BIRZEIT UNIVERSITY

Faculty of Engineering and Technology
Electrical and Computer Engineering Department

COMMUNICATION SYSTEMS
ENEE3309

Course Project – Phase 2 Report
Bread-board Circuit Implementation

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Date: 20/1/2024

Introduction

This project studies the process of normal AM modulation - a mechanism by which wave signals are transmitted by modifying their amplitudes, and AM demodulation - a process of recovering the message signal from the modulated signal. Which are particularly used to transmit information via radio carrier waves, and their spread extends across various areas of electronic communications, including portable two-way radios, citizen radios, VHF aircraft radios, and computer modems.

The project is divided into two phases, where the first phase includes highlighting the theoretical concept, representations and mathematical operations that govern the process of transmitting signals through Normal Amplitude Modulation and Demodulation and then simulating these concepts through the use of the Pspice program to represent circuits. As for the second phase, it is the task of moving from theoretical concepts to practical implementation by building the circuit using a breadboard and then comparing both the results of the theoretical simulating and the results of building the circuit practically. Which aim to contrasting the theoretical section with the practical section and to obtain an idea about the challenges and differences which might face when moving from the theoretical side to the practical side.

Due to the current circumstances and the inability to reach university laboratories or for team members to meet together to build circuits practically, we used the Tinkercade program to obtain a practical simulation, as the program provides a virtual environment for building the circuit practically.

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Solution and Discussion

As mentioned before, we will be using Tinkercade to implement the breadboard circuit. Where we need to build the circuit that we represented using Pspice in the first stage. We combined the two circuits (modulation and demodulation) in the same circuit to make it easier and more accurate.

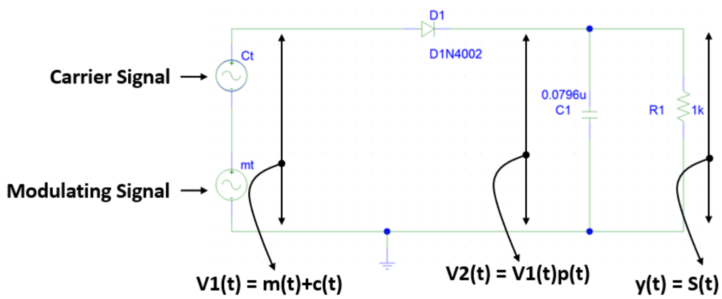


Figure 1: Modulation Circuit in Phase 1

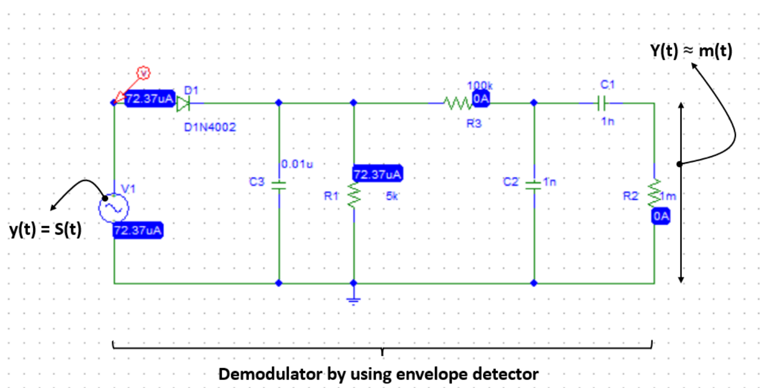


Figure 2: Demodulation Circuit in Phase 1

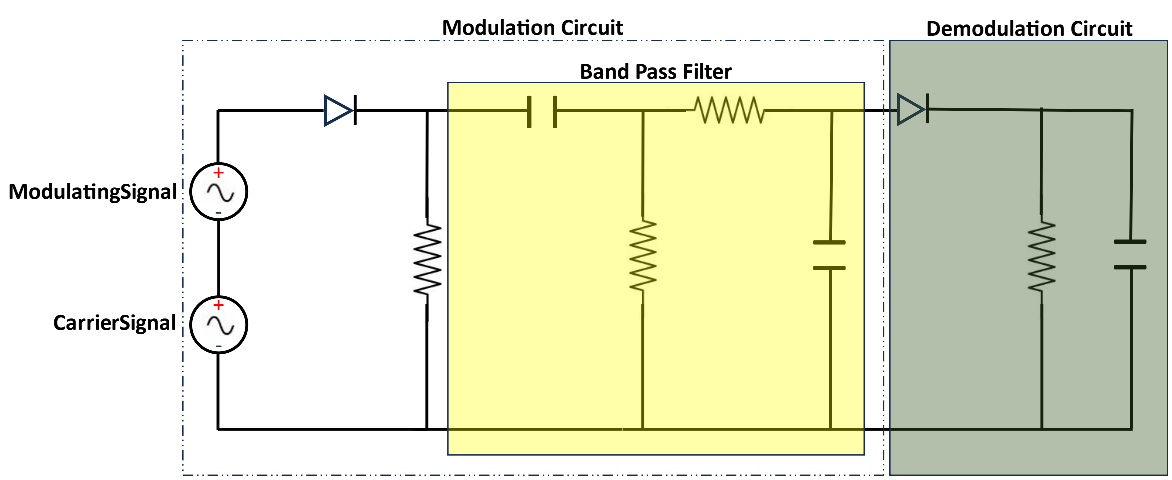


Figure 3: The circuit which combining the processes of Normal AM modulation and demodulation.

To implement this circuit, we need the following components:

Function Generator	**To represent the Modulating and Carrier Signals**
Oscilloscope	**To represent the Modulated and Demodulated Signals**
Diode	
Capacitor	
Resistance	
Bread Board	

Note: In the simulation, the modulating signal (message signal) and the carrier signal are represented by function generators, with their parameters such as amplitude and frequency. The circuit components, including diodes, capacitors, and resistors, are connected on a virtual breadboard. The oscilloscope within Tinkercade displays the modulated and demodulated signals, allowing for visual comparison with the theoretical results obtained in Phase 1.

Now we need to implement the circuit on bread board:

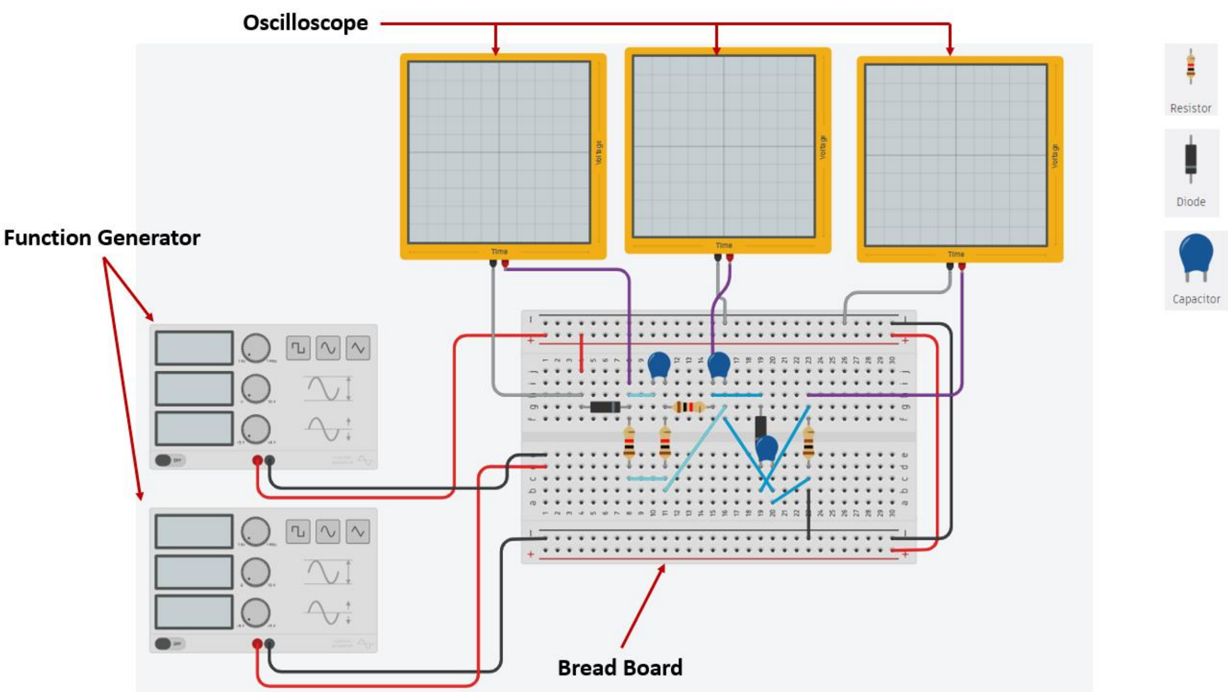


Figure 4: Circuit in Tinkercade

After we connects the components together, we need to set the information for them:

- ⇨ Modulating Signal/Message Signal:

$$m(t) = A_m \, cos(2\pi f_m t)$$

Where A_m is the message amplitude where $A_m = 0.8$ volt. And f_m is the message frequency where $f_m = 1000$ Hz.

⇨ Carrier Signal:

$$c(t) = A_c \cos(2\pi f_c t)$$

Where A_c is the carrier amplitude where $A_c = 2$ volt. And f_c is the carrier frequency where $f_c = 10000$ Hz.

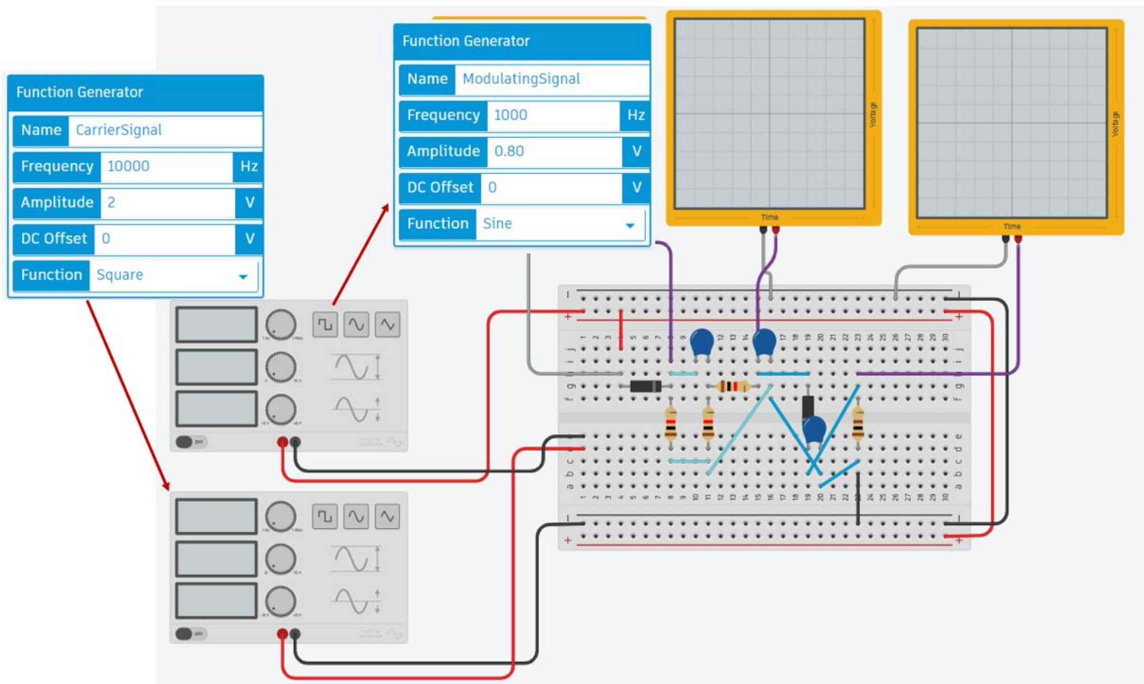


Figure 5: Modulating and Carrier Signals Information

Now to build the Band Paes Filter:

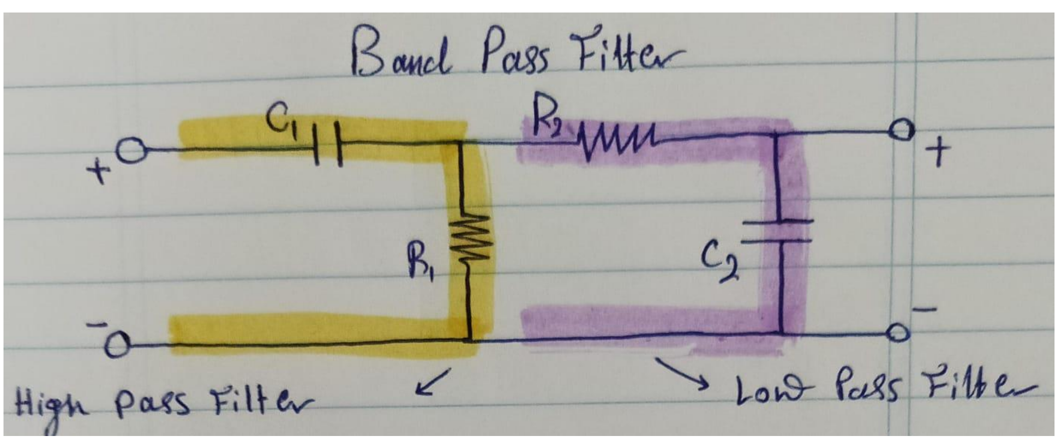
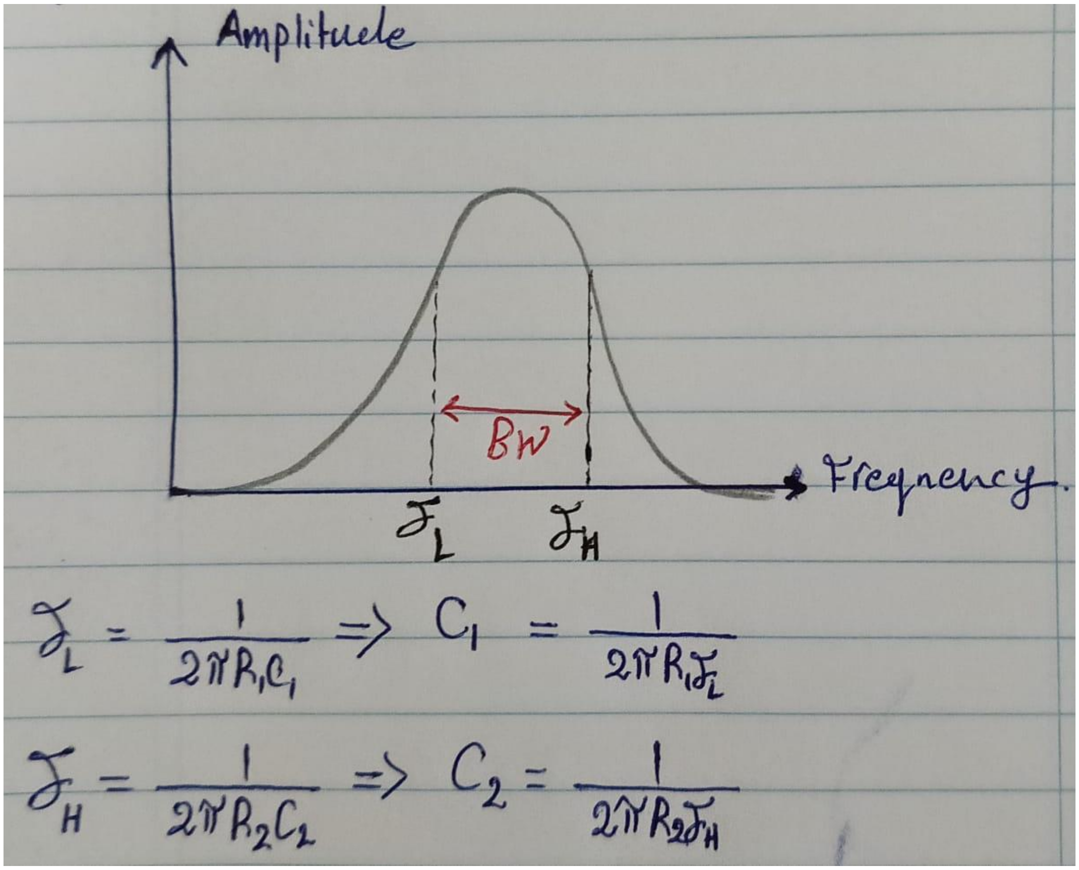


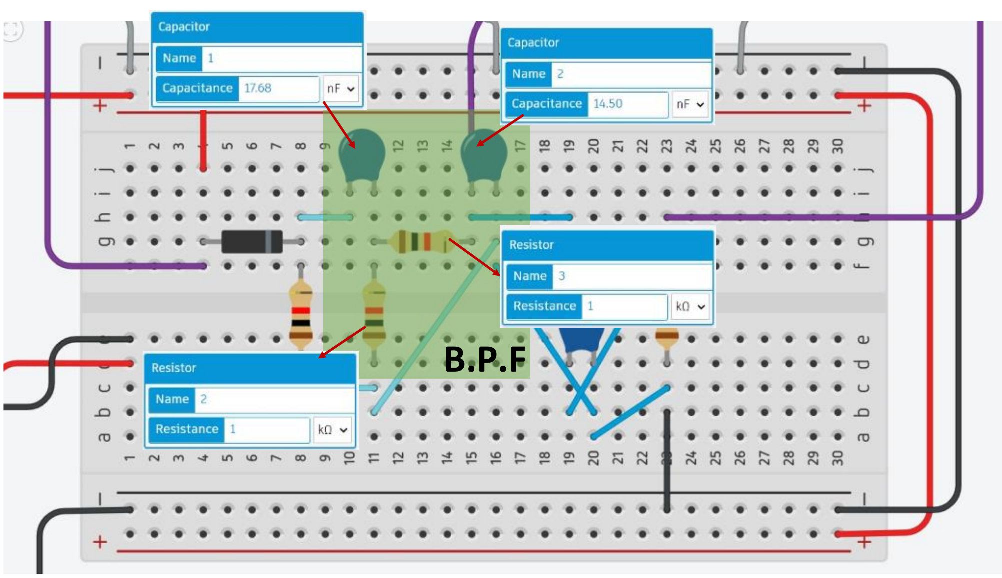
Figure 6: Band Pass Filter Circuit



From the above, we can calculate the value of the components that we need to build the B.P.F:

F_L => lower side frequency, $F_L = 9000$ Hz and F_H => higher side frequency, $F_H = 11000$ Hz.

So, if we assume that $R_1 = 1K\ \Omega$ and $R_2 = 1K\ \Omega$, then $C_1 = 17.68$ nF and $C_2 = 14.5$ nF



Finally, to build the Demodulator signal, $\mathbf{1/f_c << RC << 1/f_m}$. If we assume that R = 1K Ω then we can take the value of C = 0.55 μF.

Now if we simulate the circuit, we will have the following result:

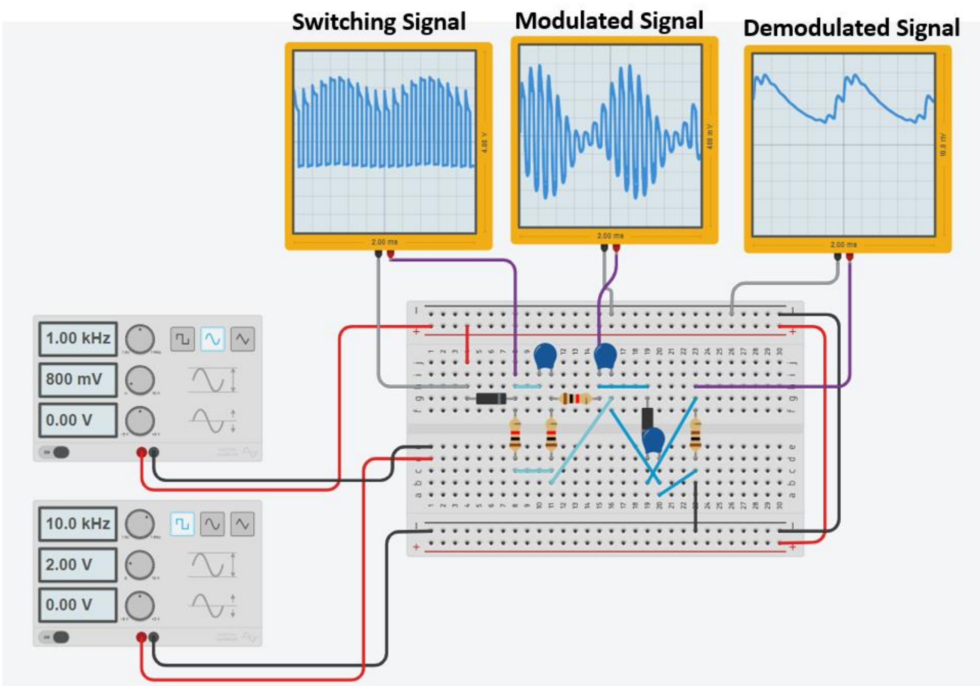


Figure 7: Tinkercade Circuit Result

Now if we compare the results that we have from Pspice and the result we got from Tinkercad:

Figure 8: Signal in Pspice vs. Signal in Tinkercad

Observing the outcomes, we note that the results are fairly similar but there are some differences. These differences may be attributed to factors including the precision of the simulation software, the specific device model employed in the simulation, or even the settings configured for the oscilloscope display within Tinkercad.

Overall, the comparison of simulated results between Phase 1 and Phase 2 of the project shows that both PSpice and Tinkercad simulations are close in terms of the outputs for modulated, switching, and demodulated signals. While PSpice offered more details into the theoretical aspects of the signals, Tinkercad provided a more interactive approach, simulating real-world conditions. On the other hand, some differences could be attributed to various factors such as the simulation software's accuracy, the hardware model in the simulation, or even the settings used for the oscilloscope display in Tinkercad.

Conclusion

In conclusion, this project has undertaken a comprehensive exploration of Normal Amplitude Modulation (Normal AM) in electronic communication systems, encompassing both theoretical analysis and practical implementation. The initial phase involved a meticulous examination of AM modulation and demodulation through the simulation using PSPICE, shedding light on the mathematical intricacies governing signal transmission. In the second phase, the project successfully bridged the gap between theory and practice by virtually constructing the circuit on a breadboard using Tinkercad. The comparison between theoretical simulations and practical implementations provided revealing both similarities and subtle differences. These variations, attributed to factors such as simulation software accuracy and device models, underscored the complexity of translating theoretical concepts into practical circuits.