Design, Analysis, and Controller Hardware-in-the Loop (C-HIL) Testing of Hybrid Control Systems for Networked Microgrids

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ABSTRACT

The goal of this research is to develop a suite of controls for a radial three-feeder microgrid, and test them in a real-time controller hardware-in-the loop (C-HIL) setting. This microgrid comprises synchronous generators on feeders 1 and 3 as well as a grid forming (GFM) inverter and grid following (GFL) inverter on feeder 2. The structure of the microgrid and our developed controls allow the microgrid to run in grid connected mode, as well as in fully islanded mode, networked mode, partially islanded mode, and backfed mode. The controls developed include secondary frequency and voltage control, tie-line power control, re-synchronization control, as well as discrete controls that facilitate mode changes. We have mathematically presented the controllers for each mode, and discussed how they interact to modify the reference setpoints for each resource. This work combines detailed models of the generating resources and microgrid elements with real time hardware. Previous work has focused on individual elements of this work, such as microgrid islanding/reconnection in the C-HIL space, or networking microgrid control formulation, however to our knowledge no work has combined elements as we have here. The result is a comprehensive look at a heterogeneous-generation microgrid that is able to change topologies on command, and recover from unintentional disturbances.