Longboard-o-Meter
Mock Design Review
ECE 445

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1.0 Block Diagram

Key
- Red: Power
- Gray: Data (1 bit)
- Black: Data (4 bit SPI)

Power Supply
- Battery
- Flyback Converter

Dynamo

Hall effect sensor

Gyroscope

FPGA

Display

Connections:
- 4V from Power Supply to Hall effect sensor
- 1.2V from Power Supply to FPGA
- 3.1V from Power Supply to Display
2.0 One Circuit Diagram

Three Output Flyback Converter

\[ V_1 = \frac{N_2}{N_1} \frac{D}{1-D} V_{in} \]

\[ V_2 = \frac{N_3}{N_1} \frac{D}{1-D} V_{in} \]

\[ V_3 = \frac{N_4}{N_1} \frac{D}{1-D} V_{in} \]

\( N_1 = \# \text{ of turns of L1} \quad N_3 = \# \text{ of turns of L3} \)

\( N_2 = \# \text{ of turns of L2} \quad N_4 = \# \text{ of turns of L4} \)

\( D = \text{Duty cycle of switch} \)
3.0 Block Description

FPGA

The FPGA will receive data from the sensors and output them to the display. It will count the cycles received in the input from the hall effect sensor over a fixed time interval (measured by its internal clock). At the end of the interval, it will multiply the count (representing wheel revolutions) by a constant value to convert the value to miles per hour. Every interval it will also poll the gyroscope for the incline data and receive it via SPI digital interface across 4 (1.5V low, 3V high) pins. Finally, when it has the values for speed and incline, it will convert them from binary to a decimal representation. It will output the final values to the display via a 4-pin SPI digital interface.

4.0 Calculation

The FPGA will calculate the board’s speed with the following equation:

\[ v = \frac{\text{distance}}{\text{time}} = h \cdot \frac{w}{c/f} \cdot 2.237 \]

\[ v = \text{speed of the board (mph)} \]
\[ h = \text{number of cycles from the hall effect sensor} \]
\[ w = \text{wheel circumference (m)} \]
\[ c = \text{number of clock cycles} \]
\[ f = \text{clock frequency (Hz)} \]

2.237 = conversion from m/s to mph

We measured the wheel circumference as 0.21m. If we consider the FPGA clock speed of 33MHz and set \( c \) to 8192 (countable with 13 bits), we can make the screen update about 4 (33000/8192=4.028) times per second. Every 8192 cycles the FPGA will multiply the number of wheel rotations by the constant \( \frac{w}{c/f} \cdot 2.237 \) to calculate the speed of the board. With our current parameters, the constant is:

\[ \frac{0.21 \text{ meters}}{8192/33,000 \text{ hertz}} \cdot 2.237 \text{ miles/second} = 1.89 \text{ miles/hour} \]

We will determine the best digital representation for this constant when we have finalized all of the parts of our design.
5.0 Plot

Flyback Converter Output Voltage Simulation

Red - 3.96±0.15 volts
Green - 2.95±0.10 volts
Blue - 1.33±0.17 volts
## 6.0 Requirements and Verifications

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Supply</strong></td>
<td>1) Measure output voltage from flyback converter. Verify that it supplies $4\pm0.25V$ with an electronic load.</td>
</tr>
<tr>
<td>1) Must supply $4\pm0.25V$ to hall effect sensor.</td>
<td>2) Measure output voltage from flyback converter. Verify that it supplies $1.2\pm0.05V$ with an electronic load.</td>
</tr>
<tr>
<td>2) Must supply $1.2\pm0.05V$ to microcontroller.</td>
<td>3) Measure output voltage from flyback converter. Verify that it supplies $2.6\pm0.9V$ with an electronic load.</td>
</tr>
<tr>
<td>3) Must supply $2.6\pm0.9V$ to gyroscope.</td>
<td>4) Measure output voltage from flyback converter. Verify that it supplies $3.15\pm0.15V$ with an electronic load.</td>
</tr>
<tr>
<td>4) Must supply $3.15\pm0.15V$ to display.</td>
<td>5) Use dynamo to recharge battery and verify power flow with a multimeter.</td>
</tr>
<tr>
<td>5) Dynamo must recharge battery while longboard is in motion.</td>
<td></td>
</tr>
</tbody>
</table>

### Points

| Points | 20 |

## 7.0 Safety Statement

We acknowledge all the risks that we may encounter while working on this project. We understand that safety comes before everything else and we will take the proper precautions when working with power supplies, soldering irons, and other electronic equipment. We understand that there must be at least two people working in the lab at any time. In case of an emergency, we will follow all protocol and notify the authorities immediately.
8.0 Citations


“DOGM GRAPHIC SERIES.” Electronic Assembly. Web.
<http://www.lcd-module.de/eng/pdf/grafik/dogm128e.pdf>