Electric Motor Control with Regenerative Braking

Proposal

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Project Summary

The Electric Motor Control with Regenerative Braking (EMCRB) project will develop a test system to investigate electric vehicular drive systems and regenerative braking. The test system will consist of a three phase permanent magnet synchronous motor, flywheel, and control electronics. Data collected from the test system will be used to develop a model that will establish the efficiency of regenerative braking. An on going Bradley University Mechanical Engineering project will utilize the efficiency data to design an ultra light electric vehicle. A future Bradley University Electrical Engineering project may expand upon the test bench system developed in the EMCRB project.

System Block Diagram

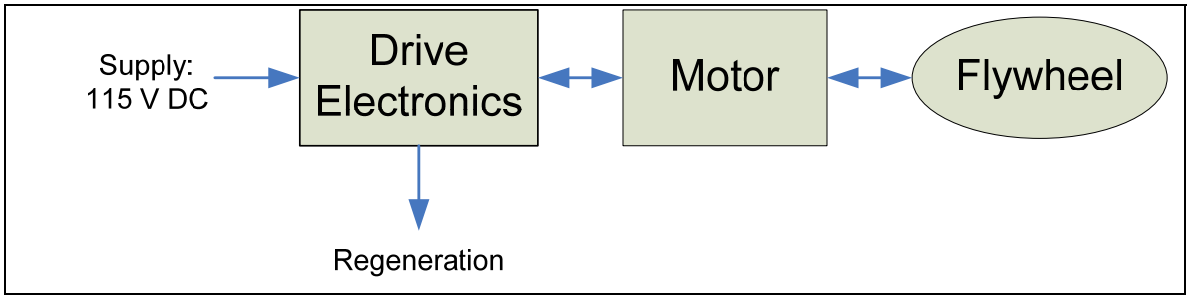

Figure 1: Test Bench Block Diagram

The system motor will initially be powered from a 115 V DC supply and will impart kinetic energy to a flywheel. Once kinetic energy is stored in the flywheel, the motor will be operated as a generator in order to recover electrical energy from the system. The rate and amount of the recovered energy will be used in order to determine the efficiency of the regenerative braking process.

Inputs and Outputs

The system will have a motion control input from a computer that will control the motor. The amount of energy used to run the system will be measured from current and voltage readings.

The output of the system will be the amount of energy that is captured when the motor is operated in regeneration mode. This will be measured through current and voltage. The motor speed and the speed of the shaft will be measured through the computer or from motor calculations.

Functional Requirements

The system must drive a flywheel with a three phase permanent magnet synchronous motor and recover energy from the flywheel by operating the motor as a generator. Since efficiency data must be gathered for the system, the drive electronics must also allow instrumentation to measure energy flow into and out of the motor. Furthermore, the flywheel must be large enough to return a measurable amount of energy during regeneration.

Safety Requirements

All system components must be operated within the manufacturer's recommended operating parameters. In particular, the motor and flywheel must be coupled according to the manufacturer's specifications. All high voltage connections must be routed in a secure and well insulated manner. Appropriate safety apparel must be worn whenever the test bench is operating.

Proposed Test Bench Components

Table 1

Test Bench Parts	
Part Number	**Description**
SGMG-09V2DBC	Yaskawa Synchronous Motor [(1)]
SGDC-10DSA	Yaskawa Servo-pack [(2)]
JUSP-ACP15GD	Yaskawa Converter [(3)]
-	Flywheel

Notes:

1. The SGMG-09V2DBC is a 1500 rpm, 0.85 KW motor with a 24 V DC brake and a position encoder with 8192 pulses/rotation.
2. The SGDC-10DSA is a drive for the motor with a capacity of 1.0 KW. It requires a supply voltage of 400 V, and has velocity and torque control modes of operation.
3. The JUSP-ACP15GD converts 480 V three-phase AC to 400 V DC.

Schedule

Table 2

Weekly Schedule	
Week	**Activity**
Week 1	Test Bench Construction
Week 2	Test Bench Construction
Week 3	Test Bench Construction
Week 4	Test Bench Construction
Week 5	Take Regeneration Data
Week 6	Take Regeneration Data
Week 7	Develop Simulation Model
Week 8	Develop Simulation Model
Week 9	Develop Simulation Model
Week 10	Develop Simulation Model
Week 11	Flex
Week 12	Final Presentation

Work Completed and Project History

The EMCRB project originated from a Bradley University Mechanical engineering senior project. To this end the original purpose of the EMCRB project was to develop a full-scale drive system for an ultra light electric vehicle. The original project scope and goals proved inappropriate due to weight and cost constraints. The project scope and goals progressed through several intermediary forms before settling on its current form. During this process a great deal of general research was completed.

- Researched Synchronous Motors
- Researched Batteries
- Researched Power Conversion
- Researched existing products using regeneration
- Conferred with Bradley University Mechanical Engineering Ultra Light Vehicle team

Conclusion

The EMCRB project will develop a model for regenerative braking. The components listed in Table 1 will comprise the primary components of the test bench that will be used to gather data for this model. This model will be used as a baseline for future regenerative braking projects.

References

Yaskawa. Sigma Series SGM/SGDC User's Manual. Manual No. SIE-S800-22. Japan, January 1999.