AM Modulation

Topic	Student Name	Date	Course Leader
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This laboratory exercise expands the characteristics of the AM (amplitude modulation) linear modulation. Usually an AM demodulator consists of a diode which has its parameters set to in order to perform the role of an envelope detector. 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

AM is a type of modulation that is very popular type of communication within electronic signals. An example of this could be a radio wave carrier wave. In order to introduce this further I believe that it'll be easier to introduce some theory from the lecture. For the sake of understanding let a(t) reperesent any arbitrary wave which is being transmitted (message) and let A represent it's amplitude:

$$a(t) = A * \cos\left(f_c t + \emptyset\right)$$

Below please find the model of a sine carrier wave representation:

$$c(t) = A * \sin\left(f_c t + \emptyset\right)$$

For both the frequency [Hz] of an audio tone is given by:

$$w_c/2\pi\ ;\ w_a/2\pi$$

Since we have all of the information provided already in front of us, we can now biuld y(t) being our amplitude modulation (AM) signal. And from this we know that our modulated signal is built up of three main componenets, a carrier wave and <u>two</u> sine waves. These sine waves are often referred to as sidebands.

$$y(t) = A * \sin(w_c t + \emptyset) + \frac{A^2}{2}\left(\sin(w_a + w_c)\, t + \emptyset) + \sin\left((w_c - w_a)t - \emptyset\right)\right)$$

We can conclude this introduction section with the information that AM is different than frequency modulation and always must be taken into account as for frequency the carrier and phase signal is varied.

Measurements

All measurements for this experiment were simulated using the program TINA TI where we will assemble circuits for the AM signal generation.The question describing AM signal is:

$$s(t) = A_c \cos(w_c t + A_c k_{AM} m(t) \cos\left(w_c t\right)$$

In Transient Analysis:
As seen in the figure below, I have added a controlled source as requested in the instruction manual. According to the given instructions and parameters I have set the expression as CS1 = V(N1)*V(N2) and number of voltages to two entries, later I proceeded to insert the generator with given VG1 and VG2 parameters.

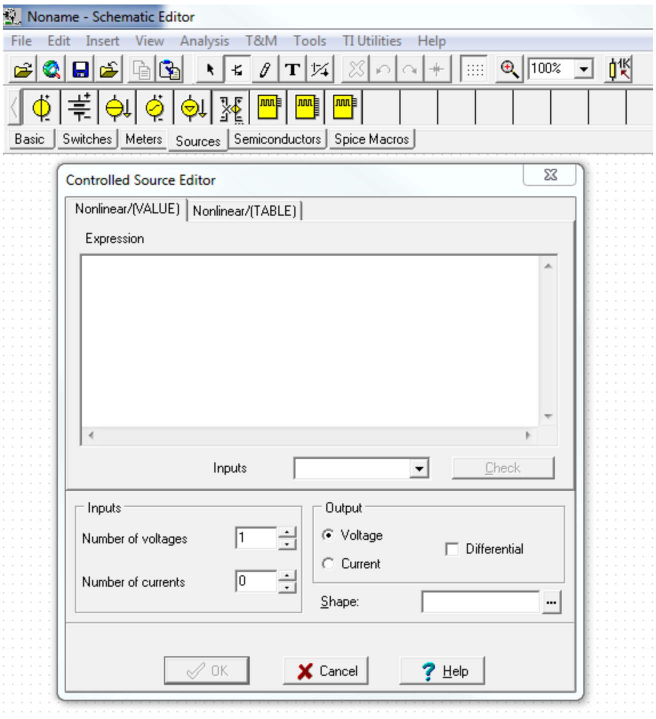

Figure 1.1 – Presents the process of specifying controlled sources.

Below please find the parameters that have been provided into the simulation for the voltage generators as given in instructions.

VG1 – Set to sine wave; amplitude of 5V; frequency 10 kHz (carrier)

VG2 – Set to sine wave; amplitude of 5V; frequency 1 kHz (message)

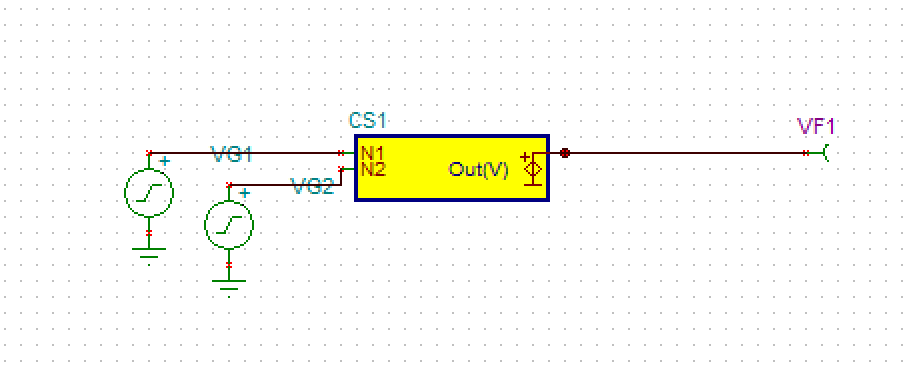

Figure 1.2 – Presents the generated voltage generator according to parameters provided. One controlled source and two voltage generators

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 equivalent to estimately 30V.

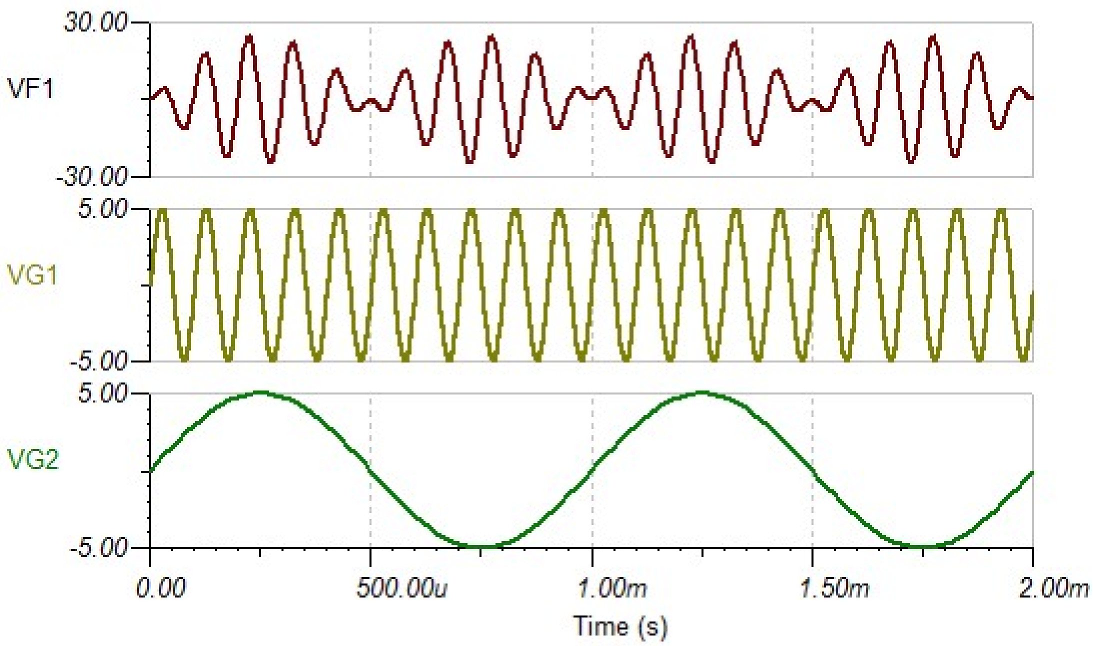

Figure 1.3 – Presents results of the transient state set according to provided parameters.

In the below please find a figure that presents the new circuit with our new summing-controlled source, here I have followed all parameters provided.

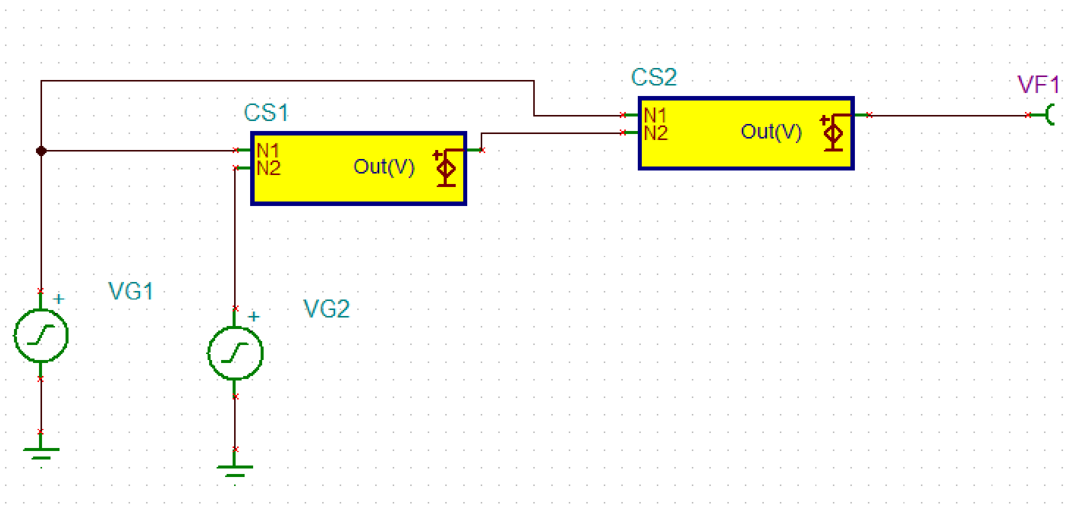

Figure 2.1 Presents new circuit with summing generator

Below please see figure 2.2, which shows the new output simulation where can see that changing parameters of VG2 to 0.5V with 1kHz frequency makes a big change in the signal. We can see that the max output voltage of our message signal is estimately 7.4V.

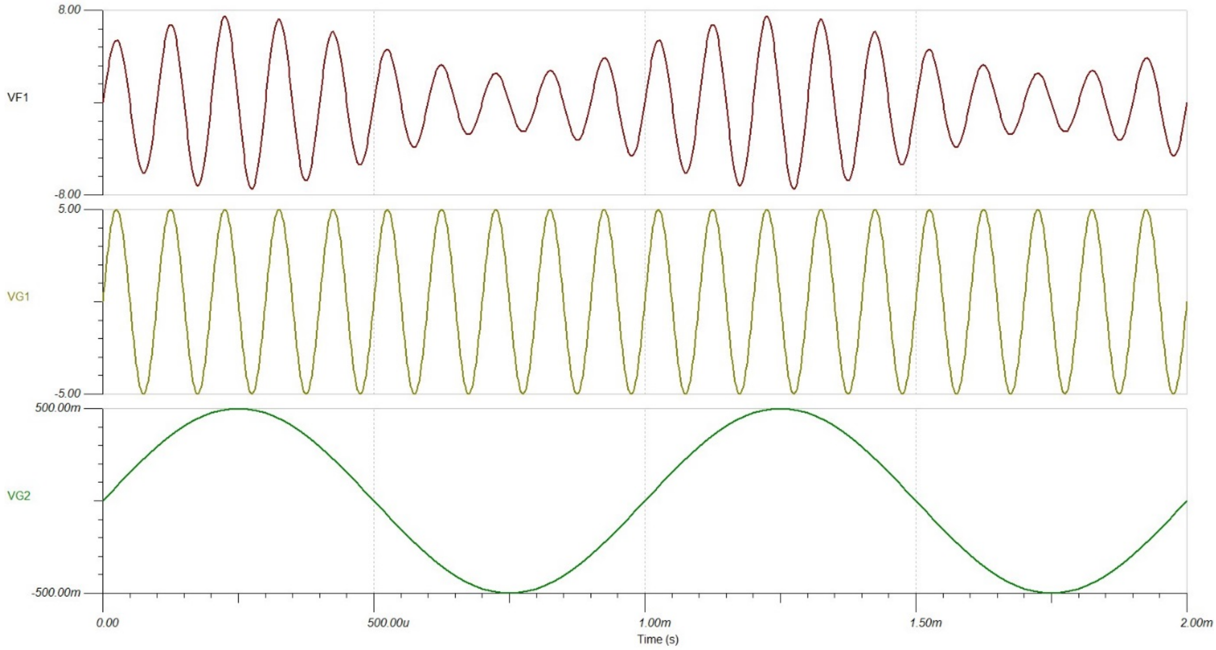

Figure 2.2 Presents simulation with new parameters for VG2 set to amplitude 0.5V.

Below please see figure 3.1, which shows the Fourier analysis. We see our 20 harmonics. We see that in our phase we have a sine waveform.

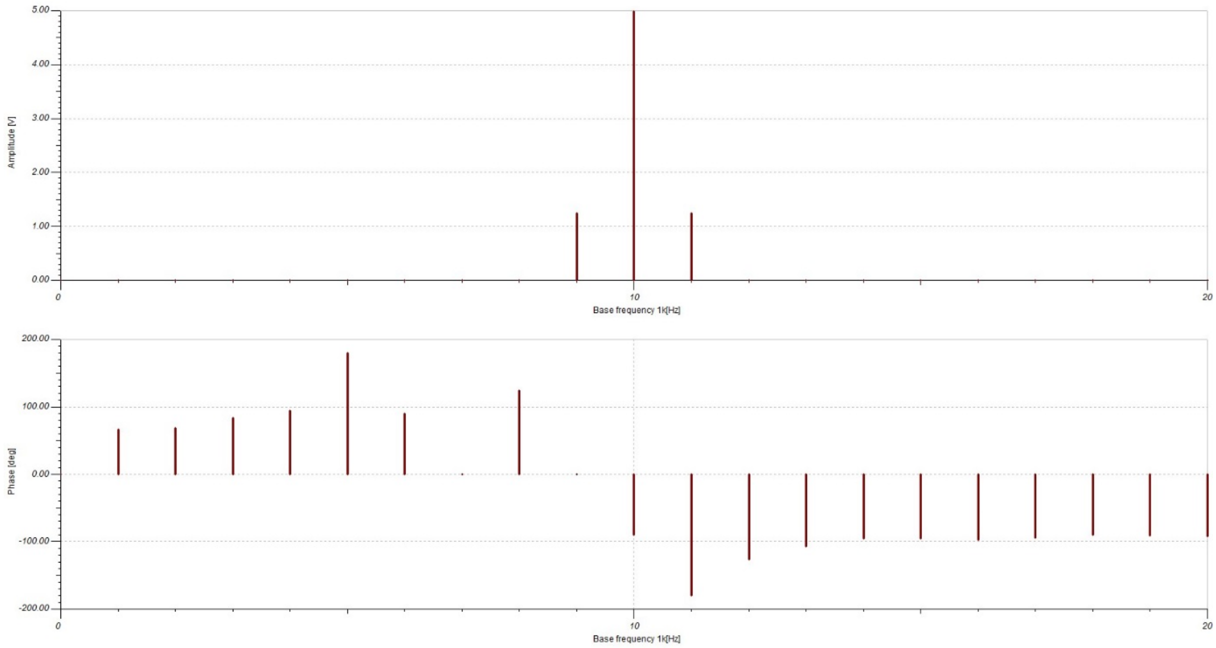

Figure 3.1 Presents graphed calculations of Fourier Series analysis

Simulation repeated by using random parameters with frequency setting kept the same, please find them included:

Cosine Wave Form:
VG2 Parameter = 0.1V

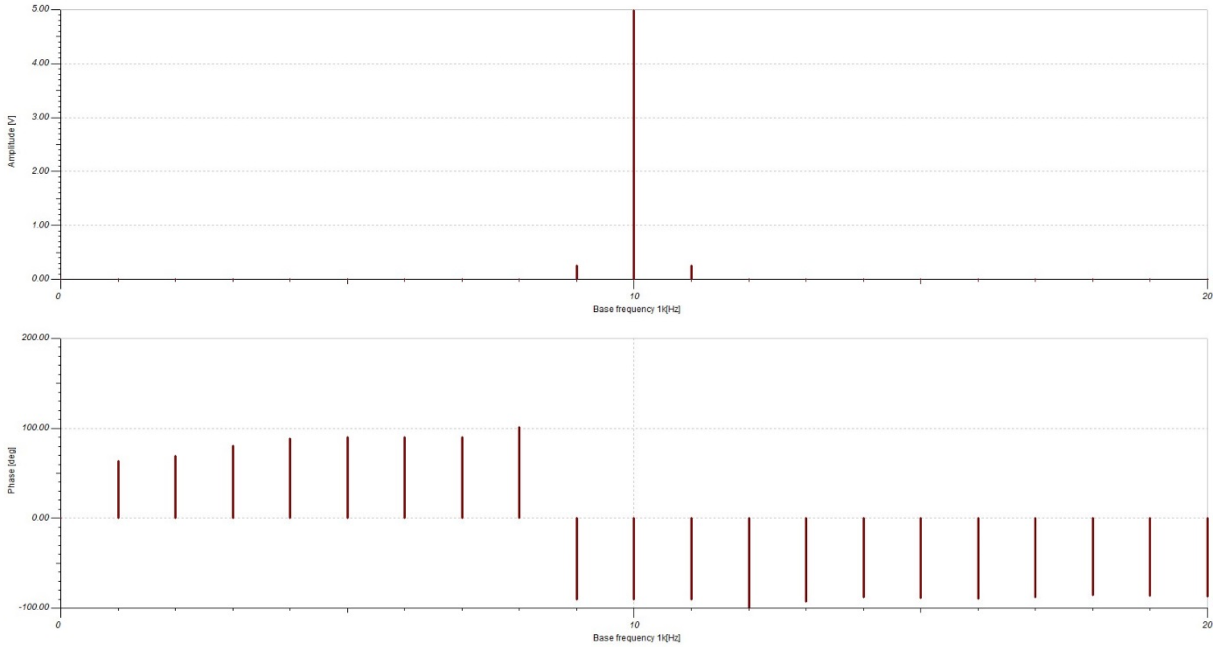

Figure 4.1 Presents graphed calculations of Fourier Series analysis using provided parameters

Triangular Wave Form:

VG2 Parameter = 10V

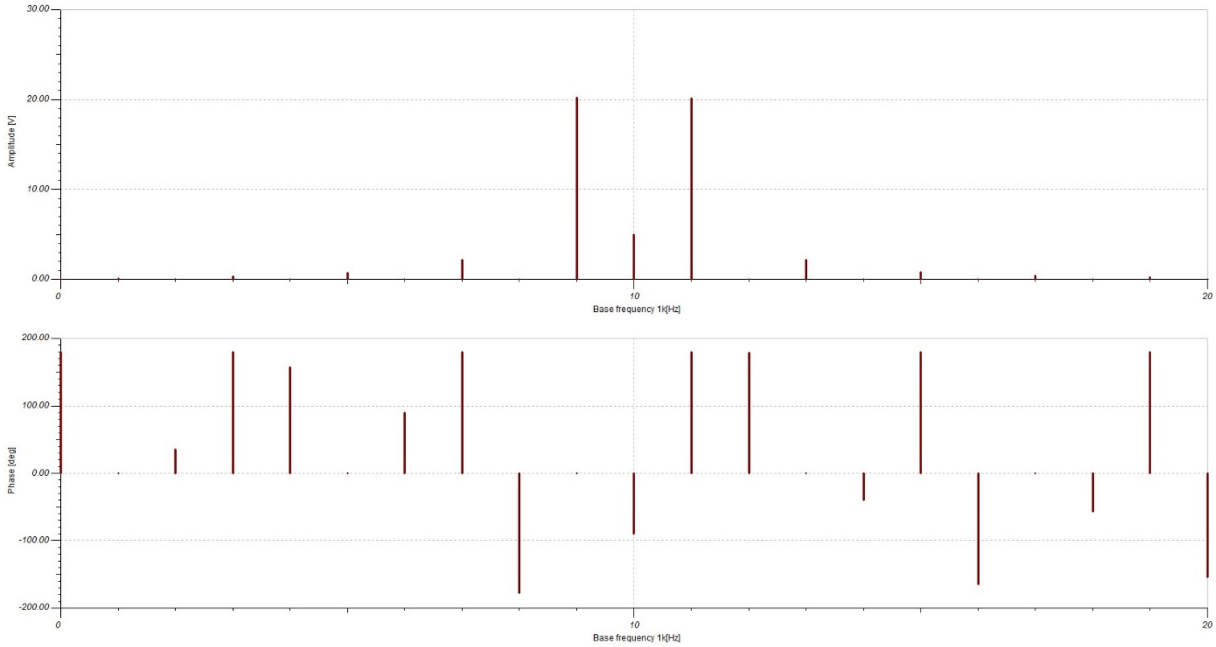

Figure 4.2 Presents graphed calculations of Fourier Series analysis using provided parameters

Square Wave Form:

VG2 Parameter = 50V

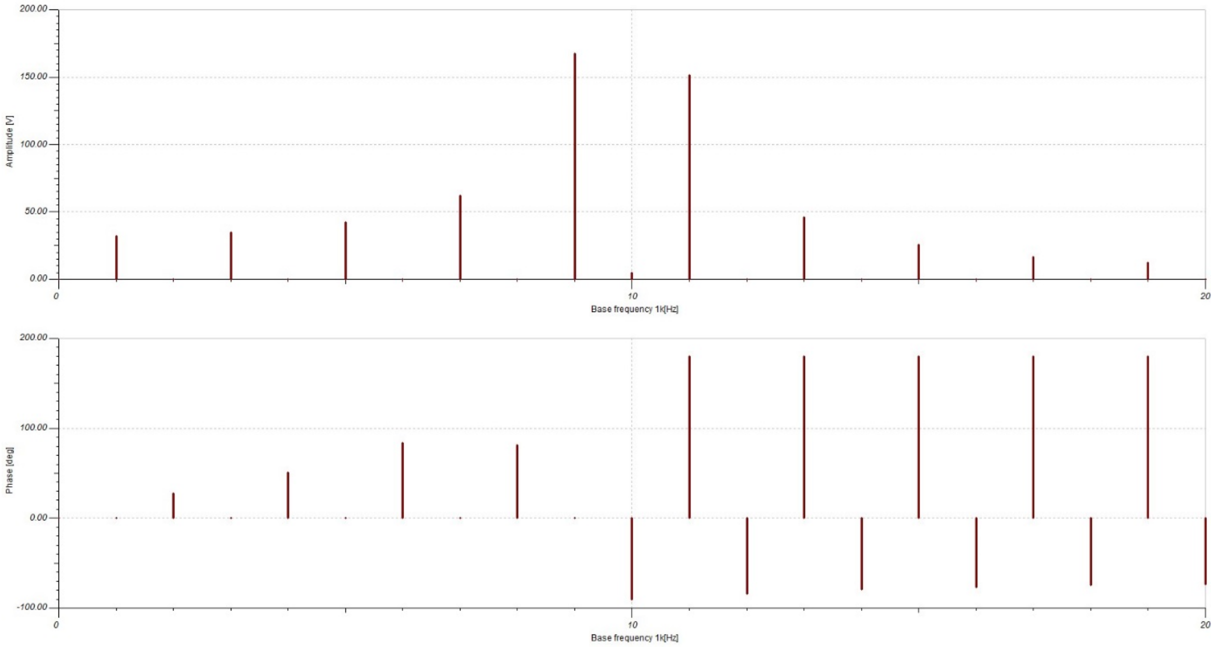

Figure 4.1 Presents graphed calculations of Fourier Series analysis using provided parameters

Conclusion

By changing the value of the amplitude of our message signal, we are able to see that the waveform is changing of course we have changed the values of types of waveforms we used. We have seen distortion of the envelope of the AM signal. To conclude, since this is a very old technique of modulation performing modulation is very limited by two main factors being the power needed as well as the bandwidth. Today we use frequency modulated signals more often than AM, however AM is still used.