Receiver Front-End Integration

Objectives:
- To demonstrate the functionality of a voltage controlled oscillator (VCO).
- To integrate components to down convert a 915 MHz signal to 100 MHz.

Equipment:
- Spectrum/Network/Impedance Analyzer - (Agilent 4396B)
- Vector Signal Analyzer (VSA) – (HP 89441A)
- RF Signal Generator (HP 8647A)
- Function Generator (HP 33220A)
- Bench power supplies (3) (Agilent/HP E3631A)
- RF front end components and antennas

Pre-lab:
1. Prepare an Excel Spread sheet to plot and fit a curve to the data being collected in Table 1. During the course of the experiment you will need to use this spreadsheet to predict (via extrapolation) the control voltage for the VCO.
2. In the receiver assembly, what output power will be required of the VCO? Why?
3. In the receiver assembly, what LO frequency will be required of the VCO? Why?
4. Include a block diagram for the receiver front-end at the end of this document.

PROCEDURE

1. VCO Basics
   - This portion of the lab will be performed on the WIRELESS AND DIGITAL COMMUNICATIONS BENCH.
   - Configure the bench power supply for 12 Volts (+25V, Output ON/OFF, dial to 12V). Check the voltage with the multimeter.
   - Connect this supply voltage to the VCO power cables.
   - Now, configure the bench supply so that you can vary the 6 volt source (+6V). Connect the VCO control (CON) to these terminals. Set the voltage to 0.0V.
   - Connect the output port (OUT) of the VCO to the VSA. Record the frequency and power of the strongest signal in Table 1 and in your excel spread sheet.

Observation: Where do the other frequency components come from?
2. **Receiver Front-end Assembly and Test**

   - This portion of the lab will be performed on the **ANALOG RF AND DEVICE CHARACTERIZATION BENCH**.
   - Configure the RF signal generator connected to the Yagi antenna for a center frequency of 915 MHz and an output power of 0 dBm. Set the modulation to a 1 kHz internal signal with a deviation of 75 kHz. Turn RF power on (**RF ON/OFF**), but have the modulation off (**MOD ON/OFF**) (for now).
   - Ensure that your active receiver components are powered on using the +12 Volt supply (as was done in Part 1).
   - Connect the receive antenna to the spectrum analyzer and record the power in the received 915 MHz signal on your block diagram and **HERE**.

   - Connect the antenna to RF amplifier’s input. Connect the output of the RF amplifier to the RF coupler. Connect the coupled port to the spectrum analyzer. Record the power of the 915 MHz component on your block diagram and **HERE**.

   **Prediction:** What should be the power of the 915 MHz signal at the RF coupler’s through port? Why?

   - Connect the spectrum analyzer to the through port of the RF coupler and record the power of the 915 MHz component on your block diagram and **HERE**. Be sure to place the load on the coupled port prior to making this measurement.
- Use your Excel spreadsheet to determine what voltage is required to control the VCO so that it provides the proper LO frequency. Record your predict HERE.

- Configure the second bench supply so that the control voltage matches your predict. Connect the output of the VCO to the 2nd coupler (LO coupler). With the coupler output loaded, record the power and frequency of the LO signal HERE.

- Adjust the control voltage so that you are as close as possible to the desired IF frequency. It may help to set up the signal track (Search > Marker Peak > Signal Trk ON); this re-centers the display as the tracked signal shifts in frequency. Record the control voltage, LO frequency and the LO coupler power reading on your block diagram and HERE.

- Connect the VCO to the mixer’s LO port and the first coupler’s through port to the mixer’s RF port. With the spectrum analyzer set to full span, capture the spectrum at the output of the mixer (IF port).
- Connect the LPF to the mixer output and recapture the spectrum.
- Zoom in so that you are clearly observing the desired IF frequency. Measure the power and frequency of the desired IF component and record these values in your block diagram and HERE.

**Observation:** How good of a job is the LPF doing in selecting only the desired IF component?

- Connect the filter output to the DC block and the DC block to the IF amplifier input. Measure the power and frequency of the desired IF component at the output of the IF amplifier and record these values in your block diagram and HERE.

**Observation:** For what purpose is the DC block included in the system?

- Turn on the radio in the lab and tune it to 100 MHz (you should hear “The Buzz”). If you can’t get this radio station, reset the VCO so that your IF is 98.9 MHz (WOKO). Connect the IF amplifier output to the test lead antenna. Turn the modulation ON on the 915 MHz signal generator.
- With luck you should now hear your 1 kHz tone. Do you?
- If not, tune the radio to find out where you down converted signal is the strongest. Record that frequency in your block diagram and HERE.
Laboratory Summary Questions:

1. Present the captured spectrums at the output of the mixer before and after the LPF was inserted.
2. What is the mixer conversion loss (RF to IF)?
3. What is the gain measured of the RF amplifier?
4. What is the gain measured of the IF amplifier?

*Please note any corrections to the procedure and give them to the instructor. Thanks.*

Table 1. VCO Performance

<table>
<thead>
<tr>
<th>Voltage</th>
<th>$f_{VCO}$ (MHz)</th>
<th>$f_{VCO}$ (dBm)</th>
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<tbody>
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