Lab 2 Mixers and Modulators

The following are supplementary notes for completing the mixer and modulator lab. All questions in the lab manual must be answered and documented in the lab report. These notes are meant to compliment the information provided in class and in the lab manual. Also make sure to look at the marking scheme on the web page, and review the lab lecture given on Oct. 10.

1) After checking all DC bias levels are correct connect the signal generator to the carrier input and adjust the amplitude for 100mVrms ~280mVpp at 800kHz. Do not set the sig gen level before connecting to the circuit and assume it will be correct once connected. Measure the output on the scope and tune the pot to null the carrier. Save the output to floppy for your report. Answer the questions in the lab manual.

2) Connect the second sig gen to the modulating signal input and adjust the amplitude and frequency for 40kHz and 200 mVrms ~560mVpp. On the output you should observe the DSBSC output waveform. Save a single plot which shows the carrier, modulation input and output signal indicating peak-peak values of the three waveforms. Do not attempt to use built in math fcns on the scope for such things as RMS for the DSBSC output waveforms. Using the pk-pk math function or horizontal markers is a better alternative in this case.

Its important here to make sure your signal levels are correct and that the output signal level is roughly what you expect before proceeding further with the lab. You need to calculate or estimate the output level/gain for your circuit. To calculate the gain there are two options

- Use Fig. 11 in the data sheet to find the output level for **each** sideband. You will have measured A+B as shown in Fig. 1 which is the double sideband output. To compare to Fig. 11 you must take ((A+B)/2)/(2*sqrt(2)) which is the equivalent single sideband rms output level. Note that you must scale the value in Fig. 11 by the ratio of 3.3/3.9 since the datasheet example is for a load resistor of 3.9k and your circuit is 3.3k. Note also that re is slightly different as they use 1 mA, you have about 1.4 mA.
- Calculate the gain on page 8-20 of the datasheet using Fig. 25 - Table 1. First determine whether you are operating under low or high level AC conditions. For high level AC the output signal level is more or less independent on the carrier amplitude. For low level AC the output signal level is dependant on the carrier amplitude. Use Fig. 11 to justify your answer. Multiply the calculated gain by Vm to calculate the expected output level (this is for a single sideband). Extrapolate single sideband level from your plot and compare to calculation. Best off to stick with pk-pk values for this comparison.

3) For this part you are to use the built in FFT function on the oscilloscope. It is recommended to increase the time scale so that several periods of the output waveform are visible. Once you take the fft you can see each sideband in the frequency domain and confirm they are at 760 and 840 kHz. The carrier at 800kHz should be suppressed and barely if at all visible. Measure the amplitude of each sideband which should correlate with your time domain plot. You can save a copy of the FFT plot for your report.

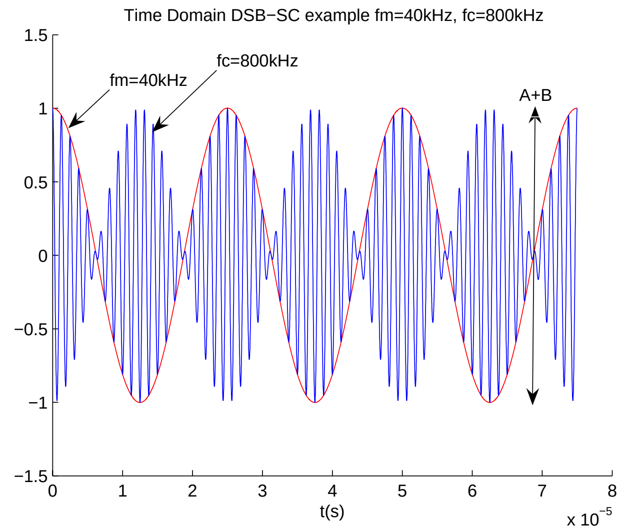

Figure 1: DSB-SC output waveform

4) Create a table of Vo vs Vin (peak-peak values) and plot a graph to show the linear range of operation and when the output compresses. Calculate the linear range based on the formula given on page 8-20 of the datasheet. You might want to save a plot of the output at the point where it starts to clip for your report. If you cannot get a large enough input signal level to compress the output you may need to use one of the spare signal generators in the lab, or simply report that the measured linearity is higher than x volts (your maximum achievable signal amplitude).

5) Measure the inductor value and Q on the LCR impedance analyzer in the lab. Extrapolate the Q value from the measured frequency (100khZ usually) to your operating frequency of 800kHz. Save a copy of the time domain and FFT plots for your report. Time domain plot should indicate the modulating input and output signal levels pk-pk. FFT plot should clearly show effect of the tuned circuit in suppressing the lower sideband. FFT plot should be in dB scale.

6,7)Follow directions in lab manual. Extract the amplitudes of the upper and lower sidebands from the time domain plot and correlate with the FFT plot. Save a copy of the plots for the report. Compare with calculation using the appropriate gain formula.

8,9)Adjust the centre frequency so that the lower sideband is in the passband of the LC filter. Extract the amplitudes of the upper and lower sidebands from the time domain plot and correlate with the FFT plot. Save a copy of the plots for the report. Compare with calculation using the appropriate gain formula

If your filter resonant frequency is not correct, (and it is not likely that it will be unless you spend way too much effort in doing the design) for example, if it is at 900 kHz, simply move your carrier frequency so the sidebands are at 900 kHz. Don't spend any time correcting the filter centre frequency.