ECE 445
Solar Powered Street Light (with USB capability)

Mock Design Review

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Group 75
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T.A.: Katherine
1. Block Diagram

- Power Module
  - Batteries
  - Battery Charger
  - Solar Panel

- Control Module
  - Non-Inverting Amplifier
  - Arduino Microcontroller

- Output
  - USB Ports
  - LED Streetlight
2. Circuit Schematic

R4, R6 and R8 represent the loads (LED street light, USB outlet and the Arduino board)

3. Calculation

a) The following will be our voltage, current, and power requirements for our project:

<table>
<thead>
<tr>
<th></th>
<th>Voltage</th>
<th>Current</th>
<th>Total Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED Streetlight</td>
<td>6V</td>
<td>0.1666A</td>
<td>1W</td>
</tr>
<tr>
<td>USB Outlet</td>
<td>4.5V</td>
<td>0.55A</td>
<td>2.5W</td>
</tr>
<tr>
<td>Arduino</td>
<td>5V</td>
<td>0.040A (per pin)</td>
<td>0.5 W (per pin)</td>
</tr>
</tbody>
</table>

This is the rated power for all our devices.

b) The solar panel that we have decided to use is 12V, with 20W, and current 1.667A.

c) We will be using a non-inverting amplifier, the circuit of which has been shown above.

\[ V_{out} = (1 + \frac{R_2}{R_1}) \cdot V_{in} \]

\[ \Rightarrow \frac{16}{12} = (1 + \frac{R_2}{R_1}) \]

\[ \Rightarrow 1\frac{2}{3} = 1 + \frac{R_2}{R_1} \]

\[ \Rightarrow \frac{1}{3} = \frac{R_2}{R_1} \]

\[ \Rightarrow R_2 = 10 \text{ ohms, } R_1 = 30 \text{ ohms} \]

\[ i = \frac{V_{in}}{R_2} = \frac{12}{10} = 1.2 \text{ Amps} \]
4. Plot (simulation)

This is the AC sweep of the 12V battery input. An AC sweep was used to accommodate the use of SPICE.

This is the amplified output. As seen, the voltage has been updated to around 16V.
This is the voltage drop for the load of the streetlight. As seen, the 6V is provided for usage. The 36Ω resistance ensures a 0.1666 Amp current and 1W power rating.

This is the voltage drop for the load of the USB charger. As seen, the 4.5V is provided for usage. The 8.182Ω resistance ensures a 0.55 Amp current and a 2.5W power rating.
This is the voltage drop for the Arduino Uno. The resistance is 8.92857Ω.

5. Block Description for one module from the block diagram

Power Module:

Our power module consists of batteries, a battery charger, and a solar panel. The main aspect of importance in the power module is to generate electricity. We will have to ensure that the solar panel is generating enough power in order to power the three devices: the LED streetlight, the Arduino, and the USB port. As calculated above, the LED street light’s rated power is 1W, the USB port’s rated power is 2.5W, and the Arduino’s rated power is 0.5W (per pin). This has been taken into account while choosing our solar panel, which is rated 12V, 20W, and 1.6667A. In the other component of this module, the batteries will be charged through a battery charging circuit.
6. Requirements and Verification for one module from the block diagram

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Verification</th>
<th>No. of Points</th>
</tr>
</thead>
</table>
| 1) Rechargeable batteries charged by the solar panel                         | 1) Discharge the battery completely.  
2) Using a multimeter, measure the time it takes to charge $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ and the full capacity of the battery. This will give an expectation of the time it takes to measure full charge and whether this is reasonable. | 5             |
| 2) Solar panel to make sure it provides enough power for the LED light.      | 1) Test the solar panel outside on a bright and sunny day to get proper measurements.  
2) Use a multimeter to measure the voltage  
3) Build a circuit powered with rechargeable batteries and see the results of this circuit out in the sunlight;  
4) Test once with the panels receiving sunlight and once with the panels not receiving sunlight. | 15            |
| Solar panel:                    | Voltage: 12 V  
Power: 20 W  
Current: 1.6667 A |                                               |               |
7. **Safety Statement**

Firstly, our solar panel will be mounted and will be programmed to move back and forth according to the amount of sunlight it receives. We will be using a motor and other mechanical parts in order to achieve this, so care should be taken to stay a safe distance away from the motor and mechanical parts, so that the solar panel’s movement is not affected. We must also be careful with the battery charger and the batteries. The following regular lab precautions must be taken into consideration:

1) Do not bring food or drinks into the lab
2) Always work in pairs in the lab; try not to work alone
3) Don’t overload the circuits
4) Always turn off the power in your circuit before inspecting it
5) Do not touch open wires while power is still turned on
6) Do not change the wiring in your circuit while the power is still turned on; turn it off first
7) If you see any damaged equipment in the lab, report to the lab teaching assistant
8) Make sure the circuits are properly grounded
8) References

[1] “Common Source Amplifier” Internet: 
http://whites.sdsmt.edu/classes/ee320/notes/320Lecture31.pdf [Feb 17, 2016]


Internet: http://users.ece.gatech.edu/mleach/ece3050/notes/mosfet/csamp.pdf [Feb 17, 2016]

[4] “ECE 342 Electronic Circuits” Internet:
https://courses.engr.illinois.edu/ece342/outline.html“ [Feb 17, 2016]

[5] “MOSFET Common Drain Amplifier” Internet:.
http://whites.sdsmt.edu/classes/ee320/notes/320Lecture36.pdf [Feb 17, 2016]

[6] “Operational Amplifier Circuits” Internet:
http://webpages.ursinus.edu/lriley/ref/circuits/node5.html [Feb 17, 2016]