BENE 2163

ELECTRONIC SYSTEMS

LAB SESSION 3

WEIN BRIDGE OSCILLATOR

Revised:
February 2011
1.0 Objective

To design, construct and test the Wien Bridge Oscillator.

2.0 Material

<table>
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<tr>
<th>No.</th>
<th>Equipment</th>
<th>Qty</th>
<th>No.</th>
<th>Component</th>
<th>Qty</th>
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<td>Resistor (for design - refer Appendix A)</td>
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<td>2</td>
<td>Resistor 10kΩ</td>
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<td>Ceramic Capacitor (for design - refer Appendix A)</td>
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<td>Resistor</td>
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<td>MultiSim Software</td>
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<td>Potentiometer 10kΩ</td>
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<td>1N4148 small signal diodes</td>
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3.0 Theory

An oscillator is generally an amplifier with positive feedback. It produces a periodic alternating output signal or waveform with a certain frequency without any external input signal. An oscillator is basically an amplifier powered by a voltage source and experiences positive feedback. For oscillation to take place the Barkhausen criterion for oscillation must be met. If the output signal varies sinusoidally, the circuit is referred to as a sinusoidal oscillator. On the other hand, if the output voltage rises quickly to one voltage level and later drops quickly to another voltage level, the circuit is generally referred to as a pulse or square-wave oscillator.

This experiment investigates an oscillator circuit that produces a sinusoidal. It has an amplifier that uses an op-amp and RC bridge oscillator circuit shown in Figure 1 and Figure 2. This circuit is known as the Wien Bridge Oscillator. The criteria for sinusoidal oscillation is that the magnitude of the loop gain equals to unity and the phase of the loop gain equal zero at the frequency selected for oscillation. The frequency of oscillation is determined by the frequency selective network.

An oscillator with a loop gain of exactly unity is unrealizable because of varying component values, parameters, and temperatures. To keep the oscillations from ceasing or increasing, a nonlinear circuit can be used to control the gain and force the loop gain to remain at unity. The Wien Bridge Oscillator of Figure 2 uses two diodes in the circuit to limit the amplitude of the oscillation.
The Wien Bridge Oscillator without amplitude stabilization is shown in Figure 1. Wien bridge oscillators are noted for high stability and low distortion. This oscillator will oscillate at the frequency:

\[
f_o = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}} \tag{1}\]

But in particular, the values are \( R_1 = R_2 = R \) and \( C_1 = C_2 = C \), then

\[
f_o = \frac{1}{2\pi RC} \tag{2}\]

and amplifier resistor ratio

\[
\frac{R_f}{R_A} = 2 \tag{3}\]

For oscillation to commence, the value \( R_f/R_A \) should be made slightly greater than 2. These relations also hold for the Wien Bridge Oscillator with amplitude stabilization shown in Figure 2.

![Figure 1 Wien Bridge Oscillator Circuit](Image)

Figure 1 Wien Bridge Oscillator Circuit
Figure 2 Wien Bridge Oscillator Circuit with Amplitude Stabilization

4.0 Procedure

Part 1: Design and simulation of a Wien Bridge Oscillator

1. Design the Wien Bridge Oscillator as shown in Figure 1 with an oscillation frequency in the range of 1.2 kHz and 1.7 kHz. Use ±15 V supplies for the op-amp. Verify your design with MultiSim®.
2. Record the values of resistors and capacitors used.
3. Observe the output waveform and record the output frequency and the peak amplitude.

Part 2: Practical Wien Bridge Oscillator Circuit

1. Construct the Wien bridge oscillator circuit of Figure 1. Use the designed values for the resistors and capacitors. Use ±15 V supplies for the op-amp.
2. Monitor the output on the oscilloscope. Observe any distortion in the output waveform or if the output oscillation begins to increase without bound. If oscillations do not start, try increasing the ratio $R/R_A$ to slightly greater than 2. (This can be done easily if you use a potentiometer for $R_n$. If oscillations increase without bound, try getting the ratio $R/R_A$ closer to 2)
3. Measure the output frequency of the oscillation. What is the peak amplitude of the oscillation? Measure the actual values used for $R_A$ and $R_f$. Remember they must be measured outside of the circuit.
Part 3: Wien Bridge Oscillator Circuit With Amplitude Stabilization

1. Add the amplitude stabilization circuit to the constructed Wien bridge oscillator of Part 2. Be sure to connect the 10 kΩ potentiometer correctly.

2. Before applying power to the circuit, adjust the potentiometer to the bottom of its range. Turn the power on, and while monitoring the output waveform on the oscilloscope gradually increase the potentiometer setting until oscillation is sustained. Note the changes in the output waveform amplitude and shape during the potentiometer’s adjustment.

3. Measure the output frequency of the oscillation. Note any distortion in the output sine wave.

4. Remove the diodes from the feedback circuit. Note the effects on the circuit output.

5. With the diodes removed, vary the potentiometer setting and note any effects on the circuit output.

5.0 Discussion

1. The output frequency from a Wien Bridge Oscillator can be approximated using the equation (1) or (2). By using equation (1) or (2), calculate the value of frequency for the oscillator and compare to the simulated and experiment result.

2. Why is positive feedback employed in this circuit?

3. Explain why the gain of Wien Bridge Oscillator must be slightly greater than two.

4. What is purpose of diode D1 and D2?

5. What are the advantages of using Wien Bridge Oscillator?