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# Simulink Implementation of Amplitude Modulation Technique using Matlab

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**Abstract** – Nowadays Communication plays vital role in various aspects of human being as it provides the information of new technology, innovations, research going on around the world. Also in our personal life, most of the people use the entertainment media like television, radio, internet and newspaper to get ourselves updated. We convey our messages to someone through voice, facial expressions and gestures. This is the communication method between human beings. But technically these messages can be base-band audio, video or digital bits from computer. Telecommunication is the core part for sending messages from one place to another place. In this paper we are discussing on modulation which is the core mechanism for any telecommunication device. Also in this paper we have implemented amplitude modulation technique with the help of matlab-simulink.

**Key Words:** AM-Amplitude Modulation, m-Modulation Index, fc-Carrier frequency, fm-modulating frequency.

## 1. INTRODUCTION

There are three basic elements of electronic communication system a Transmitter, Receiver & Communication channel. The transmitter is a important block in any communication system which is used to convert the information signal into a signal suitable for transmission over a given communication medium. The receiver is a set of devices designed to convert the signal which was transmitted by transmitter back to the original information. To transmit the information signal from one place to another place, communication channels are used as medium. The communication channel can be of two types: wired communication channel ,example- Twisted pair cable, Coaxial cable Fiber optic cable and wireless communication channel, example- RF links, microwaves.

In communication system there are chain of Electronic devices which are used to produces information in form of baseband signals, which can be video signal, audio signal or computer data bits . To send these information from one location to another location i.e from sender side to receiver side, we must implement some communication channels like twisted pair cable, coaxial cable, even wireless radio waves, microwaves or infrared. But the baseband signals are low frequency signal which are not modulated, so baseband signals

cannot be used for radio transmission where medium is free space. This is because baseband signals cannot travel over longer distance in air. After travelling certain distance it gets suppressed. To avoid this we use modulation techniques.

Modulation technique involves mixing of modulating signal with carrier signal, where modulating signal is low frequency information signal and carrier signal is high frequency signal. Modulation is the process in which one of the parameter of carrier wave is varied with respect to modulating signal. These parameters can be amplitude, frequency & phase. The modulation process reduces the height of antenna, avoid mixing of signals, Improve quality of reception, and increase the communication range.

## 2. AMPLITUDE MODULATION

Amplitude modulation is the process in which amplitude of the carrier wave will change in accordance with the modulating signal wave.

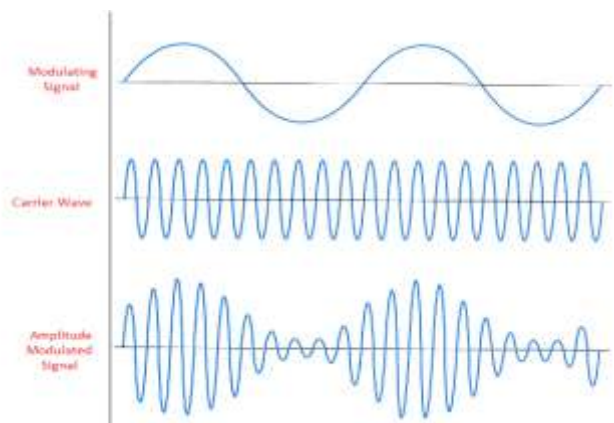
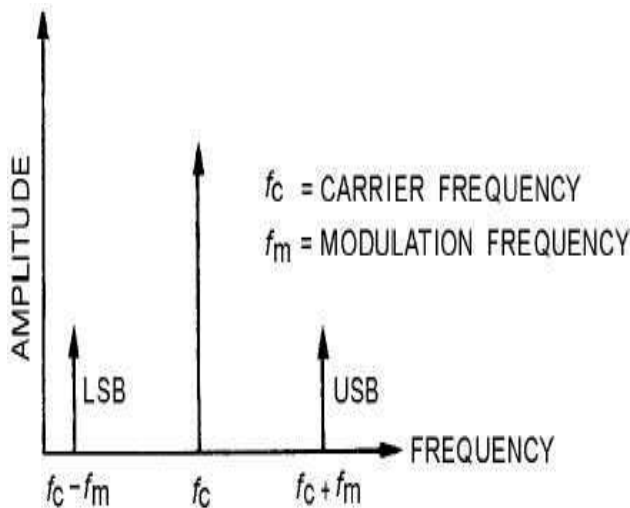


Fig -1: AM Waveform

The waveform of AM consist of two signals, modulating that is baseband or low frequency signal and carrier that is high frequency signal. These two signals are mixed together in modulator to obtain Amplitude Modulated Signal. There are three types of AM modulation :

- Perfect Modulation
- Under Modulation
- Over Modulation

The modulation index  $m$  decides the type of modulation in AM. The modulation index  $m$  is defined as the ratio of amplitude of modulating signal to amplitude of carrier signal. When the value of  $m=1$ , then it is perfect modulation. When the value of  $m<1$ , then it is under modulation. When the value of  $m>1$ , then it is over modulation.



**Fig -2:** Frequency Spectrum of AM

The frequency spectrum of AM wave is the graph of amplitude on y-axis and frequency on x-axis. The frequency spectrum gives frequency component information present in AM wave & their amplitudes. It consists of two sidebands and carrier. One sideband is upper sideband USB & another is lower sideband LSB.

$$e_{AM} = E_c \sin \omega_c t + m E_c / 2 \times \cos (\omega_c - \omega_m) t - m E_c / 2 \times \cos (\omega_c + \omega_m) t$$

The bandwidth of AM is given by,

$$\begin{aligned} BW &= USB - LSB \\ &= f_c + f_m - (f_c - f_m) \\ &= 2f_m \end{aligned}$$

### 3. Time Domain Representation of AM wave

Let modulating signal of AM wave is represented as

$$e_m = E_m \sin \omega_m t \text{ -----I}$$

Where,  $E_m$ - Peak amplitude of modulating signal

$$\omega_m = 2\pi f_m$$

Let carrier signal of AM wave is represented as

$$e_c = E_c \sin \omega_c t \text{ -----II}$$

Where,  $E_c$ - Peak amplitude of carrier signal

$$\omega_c = 2\pi f_c$$

AM wave is expressed as,

$$e_{AM} = A \sin (2\pi f_c t) \text{ ----- III}$$

Where,  $A$ - Instantaneous value of envelope & is given by

$$A = E_c + e_m \text{ -----IV}$$

Put I in IV

$$A = E_c + E_m \sin (2\pi f_m t) \text{ -----V}$$

Put V in III

$$e_{AM} = [E_c + E_m \sin (2\pi f_m t)] \sin (2\pi f_c t)$$

$$e_{AM} = E_c [1 + \frac{E_m}{E_c} \sin (2\pi f_m t)] \sin (2\pi f_c t)$$

$$E_c$$

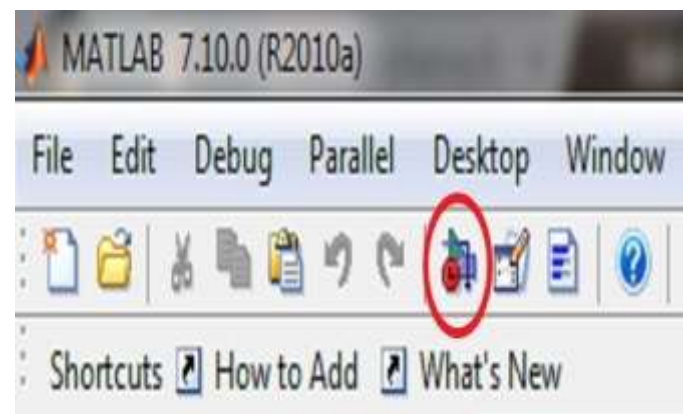
$$e_{AM} = E_c [1 + m \sin (2\pi f_m t)] \sin (2\pi f_c t)$$

### 3. IMPLEMENTATION IN MATLAB

Matlab is a high-performance programming language used for technical application. It supports different toolboxes for engineering computation & interfaces. Simulink is a block diagram environment for multi domain simulation and Model-Based Design. In order to implement AM in matlab we need to design the equation of AM  $e_{AM} = E_c [1 + m \sin (2\pi f_m t)] \sin (2\pi f_c t)$  practically using simulink library blocks.

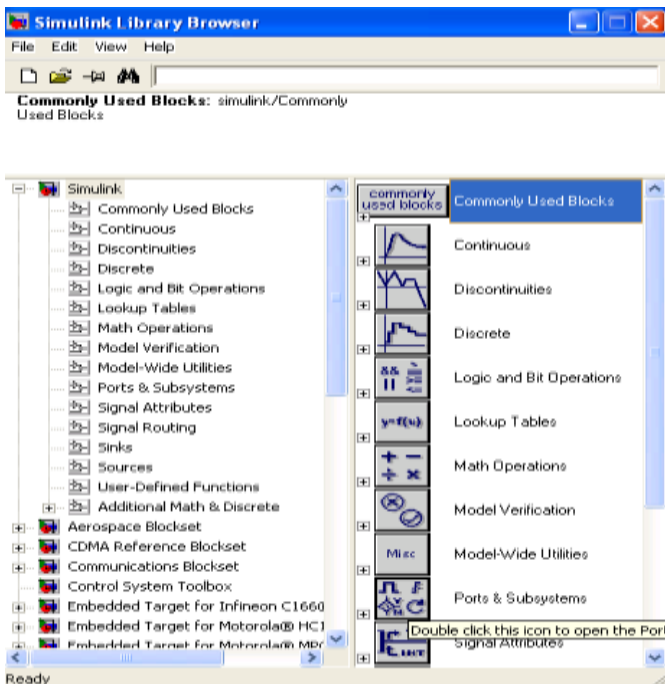
The step by step procedure to Implement AM in Matlab:

- 1) To start Simulink, you must start the MATLAB first
- 2) Now open the Simulink, by clicking on Simulink Icon



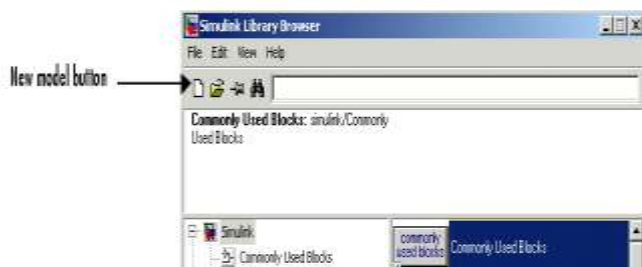
**Fig -3:** Simulink Icon in Matlab

3) It will open simulink library browser as shown below



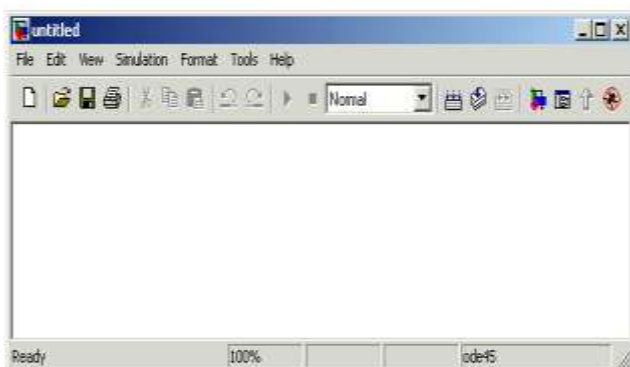
**Fig -4:** Simulink Library in Matlab

4) To create a new model , click the New Model button on the Library Browser's toolbar.



**Fig -5:** New Model button in Matlab

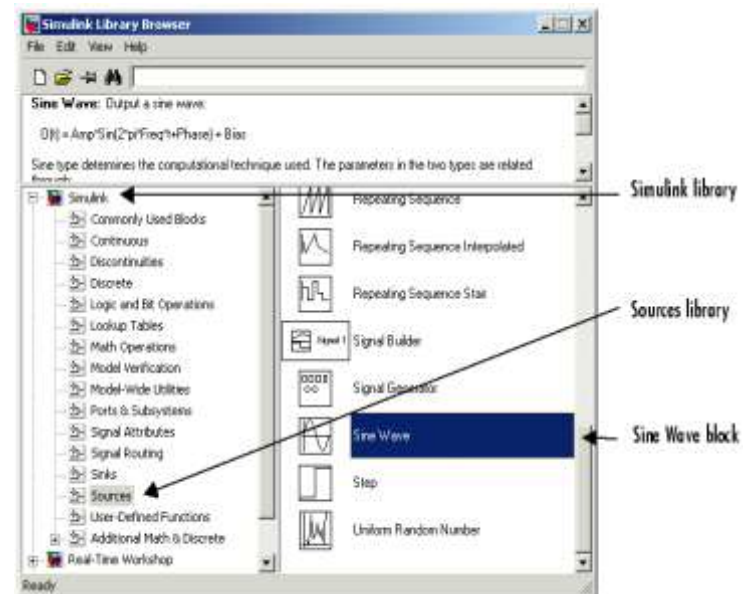
5) Simulink opens a new model window.



**Fig -6:** New model window

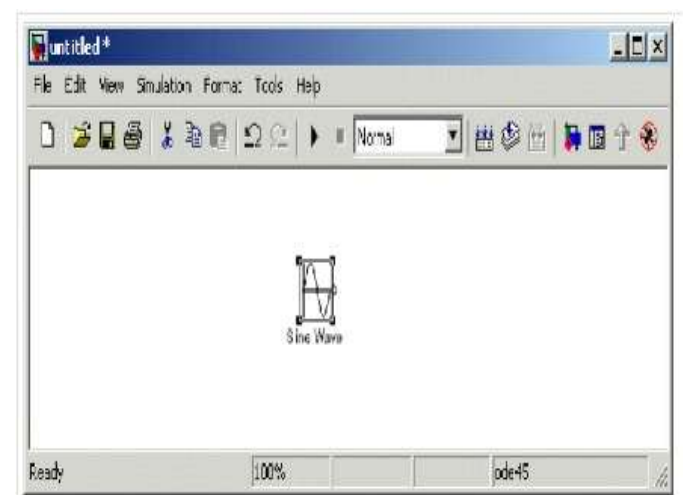
6) To create the model, you need to drag and drop required blocks into the model from the following Simulink block libraries:

- Sources library (the Sine Wave block)
- Sinks library (the Scope block)
- Commonly used blocks



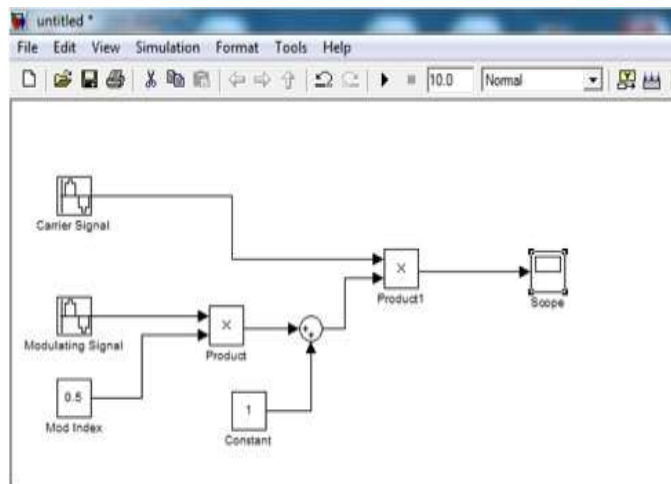
**Fig -7:** Simulink block libraries

6) Sine wave block drag and drop from sources to new model



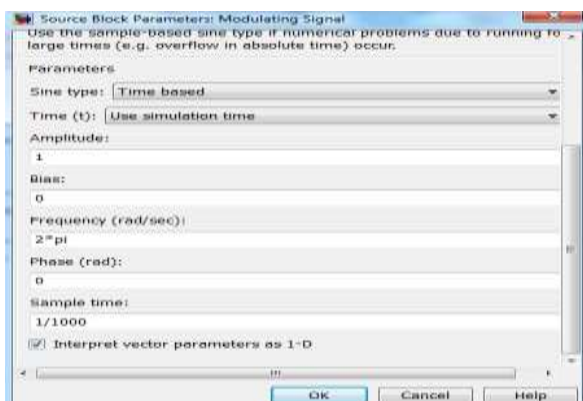
**Fig -7:** Sine wave block

7) Construct the model as shown below with blocks and links to connect them



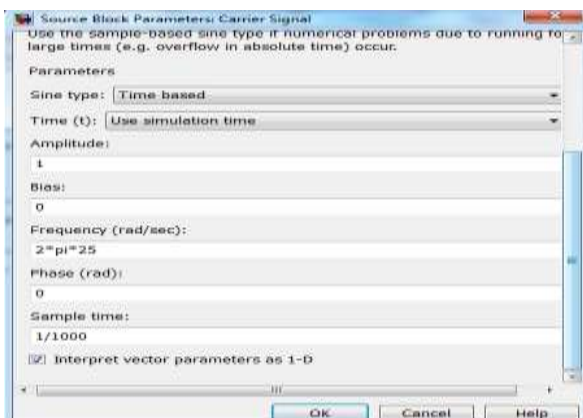
**Fig -8:** AM equation implemented using simulink tool

8) Set the parameters for modulating signal by clicking on it.



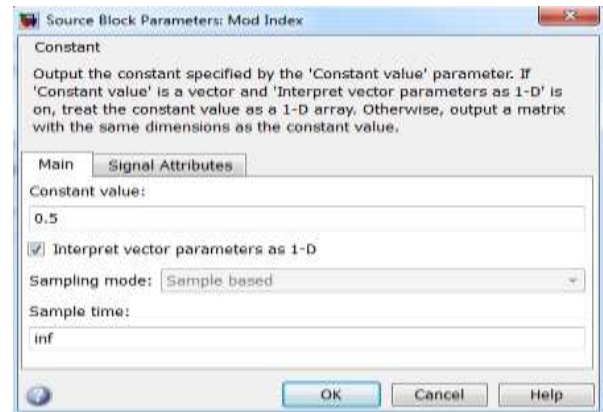
**Fig -9:** Parameters for modulating signal

9) Set the parameters for carrier signal by clicking on it.



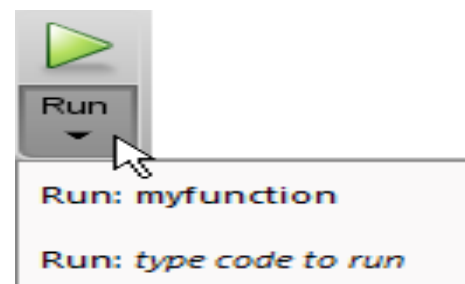
**Fig -10:** Parameters for carrier signal

10) Set the parameters for modulation index=0.5 for under modulation, 1 for perfect modulation, 1.5 for over modulation.



**Fig -11:** Parameters for m

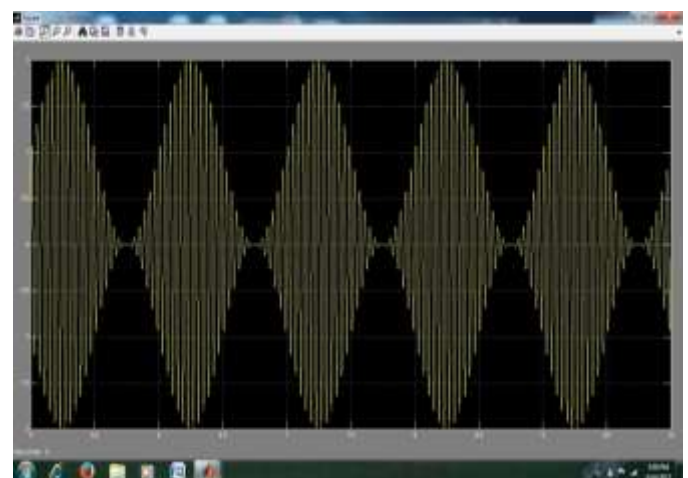
11) Run the simulink by clicking on run button .



**Fig -12:** Click on run button

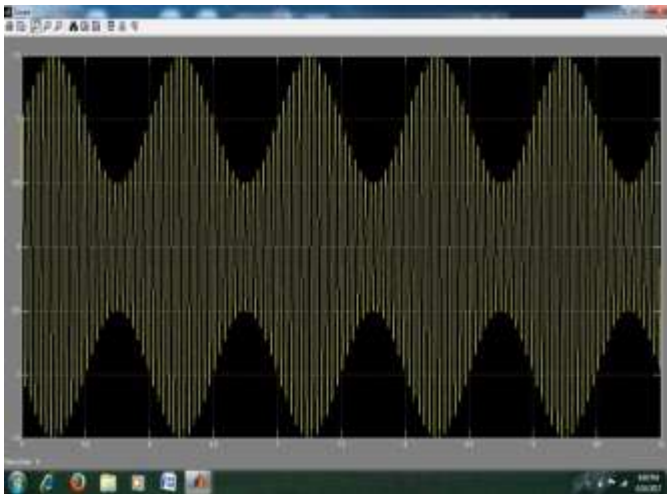
12) Double click on scope block to observe waveforms.

## 4. RESULTS

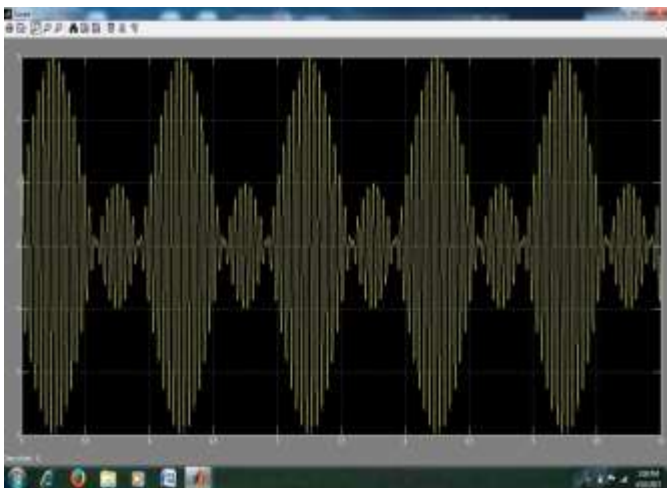


**Fig -13:** For m=1, Perfect Modulation





**Fig -14:** For  $m=0.5$ , Under Modulation



**Fig -15:** For  $m=1.5$ , Over Modulation

## 5. CONCLUSIONS

In this paper, we have implemented amplitude modulation technique with the help of equation of AM. We have used Simulink library tool in Matlab to practically implement the equation of AM with the help of blocks in library. We generated three types of modulation- perfect modulation, under modulation & over modulation and practically it is clear that type modulation in AM depends of modulation index.

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