High Altitude Balloon

Power Bus Development Team

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Faculty Advisors

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• Joseph Slater
• Bruce Rahn (Mentor)
Introduction to HIBAL Design

• What is HIBAL?
  – Dedicated to the exploration of near space for scientific and educational purposes
  – Undergraduate and Graduate Students
  – Multidisciplinary projects
Objective

• Design a universal power bus that replaces multiple power sources
  – Reduce weight
  – Space (physical access)
  – Providing power for 5 to 8 hours

• Research alternate power source
  – Solar panels
  – Secondary power supply
Specifications for Centralized Power Bus Battery Design

- Light weight (two boxes, 12 lb limit)
- Small size (area inside box is limited)
- Temperature sensitive (0° C at 85 K ft.)
- Rechargeable
- Power all components for 5 hours
### Centralized Power Bus Battery Design (8 hrs)

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Voltage (V)</th>
<th>Input Current (A)</th>
<th>Power Consumption (Watts)</th>
<th>Amp Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin GPS model</td>
<td>5.4</td>
<td>0.085</td>
<td>2.805 - 4.59</td>
<td>0.85</td>
</tr>
<tr>
<td>GPS15L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garmin GPS 25-lvs</td>
<td>6</td>
<td>0.12</td>
<td>0.432 - 0.72</td>
<td>1.2</td>
</tr>
<tr>
<td>Microtrak 300</td>
<td>9</td>
<td>0.18</td>
<td>1.62</td>
<td>1.18</td>
</tr>
<tr>
<td>Basic Stamp Version 2.2</td>
<td>9</td>
<td>0.5</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Servo</td>
<td>12</td>
<td>0.01859</td>
<td>0.26</td>
<td>0.12</td>
</tr>
<tr>
<td>Cutter</td>
<td>14</td>
<td>0.085</td>
<td>0.459</td>
<td>0.85</td>
</tr>
<tr>
<td>3rd gps</td>
<td>3.3</td>
<td>0.085</td>
<td>2.805 - 4.59</td>
<td>0.85</td>
</tr>
</tbody>
</table>

**Total Power Required:** 35 Watts

**Total Amp Hours:** 10.05 Ah
Centralized Power Bus Battery Design (5 hrs)

<table>
<thead>
<tr>
<th>Garmin GPS model number</th>
<th>Input Voltage Max (V)</th>
<th>Input Current (A) Nominal</th>
<th>Power Consumption (Watts)</th>
<th>Amp Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS15L</td>
<td>5.4</td>
<td>0.085</td>
<td>2.805 - 4.59</td>
<td>0.53</td>
</tr>
<tr>
<td>Garmin GPS 25-lvs</td>
<td>6</td>
<td>0.12</td>
<td>0.432 - .72</td>
<td>0.75</td>
</tr>
<tr>
<td>Microtrak 300</td>
<td>9</td>
<td>0.18</td>
<td>1.62</td>
<td>1.13</td>
</tr>
<tr>
<td>Basic Stamp Version 2.2</td>
<td>9</td>
<td>0.5</td>
<td>27</td>
<td>3.13</td>
</tr>
<tr>
<td>Servo</td>
<td>12</td>
<td>0.01859</td>
<td>0.26</td>
<td>0.12</td>
</tr>
<tr>
<td>Cutter</td>
<td>14</td>
<td>0.085</td>
<td>0.459</td>
<td>0.53</td>
</tr>
<tr>
<td>3rd gps</td>
<td>3.3</td>
<td>0.085</td>
<td>2.805-4.59</td>
<td>0.53</td>
</tr>
</tbody>
</table>

| Total Power Required    | 35 Watts              | Total Amp Hours           | 6.72 Ah                   |


Nickel Cadmium Battery
14.4 V – 4 Ah - 37 W

- Weight (4.1 lbs)
- Size (7.56") x (2.4") x (2.6")
- Contains memory effect
- Higher cost than average
- Temperature range (-40° C to +70° C)
- Stronger, less likely to damage
- Rechargeable
Nickel-Metal Hydride Battery

14.4 V – 10 Ah – 144 W

- Weight (4.6 lbs)
- Size (7.8” x 2.3” x 2.2”)
- Contains memory effect
- Higher cost than nickel cadmium
- Temperature range (-5° C to +70° C)
- Stronger, less likely to damage
- Rechargeable
Lithium-Ion Battery
14.8V – 7 Ah -95 W

- Light weight (1.1 lbs)
- Rechargeable
- Small size (7.0" L x 2.2" W x 1.2" H)
- Low internal impedance
- Temperature range (-40° C to +80° C)
- If battery completely discharges, it’s ruined
- No memory effect (charge at any time)
- Higher cost than nickel-cadmium
Problem: Voltage Conversion

- Power requirements
  - Voltage
  - Current
- Power Bus needs to power all systems
Our solution

- Voltage Regulators
- DC to DC voltage converters
  - Micro-converters
  - Step-up voltage converter
  - Step-down voltage converters
- Several Batteries connected in series
DC Converter

• A DC to DC converter is a circuit which converts a source of direct Current from one voltage to another.
  – Class of Power Converter
• Step-up: Outputs a voltage higher than input
• Step-down: Outputs a voltage lower than input
Model Information

• If input to output isolation is needed, model D112E
  – Has unregulated output

• With Unregulated units the output voltage will vary with change in output load and/or input voltage

• For input to output isolation and regulated output, model SR7805-05W
DC-DC converters

- LM2621 – Low input voltage
  - Step up DC-DC
  - 1.09 mm Package Height
  - 1.2V to 14V Input Voltage
  - 1.24V - 14V Adjustable Output Voltage
  - Up to 90% Regulator Efficiency
LM2621 Typical Application
LM25574

- LM25574 – Step Down Regulator
  - Integrated 42V, 750 mΩ N-Channel Mosfet
  - Wide input voltage range from 6V to 42V
  - Adjustable output voltage as low as 1.225V
SR7805 Miniature Regulator

- **SR7805-09W**
  - To power 9V Units
  - Output Current 500mA
  - Input V Range 11-32V
  - Regulated Output.
  - Greater Efficiency and wide input voltage range
D111ER DC/DC Converter

- Regulated output Voltage
- Input Voltage Range
  - 11.4-12.6 V
- Output Voltage/Current
  - 5V
  - 150mA
<table>
<thead>
<tr>
<th>MN:</th>
<th>Vin (Min)</th>
<th>Vin(Max)</th>
<th>Input Current (Amps)</th>
<th>Power Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garmin GPS GPS15L</td>
<td>3.3</td>
<td>5.4</td>
<td>0.085</td>
<td>2.805-4.59</td>
</tr>
<tr>
<td>Garmin GPS GPS15L</td>
<td>3.3</td>
<td>5.4</td>
<td>0.085</td>
<td>2.805-4.59</td>
</tr>
<tr>
<td>Garmin GPS 25-lvs</td>
<td>3.6</td>
<td>6.0</td>
<td>0.12</td>
<td>0.432-0.72</td>
</tr>
<tr>
<td>Microtrak 300</td>
<td>9.0</td>
<td>15.0</td>
<td>0.18</td>
<td>1.62-2.7</td>
</tr>
<tr>
<td>Basic Stamp v2.2</td>
<td>5.0</td>
<td>15.0</td>
<td>0.003</td>
<td>0.015-0.045</td>
</tr>
<tr>
<td>Servo</td>
<td>12.0</td>
<td>12.0</td>
<td>0.5</td>
<td>6.0</td>
</tr>
<tr>
<td>Cutter</td>
<td>12.0</td>
<td>14.0</td>
<td>.02</td>
<td>0.24-0.28</td>
</tr>
<tr>
<td>Model Number</td>
<td>Weight (Oz)</td>
<td>Current Power Source (mA)</td>
<td>Current Weight of Power Source</td>
<td>Mission Criticallity</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>---------------------------</td>
<td>-------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Garmin GPS GPS15L</td>
<td>0.5</td>
<td>3 AA battery 4.5V</td>
<td>0.276 lb</td>
<td>High</td>
</tr>
<tr>
<td>Garmin GPS GPS15L</td>
<td>0.5</td>
<td>3 AA battery 4.5V</td>
<td>0.276 lb</td>
<td>High</td>
</tr>
<tr>
<td>Garmin GPS 25-lvs</td>
<td>1.3</td>
<td>4 AA battery 6V</td>
<td>0.150 lb</td>
<td>High</td>
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<tr>
<td>Basic Stamp v2.2</td>
<td>1.85</td>
<td>9V</td>
<td>0.080 lb</td>
<td>High</td>
</tr>
<tr>
<td>Microtrak 300</td>
<td>1.15</td>
<td>9V</td>
<td>0.080 lb</td>
<td>Medium</td>
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<tr>
<td>Servo</td>
<td>1.25</td>
<td></td>
<td>0.078 lb</td>
<td>Low</td>
</tr>
<tr>
<td>Cutter</td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
</tbody>
</table>
Tasks

• Approval of design
• Advisors approval to order parts
• Start testing
• Debugging systems for maximum efficiency
• Final report
Conclusion

- HIBAL – What is HIBAL?
- Our main objective and solution
  - Centralized Power bus system
- Battery
- Micro-converters, voltage converters
Contact Information

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– ANY QUESTIONS?