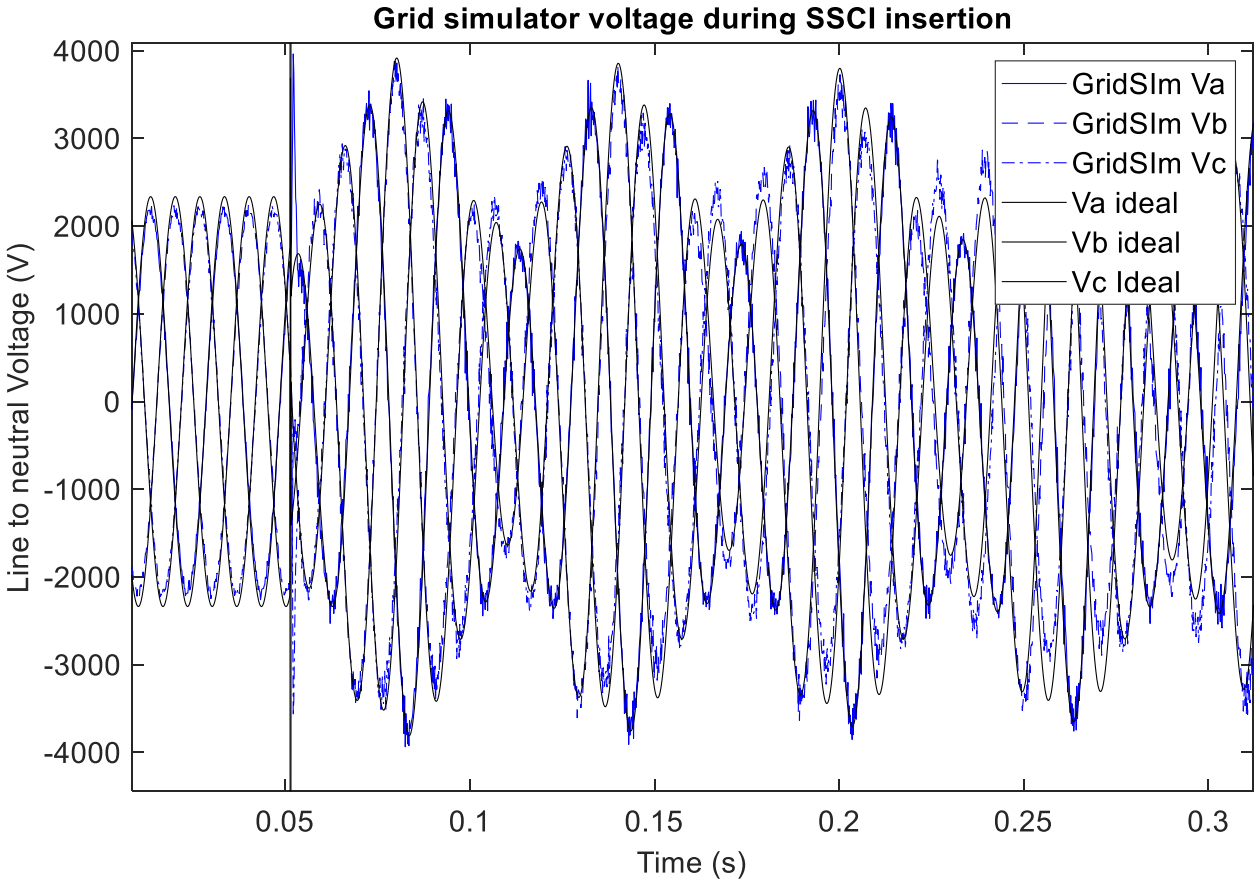
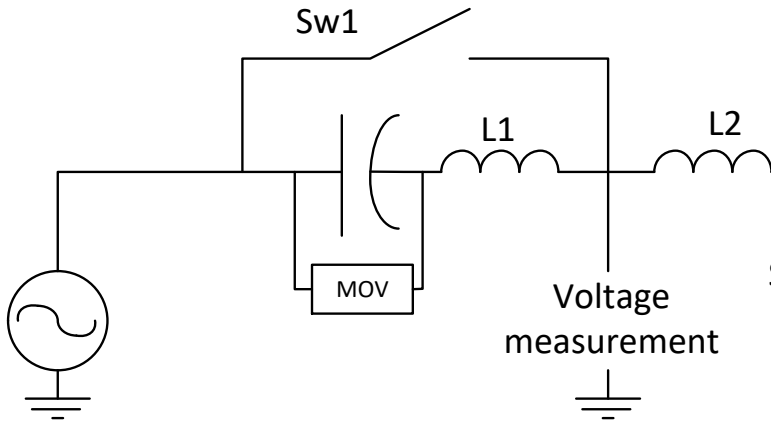
Transient events, experimental examples

Series comp insertion, passive load



- Example of validation of Series comp insertion model
  - Closed loop operation
  - S1 opens at T=0.05s
  - 50 Hz, 3 kV grid
  - 17 Hz resonating Frequency
  - Passive load (resistive)

  - Black traces are from ideal model (MATLAB circuit model)
  - Blue traces are from Experimental measurements



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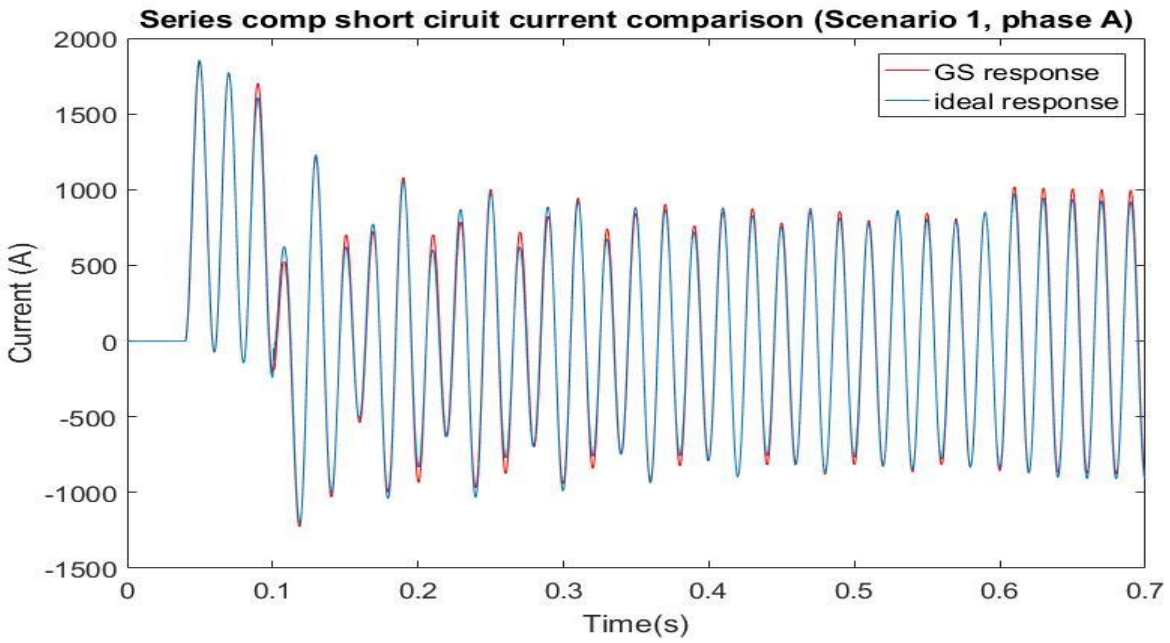
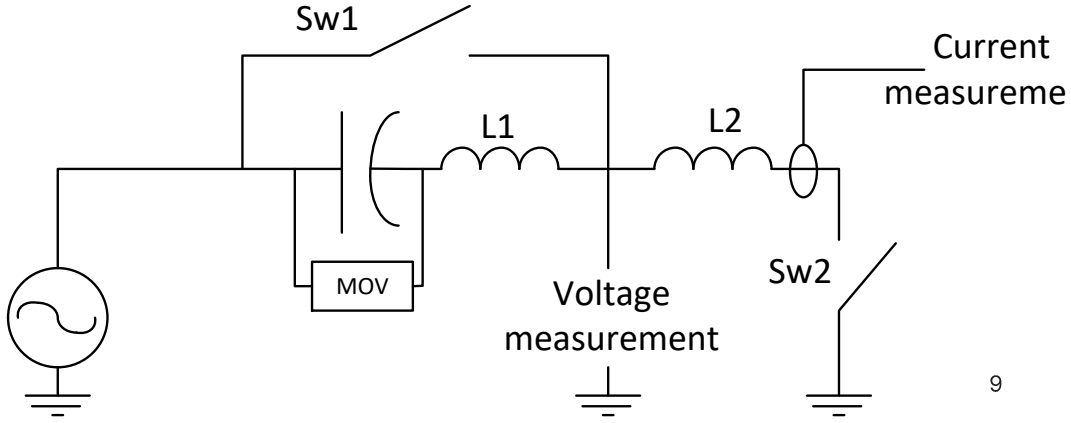
Transient events, experimental examples

Series comp insertion, passive load



- Example of validation of Series comp insertion model
  - Closed loop operation
  - S2 is closet t=0.1s and opens at t=0.6 seconds
  - 50 Hz, 3 kV grid
  - 17 Hz resonating Frequency
  - Passive load (resistive)

  - Black traces are from ideal model (MATLAB circuit model)
  - Blue traces are from Experimental measurements



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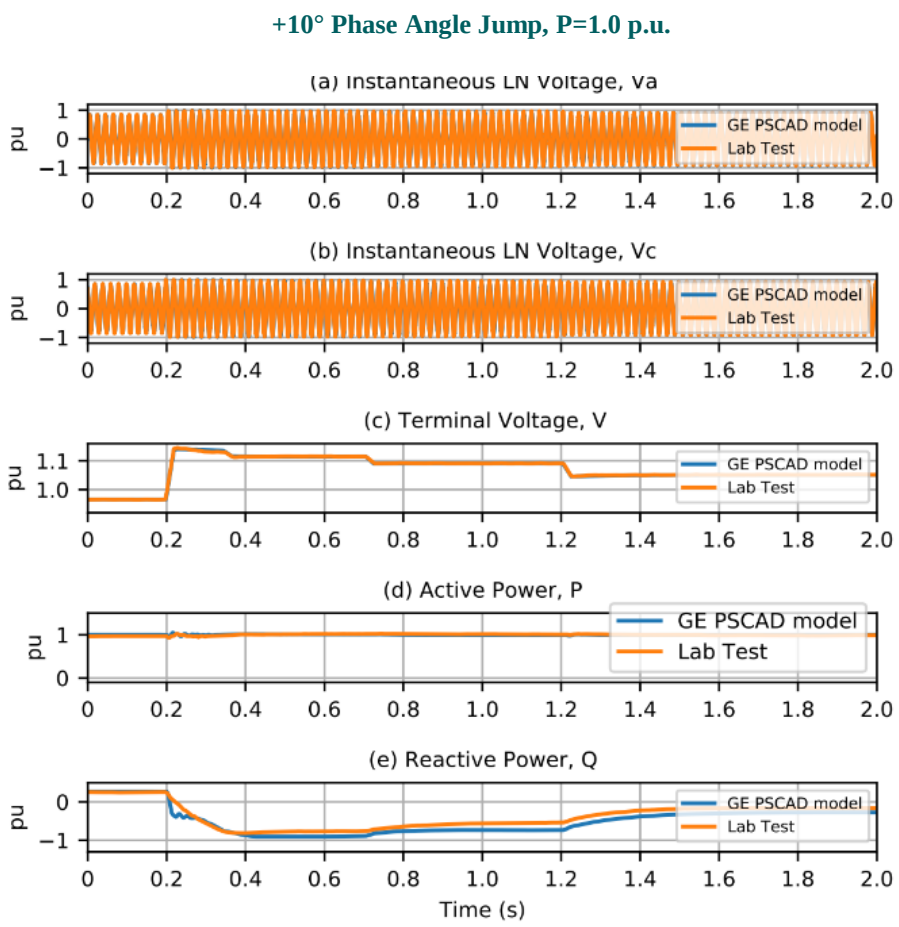
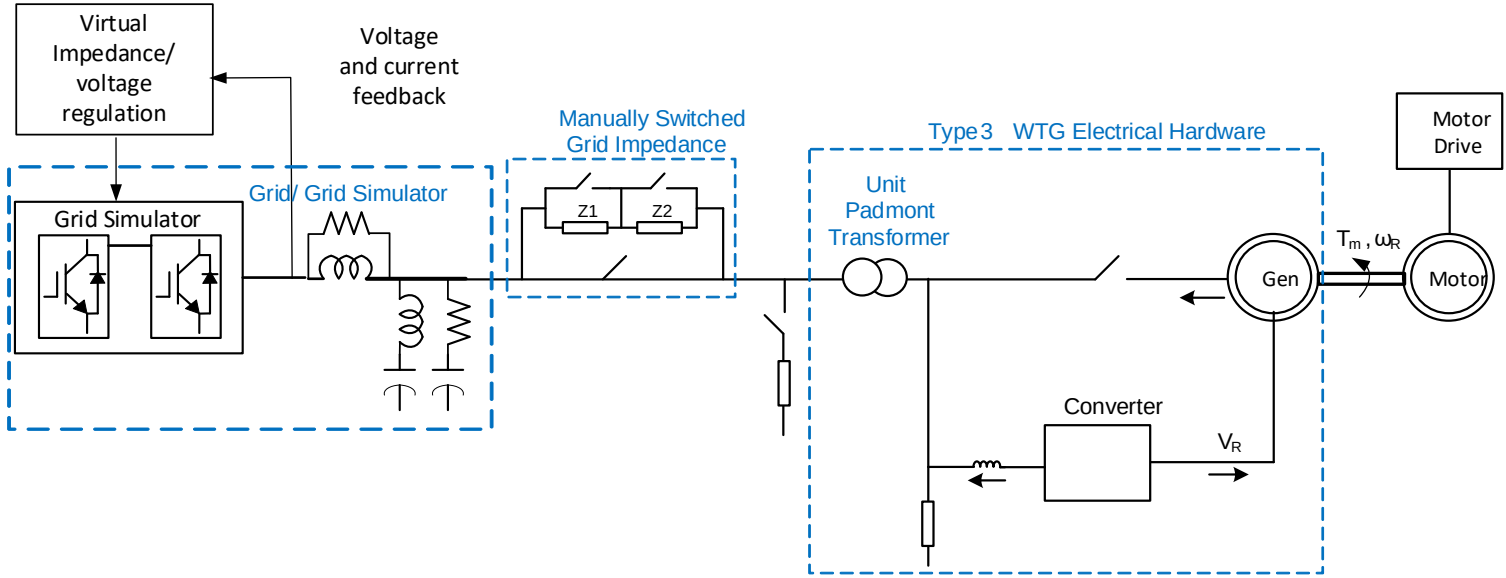
Transient events, experimental application

Lab benchmark required to meet grid operator request





- Example of test required by grid operator
  - 6.1 MW system, 60 Hz
  - 10 degree phase jump
  - Lab results are used to confirm accuracy of circuit models provided by OEM.

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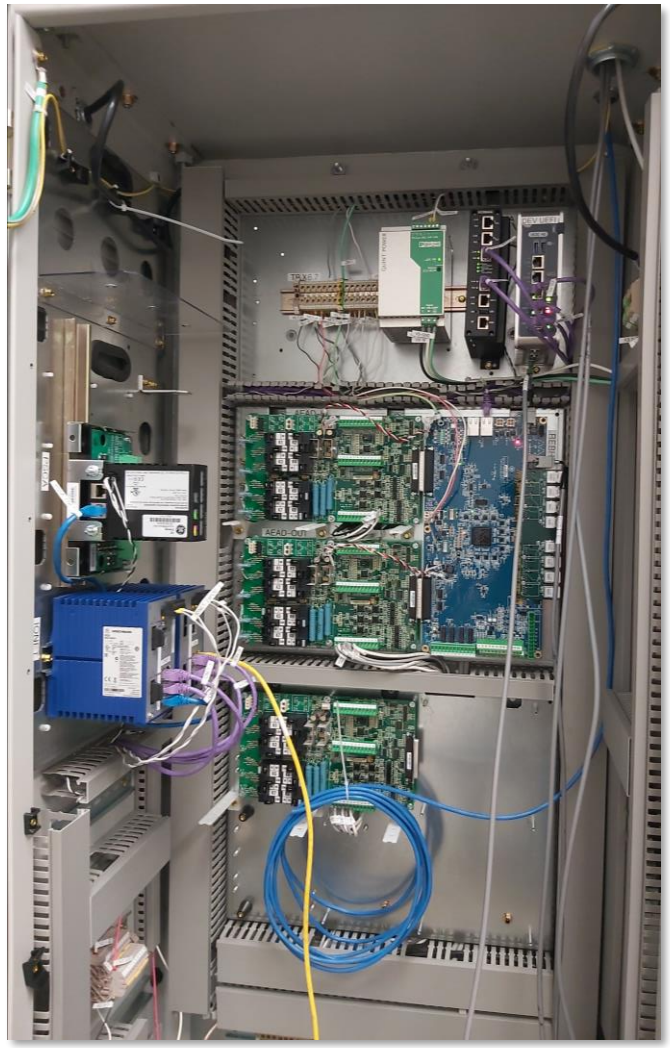
Back up



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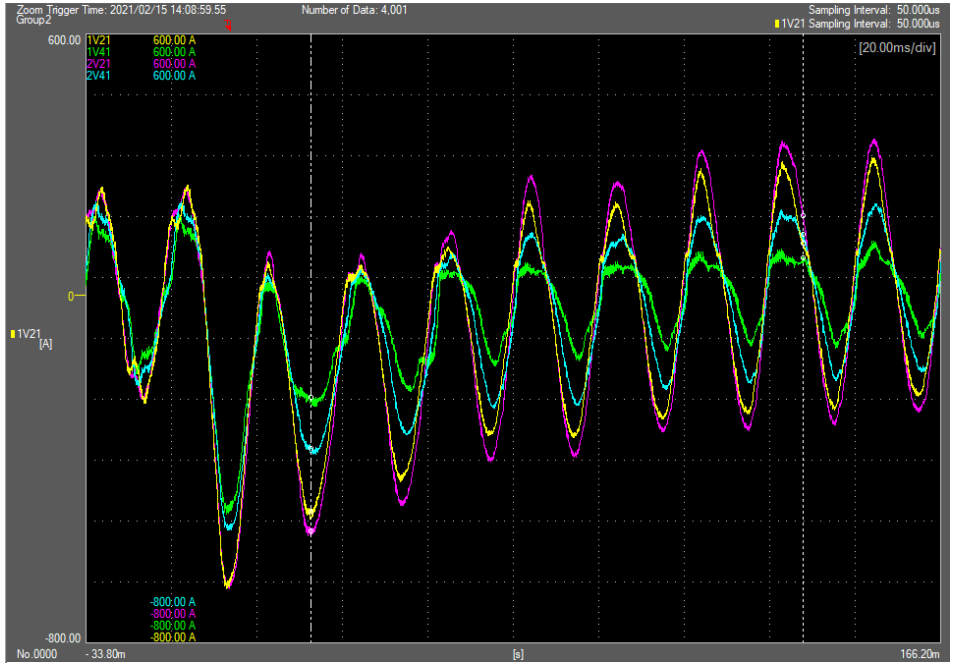
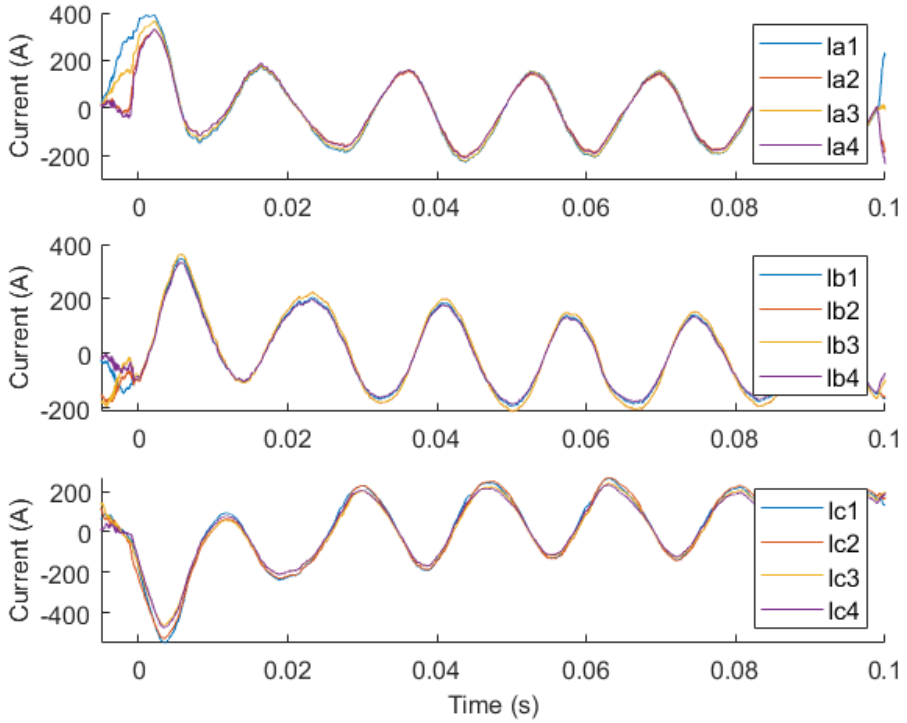
Back up, current sharing before and after.





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