ECEN 2420: Wireless Electronics for Communication

Goals

- Build the BFO Oscillator and Product Detector
- Build and measure the AF (audio frequency) amplifier of the NorCal 40A receiver.

Problems

Problem 1:

Make sure that your oscilloscope probe is set to 10:1 attenuation to avoid getting wrong results that result from the capacitance of the coaxial cable and the input resistance of the oscilloscope.

The goal of this problem is to build the Product Detector and the BFO (Beat Frequency Oscillator) for future testing, both of which are located after the IF filter and before the audio amplifier. We will also complete the circuitry for the RIT (receiver incremental tuning) which uses the bias voltage of the product detector (Integrated circuit U2, SA 602A) that will now be available as a reference voltage.

The circuit schematic of the Product detector and BFO are shown below

![Circuit Diagram](image)

The parts needed are shown in the following picture
Here is a list of the individual components:

<table>
<thead>
<tr>
<th>Picture</th>
<th>Reference</th>
<th>Description</th>
<th>Part Number</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="C15" /></td>
<td>C15</td>
<td>Cap., Elec., 2.2 uF, 25 V</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><img src="image2.png" alt="C17" /></td>
<td>C17</td>
<td>Cap., Var., 8-50 pF, Mica</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><img src="image3.png" alt="C18" /></td>
<td>C18</td>
<td>Cap. Disc, 270 pF, 5%</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><img src="image4.png" alt="C19" /></td>
<td>C19</td>
<td>Cap. Disc, 0.01 uF, 20%, 25 V</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Solder the product detector, BFO and RIT circuit together on the PCB. The completed circuit is shown below.

You can now remove the R15 connection to ground and the 50 ohm termination resistor at the BNC antenna connector.

Also, make sure that you install the correct IC (LM 393N) at U6. Soldering the incorrect IC will result in 50% grade penalty.
The BFO will be aligned with your Crystal IF filter during final alignment.
On Site Homework #6

Problem 2

This problem requires you to solder SOME components then take measurements.

Do not solder all the components at once. Failure to do so will result in 20% grade penalty.

The parts needed for this problem are shown in the following picture

![Image of components]

Here is a list of the individual components

<table>
<thead>
<tr>
<th>Picture</th>
<th>Reference</th>
<th>Description</th>
<th>Part Number</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="C20, C21" /></td>
<td>C20, C21</td>
<td>Cap., Mylar, 0.1 uF, 100 V</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="C27, C41" /></td>
<td>C27, C41</td>
<td>Cap., Elec., 100 uF, 25 V</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
# On Site Homework #6

<p>| | | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>U3</td>
<td>IC, AF Amp</td>
<td>LM386N-1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C23</td>
<td>Cap., Elec., 2.2 uF, 25 V</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C55, C22</td>
<td>10 nF</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>R22</td>
<td>1.8 kΩ</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>47 kΩ</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
On Site Homework #6

Only solder SOME components then take measurements as described! Do not solder all the components at once.

Install the amplifier U3, coupling capacitors C27, C20, C21 and the bypass capacitor C41. For the load, solder an 8 ohm resistor between C27 and the ground for R8.

Ask a TA if you are not sure where this is supposed to be soldered.

Because the audio amp has a lot of gain, and the output can easily be saturated, we use a potential divider circuit to reduce the input voltage to prevent the output from saturating. Connect a pair of 1.5 kOhm resistors to the coupling capacitors C20 and C21, and then put a 5.6 Ohm resistor in parallel between them. Connect the function generator across the 5.6 Ohm resistor, and the scope probes across the 8 Ohm resistor. A possible setup picture of this is shown below.
At the TA station are the 5.6, 8 ohm resistors and 1.5 kohm resistors are provided or you could use the ones that are a part of your kit.

Make sure to power your radio with the 12V DC power supply.

The input from the function generator goes across the 5.6 ohm resistor. The oscilloscope probe is used across the 8 ohm load for measurements. Set the function generator for a \textbf{25 mVpp} signal. Because we have not installed the Automatic Gain Control of the audio circuit, you may damage the Audio Amplifier if the input signal is too high.

The Output coupling capacitor (C27) gives a high-pass characteristic to the audio signal. We are interested in the gain of the AF amplifier when we do not bypass the internal emitter resistor.
Q1) Measure the voltage gain at a high frequency of your choice. What is the voltage gain?

We now increase the gain by bypassing the internal 1.35 kOhm emitter resistor. Install C23 (2.2 uF capacitor). It connects between pins 1 and 8 of the amplifier.

Make sure to disconnect all equipment when soldering in the additional components at all times!

Q2) Measure the voltage gain again at the same frequency you choose before. What is the increase in the voltage gain?

Now, we add a low-pass response to the amplifier by installing the bypass network C55 (10 nF) and R22 (1.8 kOhm) for the internal 15 kOhm feedback resistor. These are connected between pins 5 and 8 of the amplifier. Combined with the high-pass response we already have, we get a band-pass characteristic.

Q3) Make a Bode plot with the gain in dB and the frequency in a log scale from 50 Hz to 10 kHz. Choose enough frequency points to get the best shape of the bandpass response as possible.

Q4) What is the peak gain in dB?

Q5) Approximately, at what frequency is the peak gain observed?
On Site Homework #6

Q6) What is the -3 dB bandwidth of the bandpass response?

Finally, we will now add components to the input circuit to provide additional roll-off at low and high frequencies. Install C22 (10 nF) and R7 (47 kOhm).

Q7) Make a Bode plot with the gain in dB and the frequency in a log scale from 50 Hz to 10 kHz. Choose enough frequency points to get the best shape of the bandpass response as possible.

Q8) What is the peak gain in dB?

Q9) Approximately, at what frequency is the peak gain observed?

Q10) What is the -3 dB bandwidth of the bandpass response?

Q11) How is the response of this filter different than what you previously measured without the input circuitry components?

You must now remove the 1.5 kOhm and 5.6 Ohm resistors

The 8 ohm resistor is to be kept connected as it is needed for future labs.