



Laboratory: FM Modulation

1 Objective

Objectives of the lab:

- To get familiar with the GNURadio software and the concepts of software defined radios.
- To observe the output-versus-input voltage characteristics of frequency modulation.
- To gain some practical exposure to the FM concepts and algorithm presented in class.

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 do all the preparation needed to implement the algorithms beforehand.
- Download the file `FM_MOD.GRC` from the course website and give a block diagram of the system.
- 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 sample text in all the exercises and write his/her own lab report.
- The practical demonstration counts 40% and the report 60% of this lab.

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 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. Constant signal as input
 - 1.a. Work out by hand the expected output frequency of the modulator when a constant source of amplitude 1V is used as input.
 - 1.b. Determine the actual output frequency of the modulator when a constant source of amplitude 1V is used as input.
2. Repeat Question 1, but change the amplitude of the constant source to 2V.
3. Single-tone injection
 - 3.a. Work out by hand the expected frequency spectrum and output waveform when a sinusoidal signal of 1 kHz and amplitude 1V is used as input to the FM modulator. Assume that the carrier frequency of the USRP is set to 1 MHz.
 - 3.b. Generate a single tone of 1 kHz and amplitude of 1V, input this to the FM 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 frequency deviation of the system. Also sketch the output spectrum, indicating all important amplitude levels. (The calculations should be included in your report.)
 - 3.c. Simulate an FM system in Matlab with the same parameters as the system above, and plot the output waveform and output spectrum. Include the program listing as well as the the appropriate plots in your report. (The simulation must not make use of complex baseband.)
4. Do exactly the same as the above, but for an input signal of 1 kHz and amplitude of 2V.
5. Repeat Question 2, but now for an input signal of 2 kHz and and amplitude of 1V.