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E-design 344 Assignment #2

2021

Objectives

- Set up and test the power supplies.
- Design, simulate, implement, and test the charging circuit.
- Do a thermal analysis of the charging circuit.
- Commit all the circuits to version control.
- Write and submit a short report using the template and commit the source files to version control.
- Make and submit a 30 second video to demonstrate key features of the design.

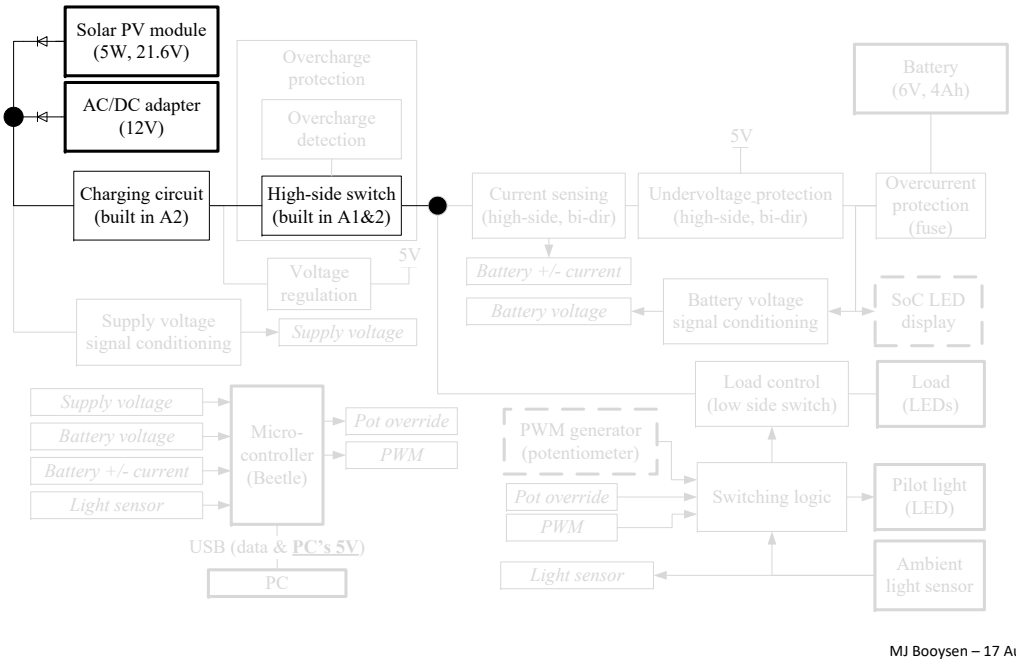

Figure 1: Your progress so far and what you are building for A3.

Deliverables and checklists

1. Submit your schematic as an `ASC` file and `RAW` files to `https://learn.sun.ac.za` for assessment. Ensure that you do/include the following:

   - ☐ Add your name and student number to the schematic.
   - ☐ Make the filenames student number and the assignment number, e.g.: `E344_12345678_A2.ASC` and `E344_12345678_A2.RAW`.
   - ☐ Do not change anything in the block, since it is used for the assessment.
   - ☐ Do not use multiple labels for a single net

2. Submit your report as a `PDF` file to `https://learn.sun.ac.za` for assessment.Ensure that you do/include the following:

   - ☐ Add your name and student number to the report, and sign the plagiarism declaration.
   - ☐ Be sure to include literature, design rationale and calculations, simulations, test results and requisite appendices in the report.
   - ☐ Make the filename your Surname, student number and the assignment number, e.g.: `Surname_12345678_A2.PDF`.
   - ☐ Keep the structure and format supplied in the template – only add and remove content.
   - ☐ Strictly keep to the following maximum page limits.
     - Literature: 2 pages
     - Design (regulator, switch, thermal): 4 pages
     - Results: 2 pages.
   - ☐ All numbers in figures must be clearly legible.
   - ☐ Each figure must have a descriptive caption and each figure must be referenced in the text.
   - ☐ Screen grab of your version control E344 folder on GitHub as an appendix.

3. Submit your thirty-second video to `https://learn.sun.ac.za` for assessment. Be sure to capture the following in an uninterrupted sequence (i.e. continuous flow of video). Note that there may be overlap in the information in the video and the report.

   - ☐ A clear close-up of your student card.
   - ☐ A clear close-up of your PCB with the barcode & number.
   - ☐ A clear close-up of a multimeter ~~and/or oscilloscope~~ showing the charging voltage ~~and current~~ under the following three conditions. Note that the AC-DC PSU should be connected to the DC input of your charger when presenting these readings.
     - Open circuit (not connected to a load).
     - ~~Connected to a power supply set to 6V power supply~~ With an 1 kΩ load[1].
     - ~~Connected to a power supply set to 7.2V power supply~~ With an 10 kΩ load.

4. Complete the online test at `https://learn.sun.ac.za`.

[1] You should be able to feel it get warm

1 Instructions

1.1 Charging circuit

The objective of this section is to design, simulate, build and test (in that order) a charging circuit. The circuit will draw power from either the DC power supply or the solar PV module, and regulate the output voltage. The output voltage will depend on the state of charge of the battery that is to be charged, such that the charging current will not exceed the battery's maximum charging current (when depleted) and the charging voltage will not exceed the battery's maximum charging voltage (when fully charged). Remember, this circuit will have to connect to the rest of the system indicated in the Project Overview, so you may want to leave connection points to simplify addition later on – for example, use jumpers where you may later connect current sense resistors or link up with the battery and load switch. *Hint: Take into account that the diode that blocks the leakage current from the battery has a voltage drop when developing the regulator.*
Note, the charging circuit will not have a "constant current" period as more complex chargers, but rather the current will be inversely proportional to the battery state of (SoC).

Develop a charging circuit for the battery (and supply for the rest of the circuit) that will meet the following requirements:

- The charging circuit will be powered from either the solar module or the DC power supply.
- The output voltage shall be equal to the battery's voltage when fully charged.
- The output current shall be limited such that the current when charging a fully depleted battery is limited such that the current level does not damage the battery.
- The charging regulator shall not exceed its temperature limitations under any input-output condition.
- ~~The charging circuit must be turned on/off using a high-side switch with a digital signal (5 V)~~
- The circuit must enable or disable charging by controlling the line between the regulator and the battery by means of a 0 to 5 V control signal.
- The charging circuit must prevent discharging of the battery when no or insufficient supply is connected.
- ~~The charging circuit should also be capable of supplying 5 V to the rest of the circuit (for later use)~~.

Document your design, circuit design, simulation results, physical implementation and actual test results.