LPARD Power Analysis per R011

Date: 3/13/12
Engineer: Edward Epple III

This document outlines and analyzes the power requirements of the LPARD system on both the shore and boat sides. Included are power budgets for the system’s components and power flow diagrams.

Proposal: AC power mode, or “maintenance mode”, will be designed and implemented, while power input independence will be analyzed and specified for future years’ design teams. It is assumed that the specified boat motors will not be operational during AC power mode.

Shore Power Budget
Note: The shore-side Xbee draws power from the specified shore laptop.

The following chart outlines the power requirements for the subsystems of the shore station and contains maximum or worst-case values:

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage(V)</th>
<th>Current(A)</th>
<th>Power(watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ/EL Positioner</td>
<td>18</td>
<td>1.00</td>
<td>18.0</td>
</tr>
<tr>
<td>Ultrasonic Range Shore</td>
<td>18</td>
<td>0.01</td>
<td>0.18</td>
</tr>
<tr>
<td>IR Angle Shore</td>
<td>18</td>
<td>0.02</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Boat Power Budget
Note: GPS, magnetometer, Xbee, Xbee shield, and IMU shield all draw power from the ardupilot.

The following chart outlines the power requirements for the subsystems of the boat:

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage(V)</th>
<th>Current(A)</th>
<th>Power(watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ardupilot</td>
<td>5.0</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>GPS</td>
<td>3.3</td>
<td>0.048</td>
<td>0.1584</td>
</tr>
<tr>
<td>Magnetometer</td>
<td>2.5</td>
<td>0.0001</td>
<td>0.00025</td>
</tr>
<tr>
<td>Visual Beacon</td>
<td>5.0</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Audio Beacon</td>
<td>18</td>
<td>0.01</td>
<td>0.18</td>
</tr>
<tr>
<td>Arduino Uno</td>
<td>9.0</td>
<td>1.0</td>
<td>9.0</td>
</tr>
</tbody>
</table>
**Shore Power Flow**

Below is the top-most level diagram for shore power, which covers both the implementation and power input independence specification aspects of the design. Differentiation of implementation and power input independence specification takes place in the A1 station box and will be shown in further diagrams.
Shore Power Flow (Implementation)

For implementation, we will provide power through the AC mains, in a permanent "maintenance mode" state. In this state tracking and data fusion is still possible, though motors will not be functional and the system should not move. Design for possible shore power input independence will be specified in the next section. Below are the diagrams of the power flow diagram and the corresponding A1 Station box based on the design implementation.
Shore Power Flow (Power Input Independence Spec)

This is a possible design for power input independence on the shore side, which will include batteries as well as a jack for an AC adapter. In this way, the system can operate temporarily on battery power. A switch will exist to route either battery or AC power, depending on the situation. It would then require only a flip of a switch to change between modes. Flipping the switch to the AC side will activate "maintenance mode", in which the boat could be operated for extended periods of time without draining the batteries. A possible top level shore system diagram and shore power flow diagram are below.
Shore Power Flow
Power Input Independence

Wall Power 120VAC → Wall Adapter (Vout = 18 V; Imax = 2.7 A) → Batteries ~18V

Maintenance Switch → P&D Interface → Expansion Board

~1A 18V

Sensor Board

AZ/EL Positioner (18V; 1A)

5V 18V
**Boat Power Flow (Implementation)**

For implementation, we will provide power through the AC mains. Design for possible boat power input independence will be specified in the next section. Below are the diagrams of the power flow diagram and the corresponding boat top-level diagram based on the design implementation. LM317s are included in the design to provide the additional voltages needed by the boat system.
Boat Power Flow (Implementation) (continued)

Beacon-Power PCB contains voltage regulators, an Arduino Uno, and the audio/visual beacons.
**Boat Power Flow (Power Input Independence Spec)**
Again, it is assumed that the batteries for the motor are separate, and not included in the design for power input independence of the rest of the boat. A possible top level boat system diagram and boat power flow diagram are below.
Boat Power Flow (Power Input Independence Spec) (continued)
The “Power” block contains a maintenance power switch, batteries for the motor, and batteries for the rest of the boat. Again, this is a possible design for future implementation.