COMMUNICATIONS LAB. Experiment #3: Frequency Modulation / Demodulation

OBJECTIVES

Introduction to frequency modulation and demodulation.

GENERAL INFORMATION on Frequency Modulation/Demodulation

The most obvious modulation method is to vary the carrier amplitude with the instantaneous message signal value. However, the amplitude is not the only quantity the carrier that can be used to carry the message. It is also possible to vary the frequency of the signal, and this is called frequency modulation or FM. In FM, carrier frequency is varried within some small range about a center frequency with message signal's instantaneous amplitude. This is illustrated in Fig. 1. The relation is as follows;

Message Signal: $V_M(t)$

Carrier Signal: $V_C(t) = V_{CO} \sin(2 \pi f_C t + \phi)$

FM Signal: $V_{FM}(t) = V_{CO} \sin (2 \pi [f_C + (\Delta f / V_{MO}) V_M(t)] t + \phi)$

where Δf is the peak frequency deviation (swing).

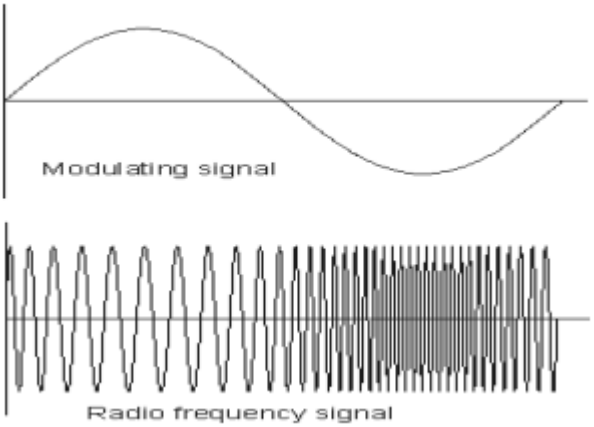

Figure 1 *Illustration of modulating and modulated signal*

There are also some advantages & disadvantages of FM compared to AM;
- FM systems are far better at rejecting noise than AM systems. (research why?)
- FM signals generally have significantly larger effective bandwidths than AM.
- One disadvantage of FM is that the demodulator is somewhat more complicated and expensive than the very simple envelope detectors used in AM.
- The sidebands of FM signal theoretically extend out to infinity. To limit the bandwidth, filters are used. Filters may introduce some distortion.

Wideband FM is regarded as a very high quality voice transmission method in broadcasting. It is widely used for communications where resilience to signal strength variations is desired.
In modern digital communication systems, FM (or its digital version FSK) is rarely used by itself alone. It is usually combined with other digital communication techniques.

EXPERIMENT

1. The Frequency Modulation

a) Generate (and observe within CH1) 0Volt DC on "DC supply" and connect it to Vm input of the FM module.

b) Connect CH2 of the scope to the FM output of the FM module and adjust Carrier Frequency to get a 160kHz carrier. Draw the signal in your report.

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c) Adjust message signal to +5V DC and observe Vm and FM outputs. Draw the resulting signal on CH2 in your report.

d) Repeat step c with -5V DC. Draw it again in your report. Summary; We have observed the changes on the carrier signal with message inputs of 0V, +5V and -5V. Comment on the dependency between the frequency changes of the output signal and the input message signal. Estimate the frequency deviation constant we have seen in FM subject in the class.

e) Instead of using DC supply output as input, now generate 40kHz 15Vpp sinusoidal signal on FG1 and us it as the message signal. Try to stabilize the display on the scope and draw the resulting signal in your report (both CH1 and CH2).

f) Comment on the resulting FM signal. Does it conform the frequency deviation relation you have previously estimated?

g) Observe the frequency spectrum of FM signal using the FFT function. Draw the spectrum and comment on it. Does it meet your expectations?

h) Repeat the experiment using 10kHz 15Vpp sinusoidal message signal. Draw the FM signal in your report and comment. What changes did you see compared to your result observed with 40kHz message signal?

i) Now, sligthly change the carrier frequency and observe the changes at the output. What did you expect and what did you get? Comment on it while drawing the comparative result in your report.

2. The Frequency Demodulation

j) Observe a 170kHz FM carrier by applying 0V DC to the message input of the FM modulator.

k) Now, instead of DC, apply 40kHz 15Vpp sinusoidal (use FG1) message signal to FM modulator.

l) Make required connections to demodulate this FM signal through FM demodulator.

m) Make required adjustments so that you see both the original message sinusoidal and the demodulated message signal on CH1 and CH2 of the scope. You may need to adjust PLL Frequency. Draw both signals in your report and comment. Did you get what you have expected? What do you think of the purpose of the PLL?

n) Change the message signal to triangular from sinusoidal. Did you get what you have expected for the demodulated signal? Comment on it.