Impact Study of Value-Added Functionality on Inverters in Energy Storage Systems

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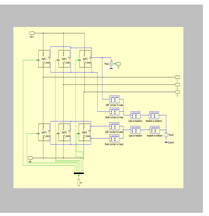

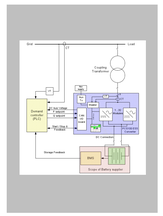

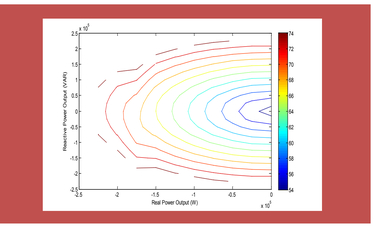

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Motivation

Power conversion systems (PCS) developers are incorporating value-added functions; little is known about the on overall PCS reliability.

Objective

Develop electrical models to gain an understanding of the degradation of a PCS and its internal components due to value-added functionality; *primarily VAR generation*. Investigation and modeling of frequency support applications may be considered as a secondary objective.

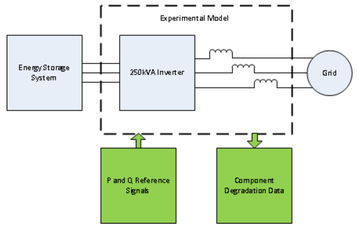

Figure 1: High-Level Diagrams of Experimental Setup

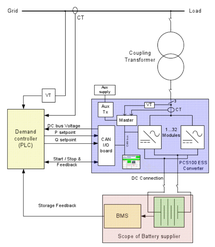

Figure 2: ABB PCS100 ESS Solution

The reliability models will then be leveraged to identify areas of improvement such as revised component selection and advanced control methods.

Simulated System

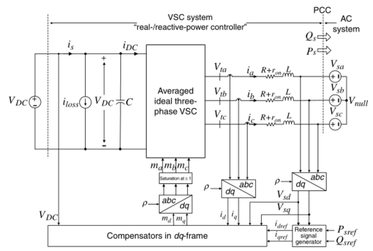

Figure 3: Theoretical PQ-Controlled Voltage-Sourced Converter

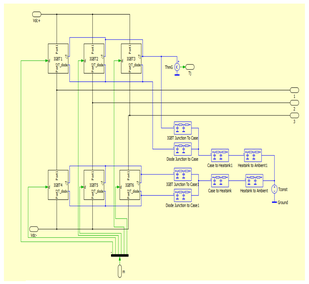

Figure 4: PLECS Switching Model with Thermal

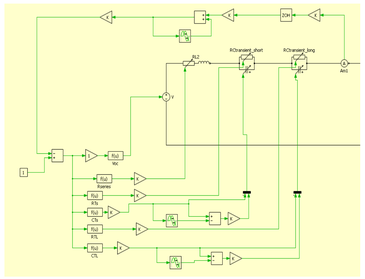

Figure 5: PLECS Battery Model

Preliminary Results (Model Validation)

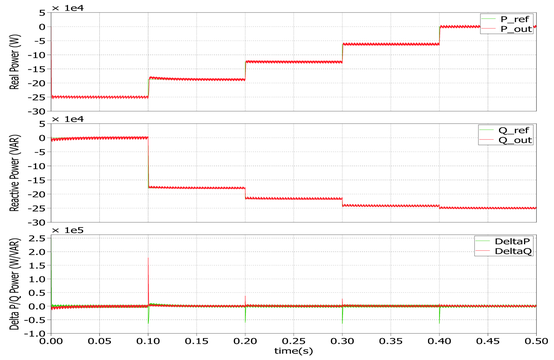

Figure 6: Real and Reactive Power Reference vs. Output

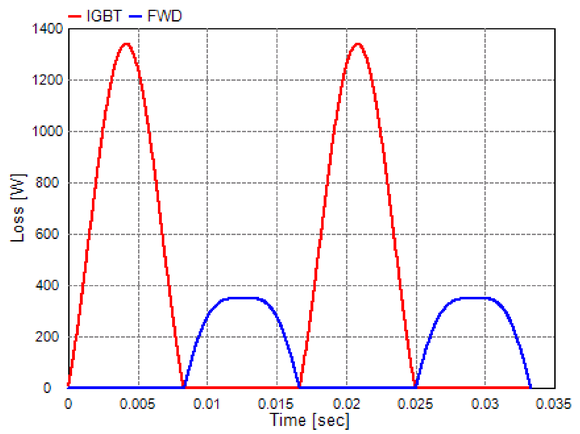

Figure 7: IGBT and Diode Loss from Manufacturer (Fuji)

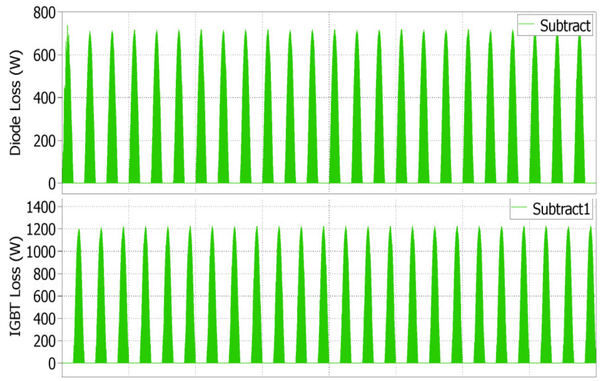

Figure 8: IGBT and Diode Loss from Simulation

Preliminary Results (Reliability)

The junction temperature (Tj) of the IGBT and Diode were used as a quantitative indication of reliability of the components. The voltage ripple of the capacitors was used in the same way.

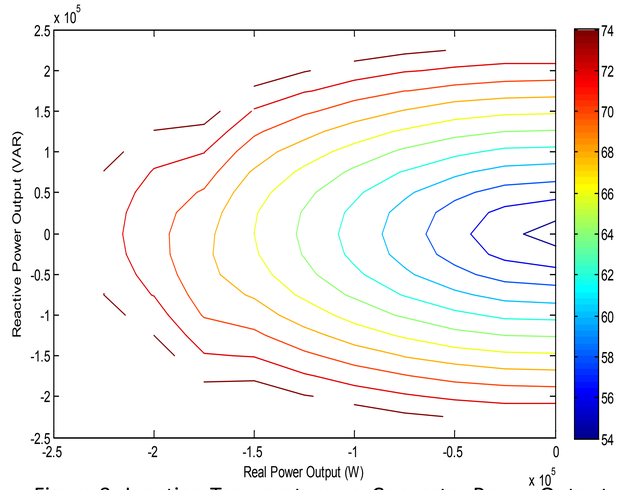

Figure 9: Junction Temperature vs. Converter Power Output

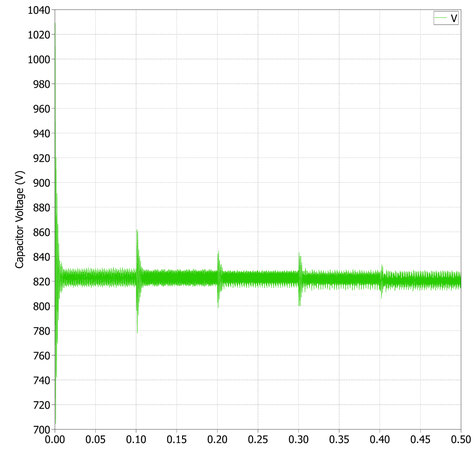

Figure 10: DC-Link Capacitor Ripple in Test Conditions (Fig. 6)

Future Work

- Selection of final converter components/topology
- Improved degradation and reliability analysis
- Assessment of PCS improvement proposals
- Evaluation of the effect of additional value-added functions

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