Iowa State University
Electrical and Computer Engineering
E E 452. Electric Machines and Power Electronic Drives

Laboratory #15
Design a Motor Drive for an Electric Vehicle

Summary

In this lab you will combine all of your class and laboratory work. You will develop a theoretical EV motor drive. This design will draw upon your knowledge of power electronics, pulse width modulation techniques, system modeling and analysis, MCU based control, and performance measurements and analysis.

Learning objectives

- Develop a detailed plan/procedure for development of an EV drive system.
- Combine knowledge gained in this class, with methods and techniques learned in other classes.

Background material (should be read before coming to the lab)

- All E E 452 notes and lecture material.
- All E E 452 lab experiments and relevant material.
- Krause
- Trzynadlowski

Exercises and Questions

Instructions: every student should deliver his/her own report by Friday, April 27, 2012. This report will take place of in-lab exercises.

1. Project Summary and Expectations

Throughout this class, we have developed DC/DC, AC/DC, and DC/AC power conversion techniques, and have implemented several types of motor drives. We used a number of tools and techniques to aid in system design and analysis, including machine and device modeling and programming applications, oscilloscopes with different voltage/current probes for data capture and analysis, signal generators, static loads, dynamometers, etc. Use the tools and techniques you have learned to move through this project.

Develop a plan for designing, implementing, and analyzing a complete motor drive system for an electric vehicle application. Compile reference materials to aid in the design, such as machine equations, test procedures or compliance standards, etc. Do not worry about the mechanical design, focus on the motor drive and power electronics.

Document your plan using MS Word. Include as much detail as possible. You should be able to use this plan as a design reference in the future. Include block diagrams, figures, tables, equations, etc. Anything that you feel is necessary and/or relevant should be documented. Warrant any assumption you make.

You may want to do the following:

1) Research currently available ACI machines for EV applications, or find a different type of machine. Explain why you chose this machine. What is it about this machine that you find desirable in an EV drive system?

2) Develop diagrams to show the main components of the vehicle and motor drive. Expand any main components, and include more detailed diagrams, circuits, etc.

3) Include part numbers of possible converter components. Will you use an "intelligent power module" or will you construct an inverter from discrete components? Maybe you will consider using system level components if you find that another manufacturer's solution is suitable for your application.

4) Include reference material which will show the details of motor drive or vehicle operation. Which converter topology will you use? How will the machine be controlled? What language/software will be used to do the programming? Will the power waveform require modulation? If so, what modulation scheme will you implement? Additional details may be necessary.

5) Consider on-board battery charging with DC/DC converters, or an external charge station. Will you design your own charger, or will you use a third party device? What battery chemistry is desirable? Will you use a constant-current followed by constant-voltage charge scheme, as used in some Li-ion chargers, or does your battery chemistry require a different scheme?

6) Describe how you will use modeling software to simulate and validate your EV drive before construction begins. What will you simulate, and what are you looking to achieve via simulation? Will you need to measure machine parameters before conducting detailed simulations? Include any diagrams that may be relevant or resourceful.

7) Consider the cost of the drive and vehicle. How can you economically justify your decisions? Will you conduct a cost/revenue analysis? Provide details.

2. Deliverable

This project is open-ended, and takes place of the normal in-class lab assignment. You should dedicate at least several hours to this project. To save time, re-use work you have done earlier in the semester (for any relevant equations, diagrams, plots, etc).

You may explore the details of the EV as you wish. If you have particular interests in batteries, you can focus on battery management (with a focus on power electronics). If your interests are geared toward vehicle control and system analysis, you can provide more detail on these topics. Perhaps your specialty is embedded control systems, or machine design. If you are a hardware expert, focus more on that.

No matter which direction you choose, you must include material you learned in this class. Everything we have done is related to an electric vehicle drive in some way. It is up to you to put the pieces together as you see fit, to form a coherent, relatively detailed plan.

The deliverable for this lab is a 3-6 page document, in a format of your liking. A *complete* document will treat the EV system as a whole, and provide insightful detail regarding one or more subsystems. Consider this document a compilation of relevant material, of which you can refer to in your future ventures.

Email this document to your T.A. before finals week. Late submissions will receive zero credit.