9. Oscillator

Chapter 9 Goals

- Analyze a Hartley Oscillator using LTspice
- Build and test the oscillator

In this section we will employ a Hartley Oscillator for use as the local oscillator source for your radio. This oscillator should produce a sinusoidal output that will be delivered to the emitter of your mixer circuit. The frequency of the sinusoid should be adjustable over a range sufficient to pick up all of the AM radio stations of interest.

Oscillator theory says that in order to sustain oscillation, the Barkhausen criteria must be satisfied: (1) the loop gain must be (at least) 1 and (2) the fed back signal must constructively add to the original signal; i.e. the loop phase shift must be n2π radians, where n = 0, 1, 2, 3….

In the circuit of Figure 9.1, feedback from the collector to the emitter is provided by the path through C5 to ground and then through C3. An additional feedback path exists from the collector to the base through C2. The resonance frequency depends on the inductance (L1 and L2) and capacitance (primarily the trimming capacitor Ctrim). Adjusting the trimming capacitor varies the oscillation frequency. Our trimming capacitor has a stated range from 8 pF to 120 pF. The 1 kΩ load is approximately what the oscillator will see looking into the emitter of the mixer circuit.

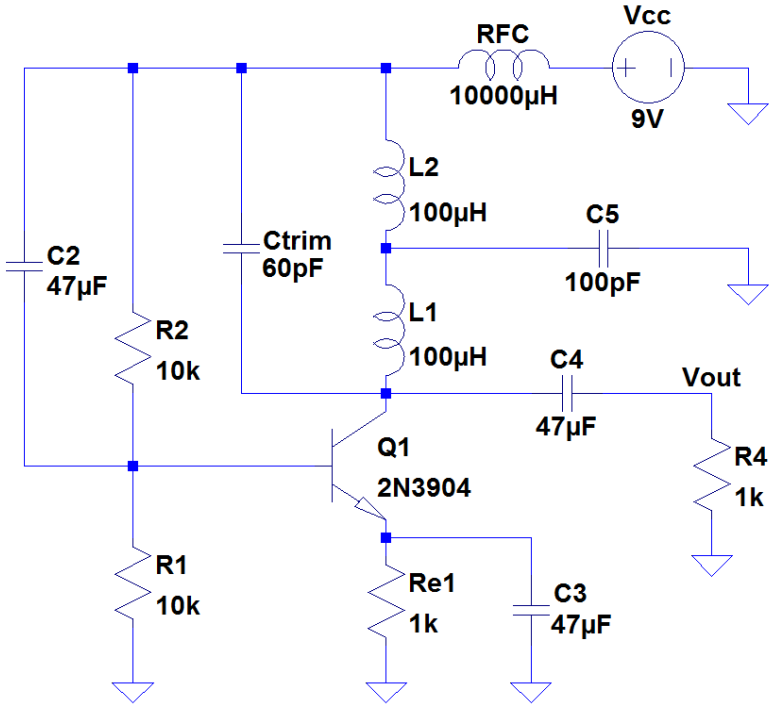

Figure 9.1: Hartley Oscillator for LTspice simulation

9.1 LTspice Simulation

1. Construct the Hartley Oscillator shown in Figure 9.1.

2. In Simulate – Edit Simulation Cmd, set the following parameters for Transient Analysis:
   Stop Time: 90us
   Time to Start Saving Data: 80us
   Maximum Timestep: 0.01us
   The long delay before saving data will let the circuit recover from turning on at time 0 us.

3. Upon simulating, notice the distortion of the sine wave. What is happening is that the loop gain is too high (well in excess of one).

4. In the plot window, select FFT in the View menu to see the frequency spectrum. Find the resonance frequency and record it as fres in Table 9.1.

5. Repeat your simulation after changing Ctrim to 100 pF. Record the new fres in Table 9.1.

6. Return to the default case and change C5 to 200 pF. Record fres in the table.

7. Return to the default case and change L1 and L2 to 10 uH. Record fres.

Table 9.1: LTspice simulation

	default			
Ctrim	60 pF	100 pF	60 pF	
L1	100 uH			10 uH
L2	100 uH			10 uH
C5	100 pF		200 pF	100 pF
fres				

9.2 Building/Testing the Oscillator

1. Construct the Hartley Oscillator of Figure 9.1. You will need to solder wire to the legs of the trimming capacitor so that it can fit in the holes of your breadboard.

2. Observe the output of the oscillator as you adjust the trimming capacitor. Over what frequency range (f_{low} to f_{hi}) does your oscillator operate? Comment on the quality of the sine wave in Table 9.2.

3. Tinker with your circuit and see if you can improve its performance. For instance, the frequency range on the default circuit may be inadequate for your radio. Recall that your bandpass filter is set up for a difference frequency of about 200 kHz. Is your oscillator range sufficient to achieve a 200 kHz difference frequency on all of the AM stations you wish to receive? One possible configuration for your oscillator is shown in Figure 9.2. This circuit has been designed for less loop gain. (*note: I've had a higher quality output with Re2 = 300 Ω and Re1 = 3 kΩ).*

Table 9.2: Measurements on constructed Fig. 9.1

		comments
f_{low}		
f_{hi}		

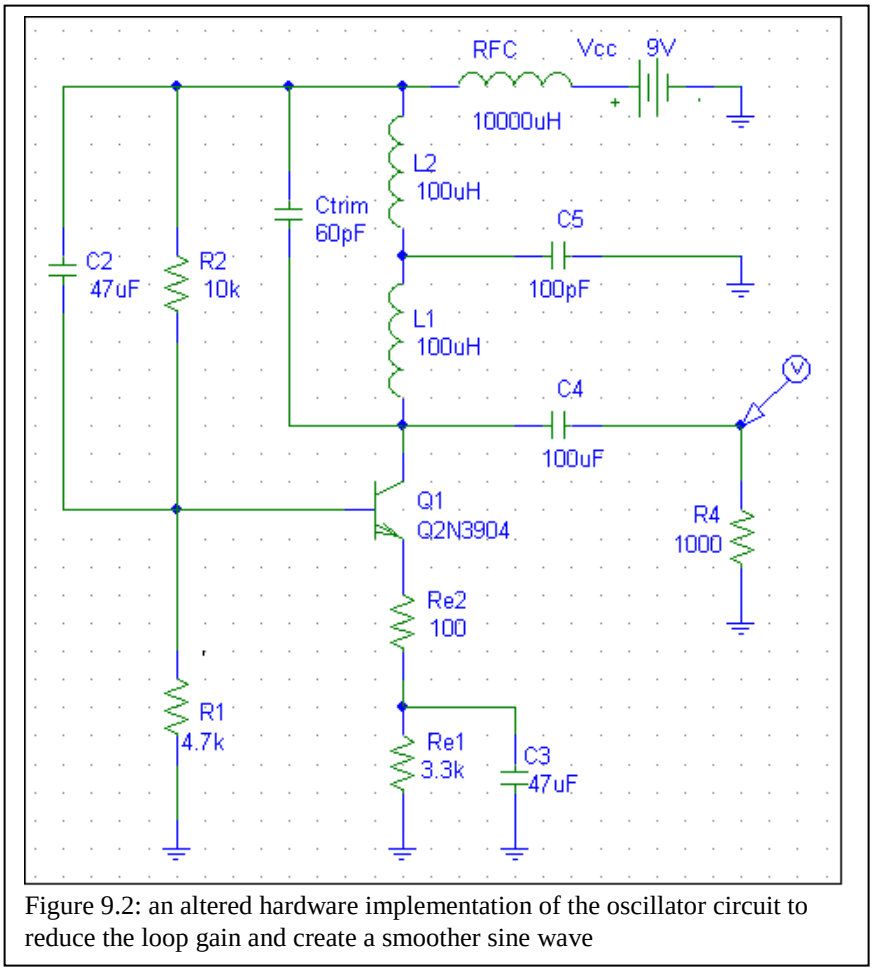

Figure 9.2: an altered hardware implementation of the oscillator circuit to reduce the loop gain and create a smoother sine wave