Front End Board & Back End Board QA Testing:

The front end board consists of two separate sections, an ultrasound section and an infrared section. For the transmission part of the ultrasound, we just needed to test the connection was correct from the back end source since only the transducer is on the front end board and none of the driving circuitry (Test01). Next we needed to test the front end receiver circuitry to ensure the gains and frequency response was acceptable (Test02).

Test01:

Procedure: Using pins 5 and 7 on Interface A, which feed to the two terminals of the transmitter, we attached a 20Vpp square wave at 40 kHz using a function generator. In order to pass the test, we simply needed to ensure that the terminal transmitter receives the provided signal. Figure 1 shows that the backend signal correctly gets to the transmitter. Figure 2 shows a received signal that is directly in front of the transmitter, proving that the transmitter transmits.

Specifications: Provided transmission signal from the backend board correctly gets to the transmitter and is transmitted.

Results:

Board #1,2,3: Boards 1-3 all connected correctly and produced the following results. No differences between them, so same picture used as reference.

20Vpp input correctly shows up on input of transmitter (shown at 5V/div)

Figure 1
**Board #1,2,3:** Boards 1-3 all transmitted the provided signal, and a receiver placed directly in front of the transmitter produced the provided signal as shown in Figure 2

Nearly 20 Vpp signal shown on receiver directly in front of transmitter at 40 kHz.

![Figure 2](image)

Pass/Fail: PASS (all three boards)

Signature: 

Date/Time: 4-27-2012, 12:10 AM

**Test02:**

**Procedure:** We placed a transmitter hooked up to a function generator applying 20 Vpp directly against the board’s receiver. With an oscilloscope measuring the voltage across the receiver, we adjusted the transmission frequency from 37 kHz to 43 kHz in increments on 500 Hz. The results of this are shown in figures 3a, 3b, and 3c. We then applied 250 mVpp across the transmitter and measured the amplified signal that is sent to the backend board. The results of this are shown in figures 4a, 4b, and 4c.

**Specifications:** Frontend board is able to amplify the input signal at a 40 kHz input range and an understanding of the frequency response of the receiver is gained.
**Results:**

Board #1:

**Received Signal vs. Frequency**

![Graph showing received signal vs. frequency](image1)

Figure 3a

**Amplified Signal vs. Frequency**

![Graph showing amplified signal vs. frequency](image2)

Figure 4a
Board #2:

**Figure 3b**

**Received Signal vs. Frequency**

![Graph showing the received signal vs. frequency with peak around 40 kHz.]

**Figure 4b**

**Amplified Signal vs. Frequency**

![Graph showing the amplified signal vs. frequency with a peak around 40 kHz.]

Board #3:
Boat Board:

**Figure 3c**

**Received Signal vs. Frequency**

- Frequency (kHz) vs. Received Signal/Input Signal

**Figure 4c**

**Amplified Signal vs. Frequency**

- Frequency (kHz) vs. Gain
Pass/Fail: PASS (all 3 backend boards and boat board #1)

Signature: 

Backend Board Date/Time: 4-27-2012, 2:51 AM

Boat Board Date/Time: 5-7-2012, 3:09 PM

Test03:

Procedure: Ensure that the input pins on the UOS are correct by using the multi-meter and power down AZ/EL. Then plug UOS into AZ/EL on the turret and power on AZ/EL. Set multi-meter to voltage measurement mode and measure zero input bias at OUTA, OUTB, OUTC, OUTD, and AMP1OUT. Then inject square wave signal on the Quad Detector input channels A, B, C, D, and AMP1IN, measure voltage at input node, and output node of the respective op amps, to calculate gain. Repeat with oscilloscope measuring OUTA, OUTB, OUTC, and OUTD, while varying input signal frequency to determine corner frequencies, center frequency, and quality factor.

Specifications: Listed as actual under results.

Results:
**Board #1:**

<table>
<thead>
<tr>
<th>Zero Input Bias (V)</th>
<th>OUTA</th>
<th>OUTB</th>
<th>OUTC</th>
<th>OUTD</th>
<th>AMP1OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Actual</td>
<td>2.558</td>
<td>2.555</td>
<td>2.452</td>
<td>2.434</td>
<td>2.519</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gain (V/V)</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>mVpp</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expected</th>
<th>OUTA</th>
<th>OUTB</th>
<th>OUTC</th>
<th>OUTD</th>
<th>AMP1OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Vin (Vpp)</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.1</td>
</tr>
<tr>
<td>Vout (Vpp)</td>
<td>0.79</td>
<td>0.79</td>
<td>0.78</td>
<td>0.79</td>
<td>2</td>
</tr>
<tr>
<td>Actual</td>
<td>197.5</td>
<td>197.5</td>
<td>195</td>
<td>197.5</td>
<td>20</td>
</tr>
</tbody>
</table>
Signal Generator @ 10Vpp w/ 100 ohm resistor 100mA
Light Output at 400mW/Sr

<table>
<thead>
<tr>
<th>Resonant Freq. (kHz)</th>
<th>OUTA</th>
<th>OUTB</th>
<th>OUTC</th>
<th>OUTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Actual</td>
<td>22.6</td>
<td>22.3</td>
<td>22.3</td>
<td>22.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Corner Freq. (kHz)</th>
<th>OUTA</th>
<th>OUTB</th>
<th>OUTC</th>
<th>OUTD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>23.7</td>
<td>23.8</td>
<td>23.4</td>
<td>23.3</td>
</tr>
<tr>
<td>Lo</td>
<td>21.4</td>
<td>21.2</td>
<td>21.5</td>
<td>21.4</td>
</tr>
</tbody>
</table>

| Q                  | 9.826087 | 8.576923 | 11.73684 | 11.73684 | 308.0968 | 0.000009 | 05 |

Pass/Fail: Pass for UOS v0.2 SN 1 & SN

Signature: 何錫泉 (Andrew S. C. Ho)   Date/Time: 4-24-2012, 5:30 PM
Test04:

**Procedure:** Used voltage source to apply 18 volts to the Vss of the backend board and used 5 volts for the enable and backend Vs input. This enabled the transmitter constantly. Oscilloscope hooked up to pins 5 and 7 to measure the signal across the transmission terminals (shown in Figure 5).

**Specifications:** The signal sent out pins 5 and 7 of the backend board of Interface A, which represent the two terminals of the transmitter have an approximately 36Vpp, 40 kHz signal applied across them.

**Results:**

Backend Board #1,2 (3 yet to be soldered), and Boat Board #1:

Shows signals across transmission terminals generated by back boards 1 and 2 (shown as one image because results were the same).

![Figure 5](image)

**Pass/Fail:** Pass (for board #1 and #2)

**Signature:**

### Backend Board Date/Time: 4-27-2012, 3:21 AM

**Boat Board Date/Time:** 5-1-2012, 5:34 PM
Test05:

Procedure: Used voltage source to provide 5 volts to the backend board’s receiver side. Used a 40 kHz, 225 mVpp signal as from the function generator as the output from the frontend board to see the frequency and gain response of the second stage of amplification.

Specifications: The second stage provides an amplification in the range of 1-2 V/V that can be tuned via a trimpot to get the accuracy needed in testing.

Results:

Backend Board #1,2 (3 yet to be soldered) & Boat Board #1: Both of these boards amplified the 225mVpp input signal to 400 mV, a gain of approximately 1.75 V/V. This shows that both of these boards are possible of amplification in the second stage. This gain represents the gain that we used in order to achieve our 10 meter results.

Pass/Fail: Pass (for backend board #1 and #2 and boat board #1)

Signature: [Signature]

Backend Board Date/Time: 4-29-2012, 11:16 PM

Boat Board Date/Time: 5-7-2012, 3:09 PM

Test06:

Procedure: power the boat board and hook up boat board IR to Arduino’s 22kHz PWM output.

Specifications: If the Ultrasound receiver does not trigger off of the IR driver circuit, then the test passes.

Results:

Boat Board #1 (2 not soldered): LED from the ultrasound receiver circuit triggers when the IR driver is powered up, so the two subsystems are incorrectly interacting with one another.

Pass/Fail: Fail (boat board #1)

Signature: [Signature]

Date/Time: 5-2-2012, 3:11 PM