

## ECE483 PROJECT (DUE APRIL 29)

### Design of a Power Supply for a Car

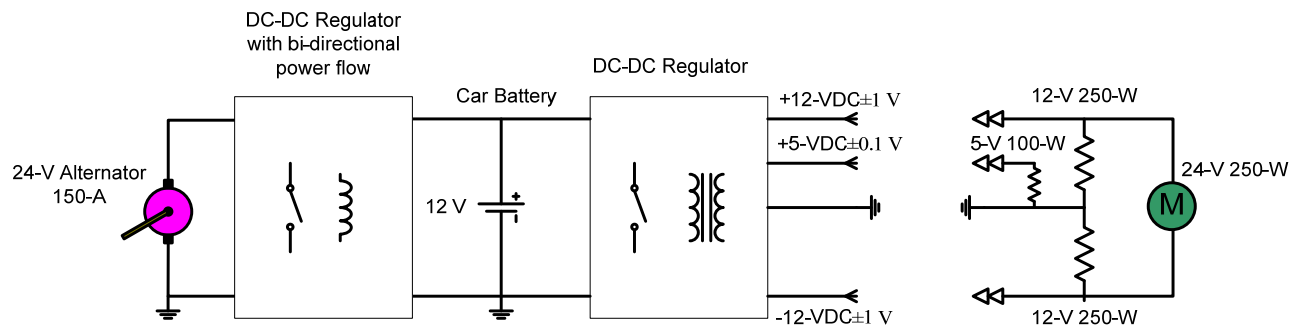
Design a DC-DC switched mode power supply for a car. The power source is a 24-V DC alternator through a 12-V battery. The load consists of a 24-V motor load, 12-V loads including other smaller motors, lights, radio, etc, and 5-V electronic loads. The maximum demand for each load group is shown in the figure.

The output specifications of the supply are as follows:

Output 12-VDC, regulation (tolerance including ripple):  $\pm 1$  V;

Output -12-VDC, regulation:  $\pm 1$  V;

Output 5-VDC, regulation:  $\pm 0.1$  V.



The supply operates in two modes:

(a) start-up mode: the battery supplies the alternator at a 150-A demand;

(b) normal mode: the alternator supplies the load power and the battery charge (trickle charging current is 2 A).

#### Conceptual Design:

- Design the above supply using a suitable topology for the switched mode regulators. Use MOSFETs and diodes as power switches.
- Assume that the saturation voltage of the MOSFET is 1.2 V, the forward voltage of a diode is 0.7 V, and the maximum switching frequency of the MOSFET is 10 kHz.

#### Calculation (draw graphs and provide explanation):

- Calculate the required sizes of capacitors, inductors and transformers.
- Calculate the peak, average and rms current of the power MOSFETs and diodes in the normal operating mode.
- Calculate the peak, average and rms current of the power MOSFETs and diodes in the start-up mode.

- Calculate the voltage and current ratings of the power MOSFETs and diodes.
- Calculate the efficiency of the above supply in the normal mode.

#### Simulation:

- Simulate the above supply in SIMULINK. (You may use appropriately sized resistors to represent the loads. Also use a dc source to represent both the battery and the alternator. For coupled coils or transformers, assume negligible resistance and a 0.996 coupling coefficient between coils [i.e. leakage inductance will be 0.004 times the core inductance.]
- Design and simulate a close-loop control system for the power supply (an elementary control and logic system will suffice to represent the basic operations of the supply). Tune the controller parameters by trial and error.
- Demonstrate the supply operation in both start-up and normal modes. Provide plots of the supply response.

#### Report (Due date is April 29):

- The document must be typed (single line spacing, 12 size font).
- The document, including figures and equations, must not be shorter than 4 pages and longer than 6 pages.
- Submit the digital version of the report, the SIMULINK file, and any m-files that you used via email ([hatz@siu.edu](mailto:hatz@siu.edu)). The document must be in pdf or MS-WORD format. Include annotations in the SIMULINK and m-files. No hard copy submissions.