E1.12 – Software Defined Radio

Project Background

A Software Defined Radio is a HAM radio that is implementing primarily in software using, rather than traditionally in hardware. Some of the benefits to this design include:

• Modified more easily, only requires change in software.
• More expandable and flexible. RF Frontend can be changed with minimal change to software.
• Less expensive to buy and create yourself.

We have been sponsored to create a Software Defined Radio, based on a pre-existing design created by a radio enthusiast who posted the design online, named Charlie Morris.

We are basing our project on his design, with modifications to include some sponsor requirements, our own personal designs, as well as some improvements.

Approach

• Significant research has had to be done in understanding radio receiving and transmitting. Including modulation, in depth amplifiers and filtering.
• Fully tested and implemented RF Amplifier.
• Low Pass Filters have been tested and implemented.
• Quadrature and Clock Generator has been implemented.
• Existing software has begun to be modified for our design.

Next Semester

• Expand software for our user interfaces.
• Need to finish receive implementation.
• Need to begin transmit implementation.
• Implement higher power amplifier, ideally 5W for long range.
• Begin on stretch goals, time permitting.

Challenges & Boundary Conditions

Boundary Conditions

<table>
<thead>
<tr>
<th>Boundary</th>
<th>Constraint</th>
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<tbody>
<tr>
<td>The device should operate around the US specification of 120V AC 60Hz</td>
<td>The input power must be minimum 100V AC 50Hz, and cannot exceed 240V AC 60Hz</td>
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<tr>
<td>The RF Amplifiers gain will be 15-20 dB</td>
<td>The RF Amplifiers Gain cannot exceed 60 over the 3.5-14.5MHz band</td>
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<tr>
<td>The Ne612 can receive RF frequencies from 3.5-14.5MHz</td>
<td>The NE612 can receive 0-500MHz</td>
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<tr>
<td>The Teensy will receive 5V from a linear power regulator</td>
<td>The Teensy can receive 2.7-5.5V for Vcc</td>
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<tr>
<td>The radio will only operate on Frequencies from 3.5-6.0MHz and 14.00-14.35MHz</td>
<td>The radio can tune to any frequency on the HF band, 3MHz to 30MHz</td>
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<tr>
<td>The Ne612 can receive RF frequencies from 3.5-14.5MHz</td>
<td>The radio cannot exceed a 500ms delay when transmitting</td>
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<tr>
<td>The Teensy will amplify the microphone signals from 0-63dB</td>
<td>The maximum transmit power cannot exceed 31mW</td>
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<tr>
<td>The Teensy may amplify the microphone signals from 0-63dB</td>
<td>The radio cannot exceed 31mW</td>
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<tr>
<td>The lineout gain of the Teensy will be 0-20dB</td>
<td>The radio cannot exceed 31mW</td>
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<tr>
<td>The Teensy will amplify the microphone signals from 0-63dB</td>
<td>The electrical model of the Teensy is a 5dB amplifier circuit outputting 0dB the input signal at 10 and 00 degree phase shifts to the mics</td>
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Some of the challenges we have faced so far have included:

• Simulations not matching up with physical circuits, was particularly a problem with our RF Amplifier.
• Extra parts needed to be ordered because the wrong form factor mixers were ordered, and a toroid core was broken in shipping.
• None of the group members have experience with RF design, so extensive research and consulting has been necessary.

Acknowledgements

Project Manager: James Bell
D2 Advisor: Thomas Cowden
Course Advisor: Dr. Semih Asian
Faculty Advisor: Dr. William Stapleton
Special Thanks to: Dr. Rich Compeau
Charles Morris