SSB Demodulation

Topic	Student Name	Date	Course Leader
SSB Demodulation	Wojciech Rościszewski-Wojtanowski (ID: 140062)	10/05/2020	Dr. Inż. Łukasz Matuszewski

This laboratory exercise expands the characteristics of the SSB linear demodulation. Demodulation is performed consistently. In fact, this can demodulated using MATLAB Hilbert transform script; however this isn't the practice of this experiment as here we will be using a program called Tina TI.

Introduction

SSB, else known as Single – Sideband Modulation (SSB-SC – Single – Sideband Modulation Suppressed Carrier) modulation is commonly used for audio / radio transmission. For example SSB-AM is a popular modulation type that is commonly detected by a product detector – it is very commonly used by radio enthusiasts as well as the military (in *HF communication systems). This is very interesting as the bandwidth is the same as the modulating signal itself, to be more precise this is an exact half of a DSB – SC or AM signal.
***HF-** High frequency

Measurements

All measurements for this experiment were simulated using the program TINA TI where we will assemble circuits for the SSB signal generation. All measurements for this experiment were simulated using the program TINA TI.

As seen in the figure below, I have created a circuit acting as a all-pass filter, phase shifter, which realizes a shift in phase of 90 degrees at a frequency of 15kHz. All of the parameters and circuit base has been provided in the instruction manual. The voltage generator has been set to an amplitude of 1V and 1.5kHz in frequency.

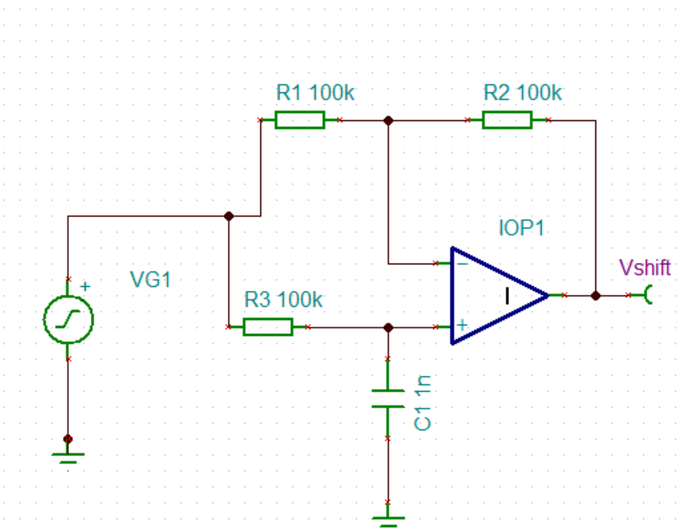

Figure 1.1 – Presents the phase shifter circuit with parameters provided above.

In the below please notice an exported graph/plot from the Transient analysis mode set to 2ms as stated in the instructions.

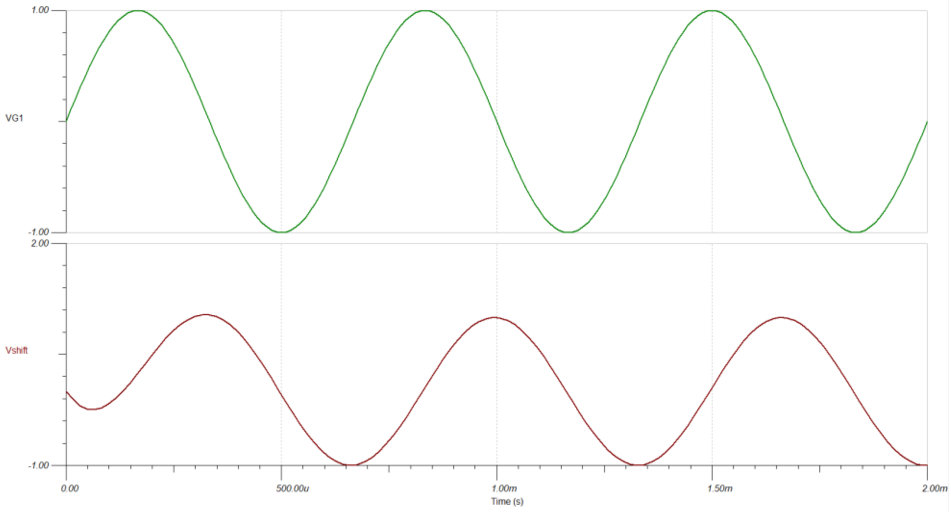

Figure 1.2 – Presents results of the transient state set according to provided parameters.

As per instructions I have checked the phase difference, we can either seek this difference by using a formula a(t)=Amax*sin(wt+phi) or in this particular case I have used the labels and marked out the center points of my signal flows where I realistically measured the actual phase shift. From figure 1.2 the phase shift was 1.58.85us, please see figure below showing a screengrab of this measurement.

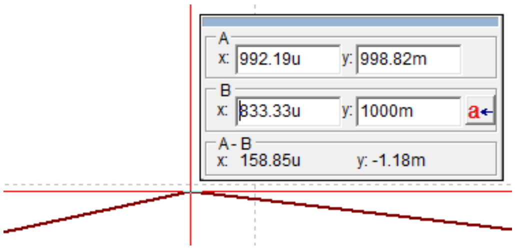

Figure 1.3 – Presents results of the transient state labels showing phase shift difference made.

In the below please notice an exported version of the graph drawn by our graph with use of the Transient analysis mode set to 2ms as stated in instructions. As we can see we have an output signal generated that has amplitude of around 30V (see below figure 1.3 and find figures 1.4 and 1.5)

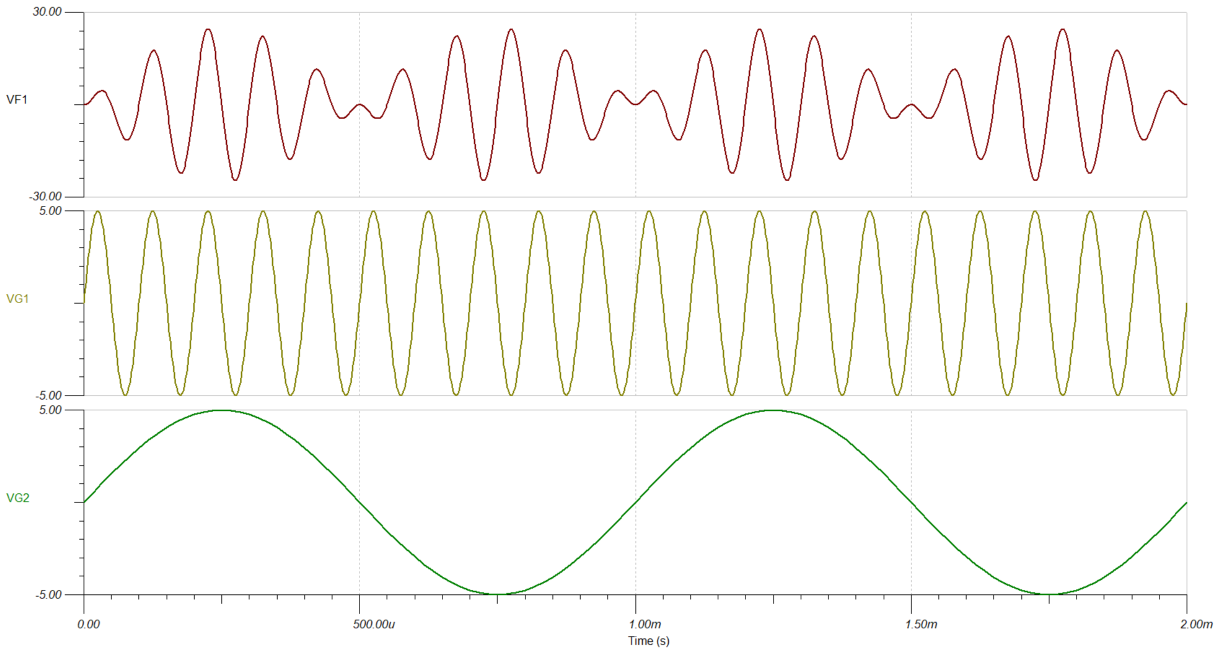

Figure 1.3 – Presents results of the transient state set according to provided parameters.

In the figures below please find the MAXIMUM and MINIMUM amplitudes of our output signal. To begin we will present the maximal amplitude value:

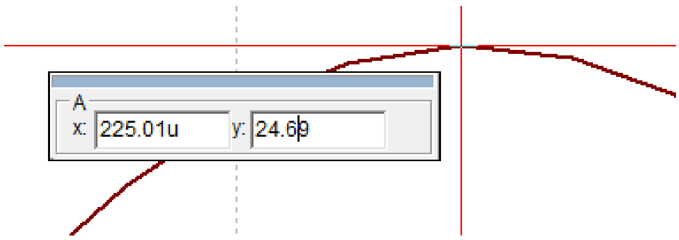

Figure 1.4 Presents the maximum amplitude of output signal

Below please find figure 1.5 presenting the minimal amplitude value.

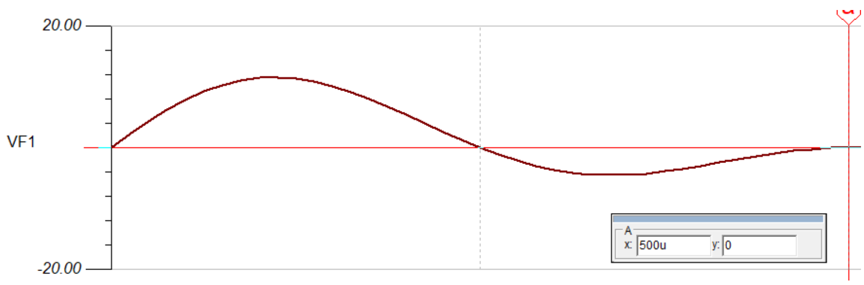

Figure 1.5 Presents the maximum amplitude of output signal

Figures above only present and confirm that my circuit produces a viable sinusoidal wave as per provided parameters in manual, therefore we can continue the laboratory simulation.

Moving on forward, by using previously provided instructions I have constructed the following circuit below. This circuit has RC components found on the output, creating a low pass filter of our signal.

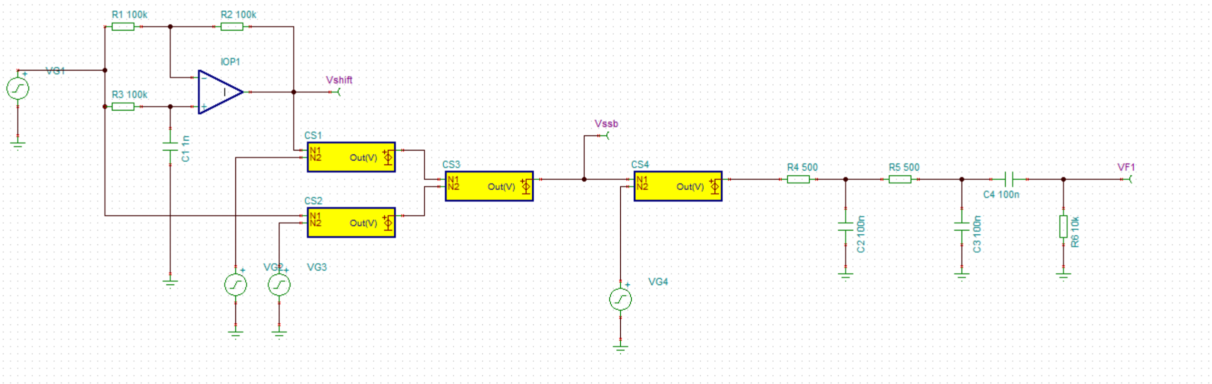

Figure 2.1 Presents new circuit with LP filter.

By using provided instructions to this laboratory, I have set the voltage gates with correct parameters, below please see a list of parameters that were chosen for specific gates.

VG1 – Sinusoidal wave with an amplitude of 1V and a frequency of 1.5kHz (this is our message)

VG2 – Sinusoidal wave with an amplitude of 1V and a frequency of 30kHz and a phase shift of 90 degrees

VG3 – Sinusoidal wave with an amplitude of 1V and a frequency of 30kHz (this is our carrier)

VG4 – Sinusoidal wave with an amplitude of 5V and a frequency of 30kHz (this is our heterodyne)

Since CS4 is not described in the manual I can only assume that since this is our heterodyne, we must multiply the inputs together.

Below please see the output results of our simulation from this circuit, I have set the transient analysis end display to 2ms, all outputs have been separated.

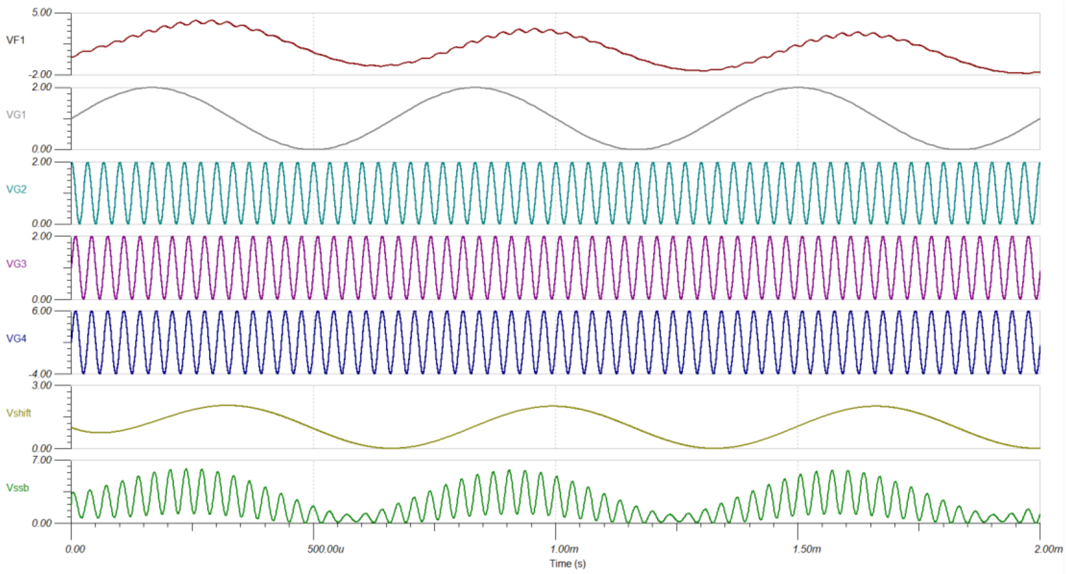

Figure 2.2 Presents simulation with circuit from figure 1.3

As seen in the above out Vssb output signal seems to be correct. As seen out message signal is VG1, our carrier is VG2 and VG3. VG4 is our heterodyne. Whilst vshift is our 90-degree phase shift and as we can clearly see Vssb is our SSB signal.

As per the instructions provided in the manual, I have changed the VG2 parameters of the phase-shift to 30 degrees. From the figure below we can see that out Vssb signal.

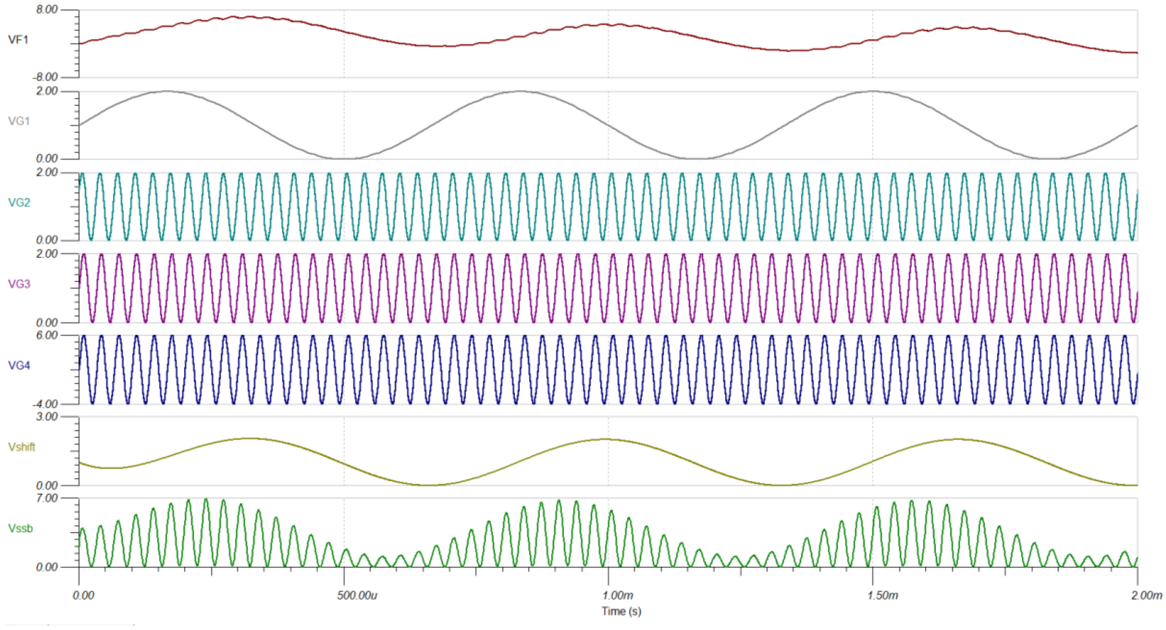

Figure 2.2 Presents simulation with circuit from figure 1.3 with VG2 changed to phase shift of 30 degrees

As seen in the above figure, the change to our results was that out ssb demodulated signal has a new changed characteristic being the amplitude, amplitude has increased to 7V. whilst before it was roughly 6V.

Next step is to change the VG4 parameters to a frequency of 30.5 kHz

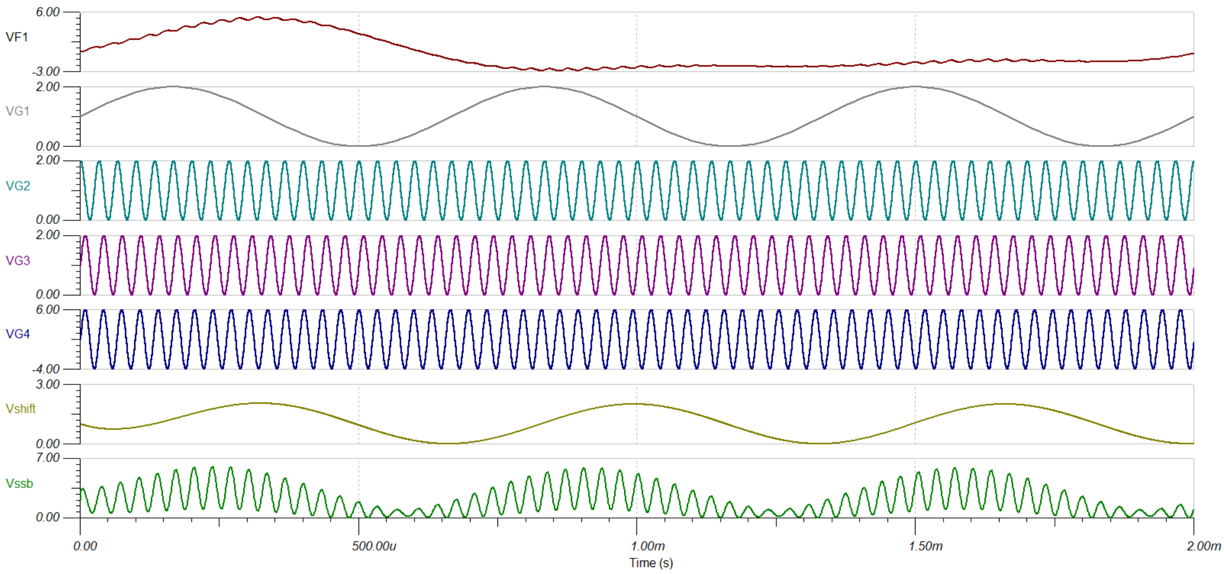

Figure 2.3 Presents simulation with circuit from figure 1.3 with VG4 changed frequency to 30.5kHz

Next step is to change the VG4 parameters to a frequency of 29.5 kHz

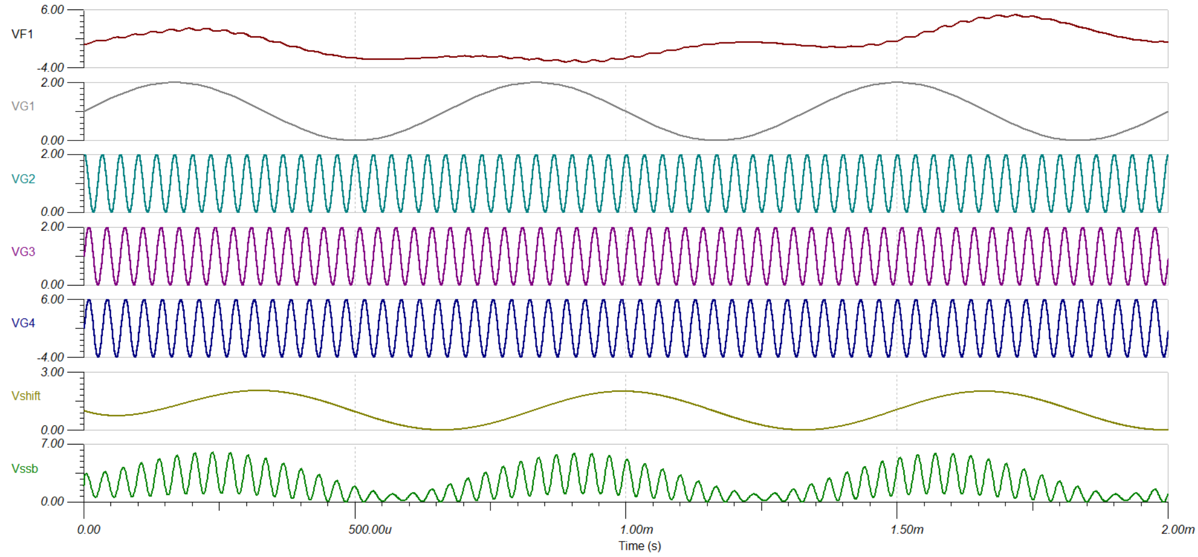

Figure 2.4 Presents simulation with circuit from figure 1.3 with VG4 changed frequency to 30.5kHz

Now next step is purely a comparison between the two plots. As seen in the figure above, there was very little change. Only noticeable change from the plots is VF1 pattern changes.

All changes have been reset to previous state. Now we will proceed and load the .wav file included with instruction manual into VG1 as a signal. The simulation has been ran for 2s.

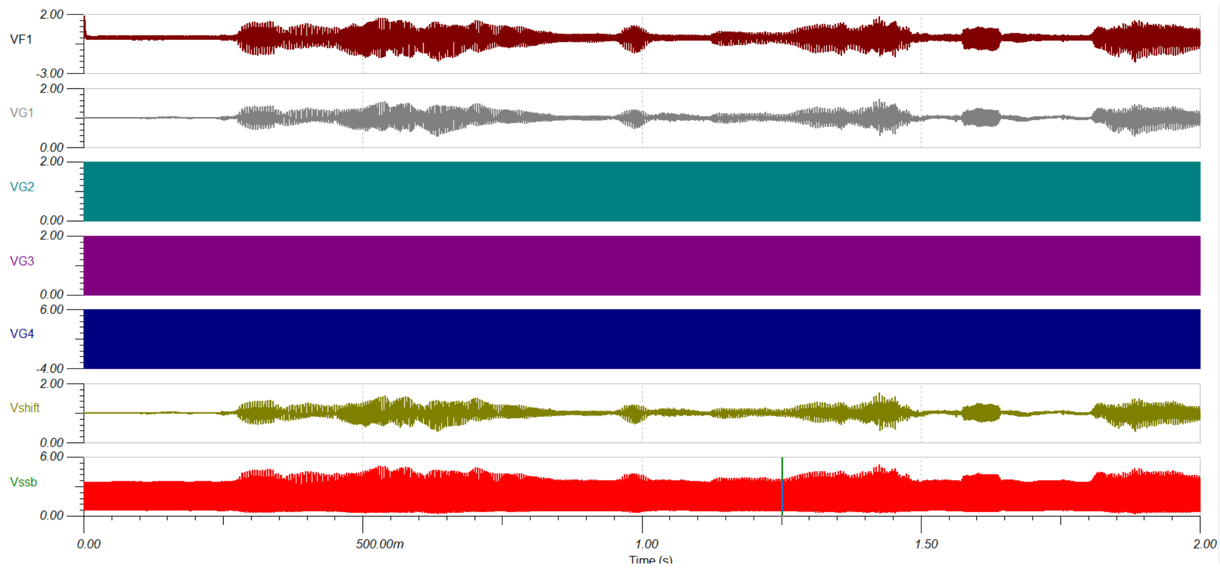

Figure 3.1 Presents simulation with circuit from figure 1.3 with VG1 having .wav input file.

For the next step, I've changed the parameters of VG2 and set a new phase shift of 30 degrees as per instructions in the manual provided.

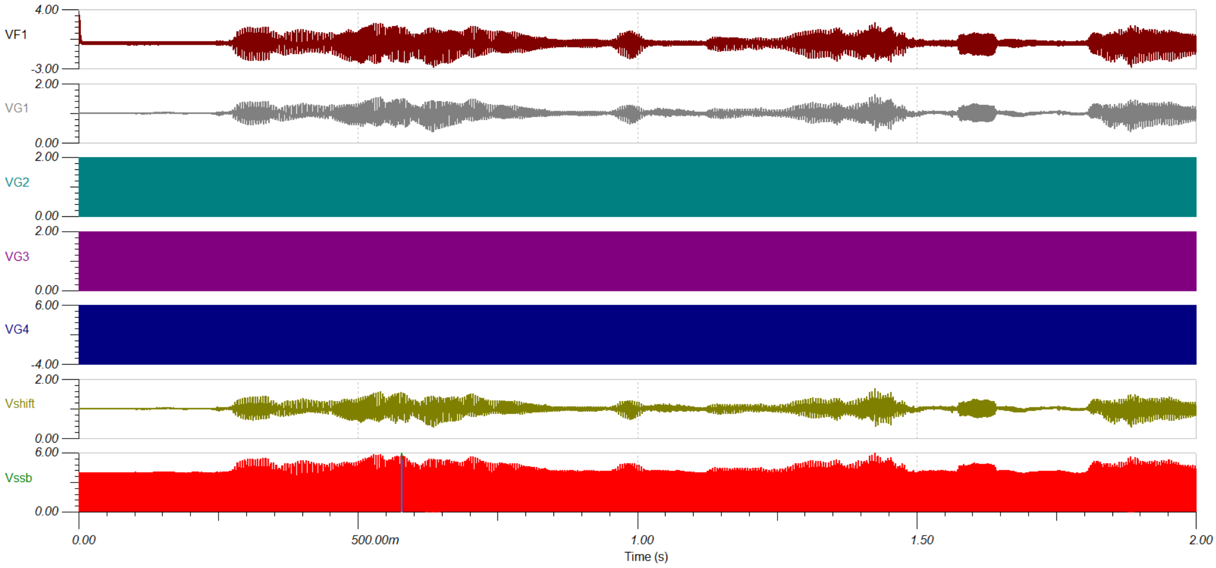

Figure 4.2 Presents simulation with circuit from figure 1.3 with VG1 having .wav input file and VG2 having 30 degree phase shift.

From the simulation above we see that by changing the phase shift of our input signal our amplitude of output signal is far more higher than when the phase shift was set to 90 degrees. When listening to this sound we can hear much more higher frequencies than before.

For the next step we changed back the VG2 signal phase to its original state of 90 degrees and then proceeded to change VG4 signal frequency to 30.5 kHz

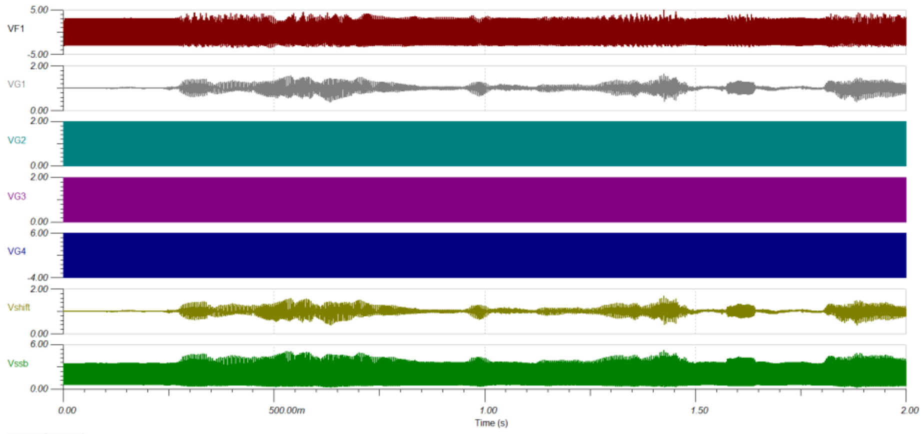

Figure 4.3 Presents simulation with circuit from figure 1.3 with VG1 having .wav input file and VG4 frequency set to 30.5kHz

For the next step we changed the VG4 frequency to 29.5 kHz

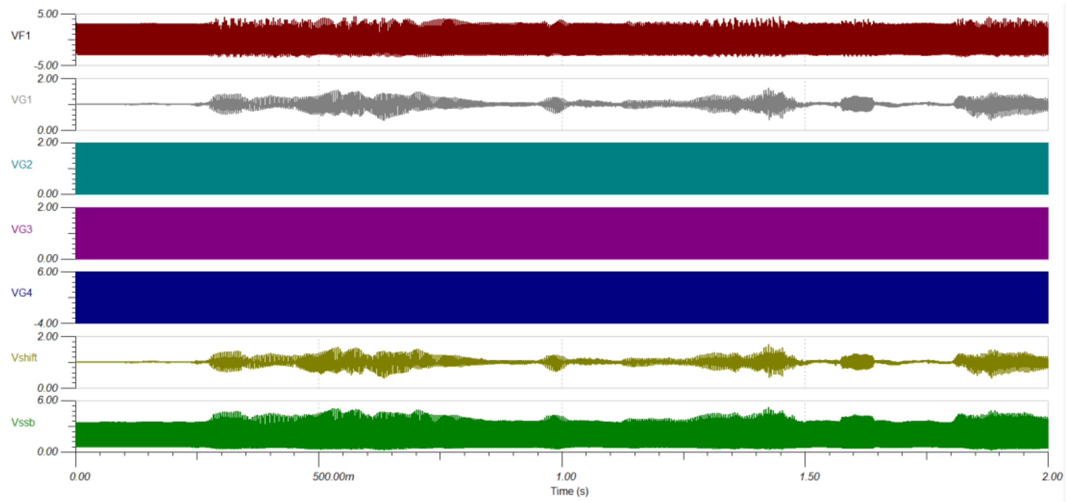

Figure 4.4 Presents simulation with circuit from figure 1.3 with VG1 having .wav input file and VG4 frequency set to 29.5kHz

From the following simulations we see that our simulation has a pattern, where the demodulated signal has no effect on the frequency change in the VG4 however the effect can be visible in VF1. Another factor worth mentioning is that the phase change affects amplitude of the output signal. We know that a true SSB method of demodulation should be able to select all sidebands. I assume that by generating a 90 phase shifter we have some strange results