Modeling and Control of a High-speed Solid-rotor Synchronous Reluctance Flywheel Motor/Generator

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Abstract

For a flywheel energy storage system, a model suitable for use in a vector control algorithm for synchronous reluctance machines with solid rotors is presented. The model takes the rotor flux dynamics into consideration and yields improved performance for a fast-changing torque command compared to the conventional model when utilized in a current regulator.

A hybrid controller, consisting of a model-based feedforward controller and a proportional–integral feedback compensator, for a solid-rotor synchronous reluctance motor/generator is also presented.

The machine current tracking error caused by model inaccuracy is mathematically analyzed and utilized to dynamically compensate the estimated flux linkage. It can be seen that the regulation performance and robustness of the system are improved.

Simulation and experimental results consisting of a flywheel energy storage system validates the performance of the controller.

Bio-sketch

Jae-Do Park received the B.S. and M.S. degrees in electrical engineering from Hanyang University, Seoul, Korea, in 1992 and 1994, respectively, and the Ph.D. degree from The Pennsylvania State University, University Park, in 2007. Since 2004, he has been with Pentadyne Power Corporation, Chatsworth, CA, where he is currently the manager of controls and software. From 1994 to 2001, he was a research engineer with LG Industrial Systems, Anyang, Korea. His current interests are various energy applications including renewable energy, distributed generation, power quality control and energy storage systems. and AC machine drives.