

Topic B

Integrated Starter/Alternator-Motor Drive for Automotive Applications

The main purpose of this challenge is to conceptualize, design, and develop a 1 kW, 3000 rpm electromechanical energy converter for operating efficiently (not less than 75% at cruising speed) as a generator and motor. It is also desired to have a (cold) stand still torque of 30 N-m, for duration of 3 to 5 seconds, to accommodate the starter requirement. The motor shall start under an initial load of 30 N-m and reach the speed of 3000 rpm within 3 to 5 seconds. Design should assume the existence of an adequate 200 Volts dc link. Following the startup process, the electromechanical energy converter should quickly and safely become an alternator, charging a set of batteries at cruising speed of 3000 rpm. The desired controller should receive and monitor an stream of data (in analog or digital format) which includes the mode of operation (motoring/generating) along with the desired level of power. The motoring action is assumed as an adjustable speed option ranging from standstill to the cruising velocity. The main objectives are:

- Cost. A target cost of \$100/complete setup (including electric machine and controller) is considered for mass production.
- Safety and fault tolerance. Development of fallback strategies in the event of failures in machine, converter, and sensors are highly encouraged.
- Efficiency. A target efficiency of not less than 75% during motoring and generating (not starting) modes of operation is required.
- Packaging.
- Smoothness in transition from motoring to generating and visa verse. This will be gauged in terms of quickness of the process, absence of mechanical bumps and irregular electromechanical transients.
- Innovativeness in magnetic design and power electronic-based controller.

An adequate dynamometer will be used to apply the necessary torque profiles to the shaft of the machine. Figure 1 illustrates the general configuration of the testbed. As can be seen a dc power supply (200V dc) and a 1 kW, 200V resistor bank will be provided. However, controllable switches for switching from motoring to generating modes of operation are considered as part of test hardware by the competitors.

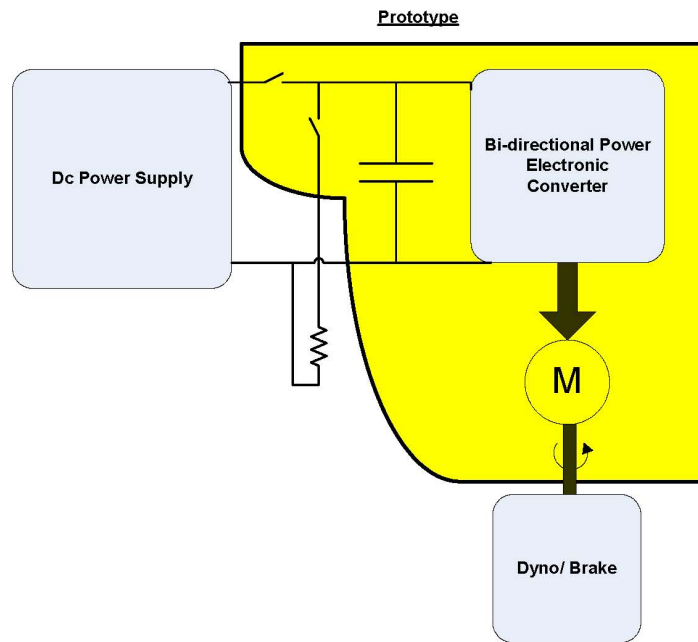


Figure 1: general schematic of the test motor, the highlighted area illustrates the required hardware from competitors

What follows is a summary of requirements for the alternator drive system.

| Design Concept | Requirements |
|----------------------------------|---|
| Manufacturing Cost | Not more than \$100 for machine and controller in a mass produced environment (1Million prototypes per year) |
| Package size | Not to exceed NEMA frame 56 |
| Package Weight | Not to exceed 10kg |
| Output power capability | 1kW at 3000 r.p.m. (motoring or generating) |
| Cold torque capability | 30N-m |
| Input Supply | 200V dc |
| Overall efficiency | Not less than 75% overall efficiency during motoring or generating at 3000 r.p.m. |
| Speed control | Speed should be controllable in motoring mode of operation from standstill to 3000 r.p.m. |
| Safety | The drive system should be safe enough to be used in an automotive environment. Development of fault detection and fault management algorithms will be viewed favorably. |
| Acoustic noise | Low noise during motoring and generating. An acoustic noise less than 60db is encouraged. |
| Electromagnetic noise Protection | It should meet FCC class A requirement. The drive system should be devised with a shut-off button to turn off the entire system safely. It should protect itself from stall conditions, over temperatures. |
| Life time | System should function for at least 10 years. |
| Technical Report | Simulation, experimental results, life time analysis, and cost study. |