Laboratory: SSB and AM demodulation

1 Objective

Objectives of the lab:

- To get familiar with the GNURadio software and the concepts of software defined radios.
- To analyse single-sideband AM generation
- To analyse AM demodulation.

2 Requirements

Note: This lab requires some preparation, in terms of theoretical background as well as the use of the tools (use of the B-Lab, GNURadio Companion, Matlab/Octave, the m-files, etc.). Students who are unable to do the lab because they have not prepared will be asked to leave.

Instructions, source material and preparation required:

- You are required to present block diagrams of the SSB transmitter and the AM demodulators before you are allowed to enter the lab.
- Lab partners must operate in groups of three (and no larger) and may help each other during the lab but each should use his/her own examples in all the exercises and write his/her own lab report.

Report: The report will take the form of the following group of files which should all be attached to a single email:

- An answer sheet (in Word or PDF format) with your name and your lab partners' names and student numbers, the date and experiment name, and your results.
- All the GRC-files used in the lab.
- All additional files (such as m files) used for the report.
- Your report should include an introduction, as well as a conclusion section, briefly explaining all important results.

3 Outcomes

1. Single-Sideband AM modulation: Single-tone injection

1.a. Work out by hand the expected frequency spectrum and output waveform when a sinusoidal signal of amplitude A_m and frequency of 1 kHz is input to a SSB transmitter. Assume that the carrier frequency of the USRP is set to 1 MHz, and that all data types are of type "short". (This should be included in your report.)

1.b. Generate a single tone of 1 kHz, input this to the SSB modulator and observe the output. Call the demonstrator to verify the results (The demonstrator has to sign your name off on a list). Calculate the period and frequency of the carrier wave, as well as the period and frequency of the envelope (if present). (The calculations should be included in your report.)

1.c. Simulate this system in Matlab and plot the output waveform and output spectrum. Include the program listing as well as the the appropriate plots in your report.

1.d Change the frequency of the input signal to 2kHz, and analyse the output signal.

1.e Change the amplitude of the input signal to $2 \times A_m$ and analyse the output signal.

2. AM DSB FC demodulation

2.a. Sketch a block diagram of how AM DSB FC can be demodulated using the USRP. Show the necessary equations.

2.b. Use a second USRP to generate an AM DSB FC signal modulated with a single tone of 1 kHz. Demodulate this signal. The output should be displayed on both a Oscilloscope Sink and an FFT sink. Verify that the demodulator is working by noting the change in amplitude and frequency when the amplitude and frequency of the input signal is changed. Call the demonstrator to verify the results (The demonstrator has to sign your name off on a list).

3. AM DSB SC demodulation

3.a. Sketch a block diagram of how AM DSB SC can be demodulated using the USRP. Show the necessary equations.

3.b. Use a second USRP to generate an AM DSB SC signal modulated with a single tone of 1 kHz. Demodulate this signal. The output should be displayed on both a Oscilloscope Sink and an FFT sink. Verify that the demodulator is working by noting the change in amplitude and frequency when the amplitude and frequency of the input signal is changed. Call the demonstrator to verify the results (The demonstrator has to sign your name off on a list).

4. AM SSB demodulation

4.a. Sketch a block diagram of how AM SSB can be demodulated using the USRP. Show the necessary equations.

4.b. Use a second USRP to generate an AM SSB signal modulated with a single tone of 1 kHz. Demodulate this signal. The output should be displayed on both a Oscilloscope Sink and an FFT sink. Verify that the demodulator is working by noting the change in amplitude and frequency when the amplitude and frequency of the input signal is changed. Call the demonstrator to verify the results (The demonstrator has to sign your name off on a list).