README.md

Lab 3: FM Simulation and USRP

Exercise 1: FM Modulator

Generalised function for FM is:

$g(t) = A_c \cos\big(2\pi f_c t + \theta_m(t)\big)$, where $\theta_m(t) = 2\pi\Delta_f \int m(\tau)\mathrm{d}\tau$,

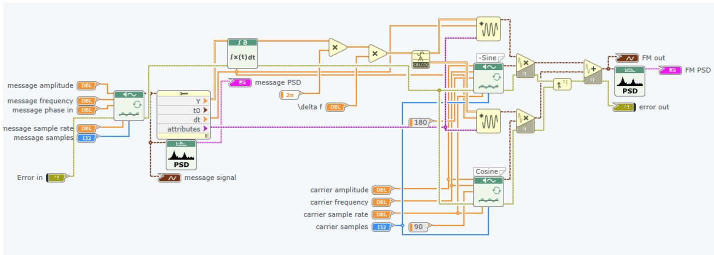
Instantaneous frequency is:

$\omega = 2\pi f_c t + \theta_m(t)$

Equivalent form we will be using:

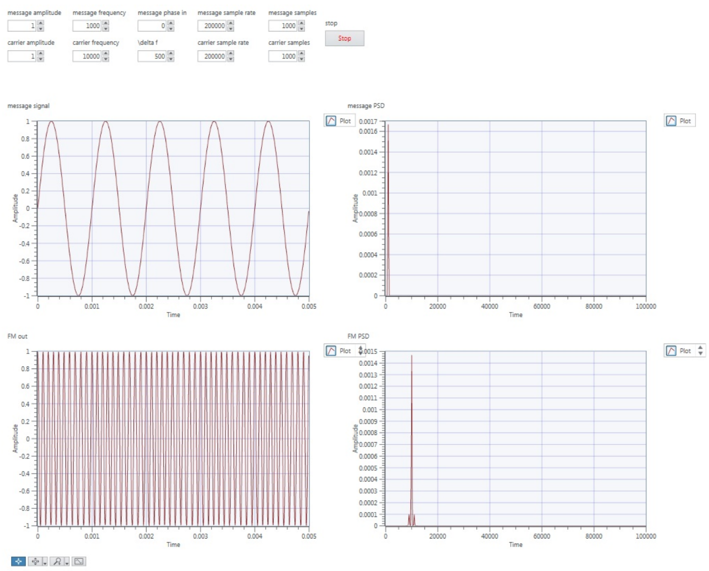
$s(t) = A_c \cos\big(2\pi f_c t\big)\cos\left(\theta_m(t)\right) - A_c \sin\big(2\pi f_c t\big)\sin\left(\theta_m(t)\right)$

Diagram

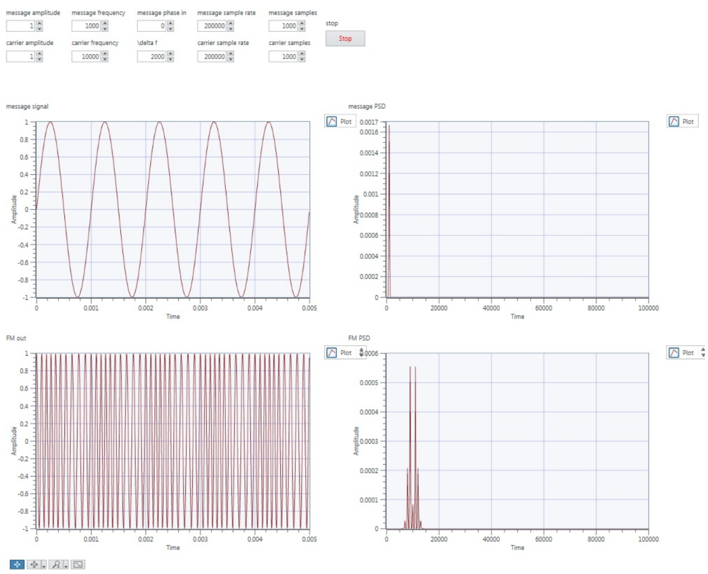


Varying *delta f*

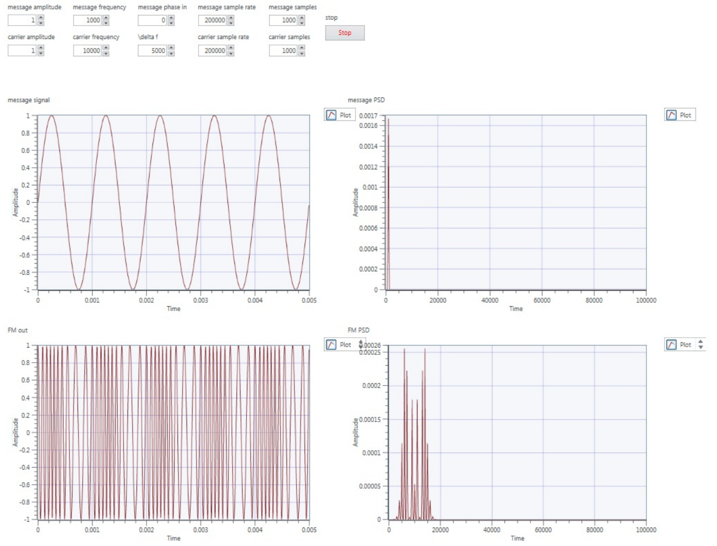
delta f=500



delta f=2000



delta f=5000

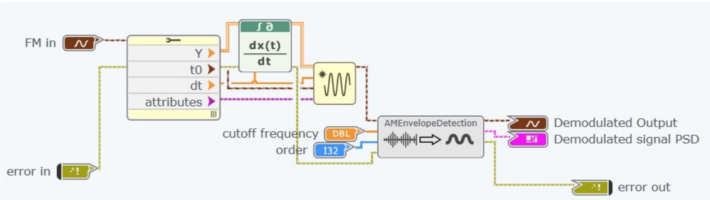


- As delta f increases, you can more easily see the variations in frequency of the FM signal.
- In the frequency domain, you can see the message signal spread across a larger bandwidth.

Exercise 2: FM Demodulator

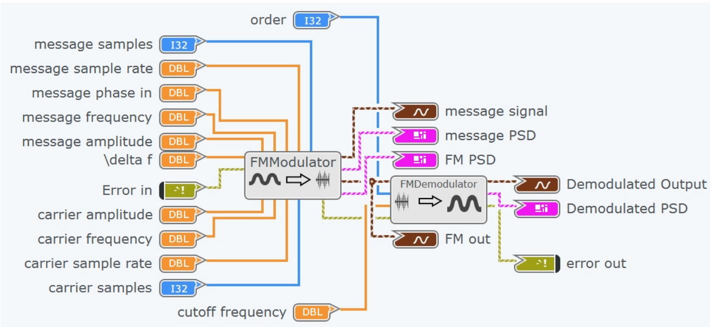
- Theory is that the derivative provides a sinusoidal signal which has amplitude proportional to the message signal.
- This is just like AM modulation, so the envelope detection method works to retrieve the signal from the differentiated signal.
- Coherent detection would not work because we do not know the phase of the resultant signal

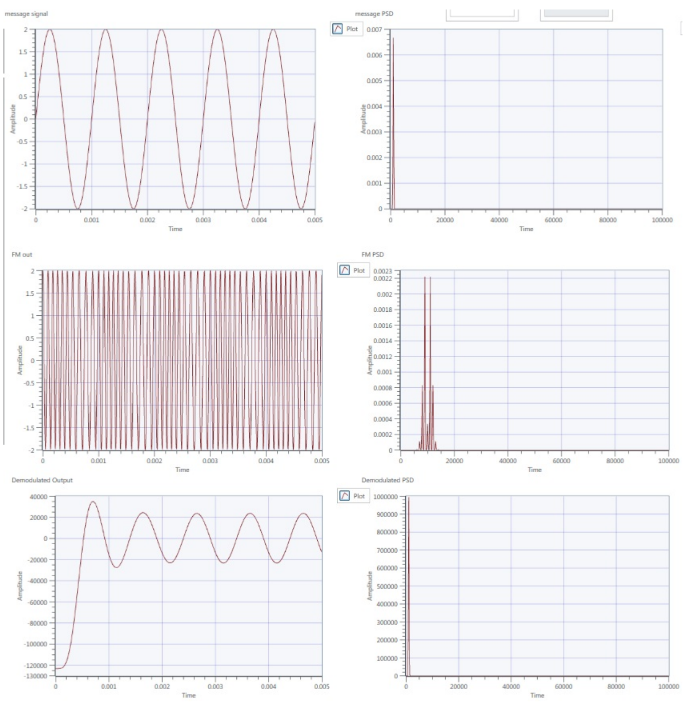
Envelope Detection

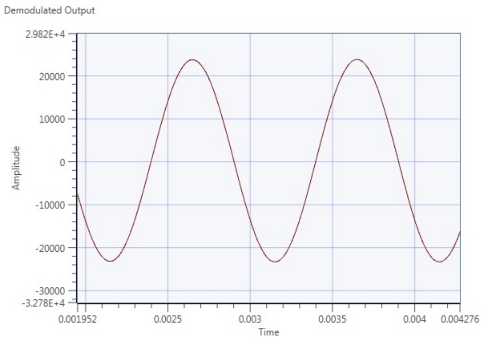


Exercise 3: FM Simulation

Top level Diagram

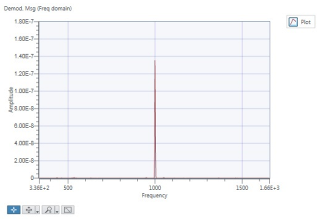


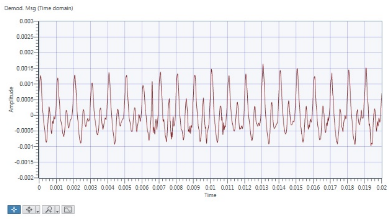


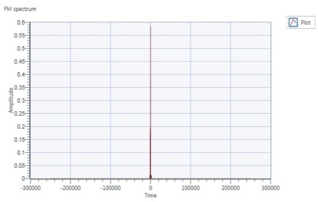


Exercise 4: FM USRP

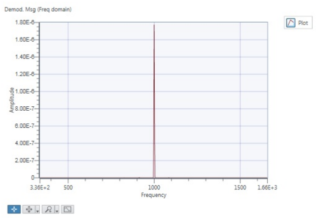
Delta f = 1kHz

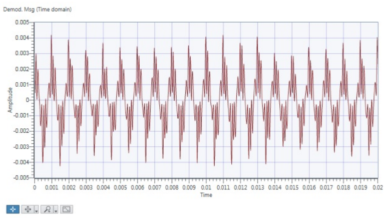


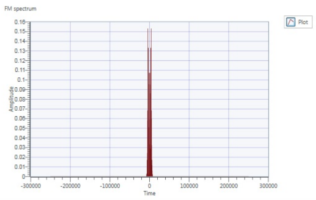




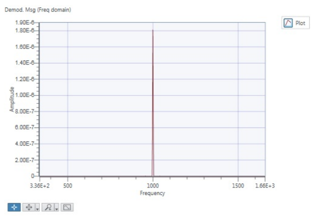
Delta f = 5kHz

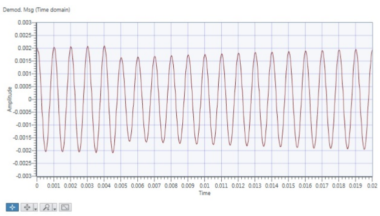


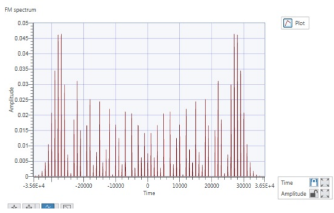




Delta f = 30kHz







- Note that the bandwidth of this signal is 62kHz, which agrees with Carsons rule for delta f = 30kHz and B = 1kHz: $B_{FM} \cong 2(\Delta f + B)$ = 62kHz.