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**Communication Systems**

EET 139 (G 92)

**MATLAB Task**

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# 1 - AM (Amplitude modulation)

## – introduction

amplitude modulation (AM) is a [modulation](https://en.wikipedia.org/wiki/Modulation) technique used in electronic communication, most commonly for transmitting information via a [radio](https://en.wikipedia.org/wiki/Radio) [carrier wave](https://en.wikipedia.org/wiki/Carrier_wave). In amplitude modulation, the [amplitude](https://en.wikipedia.org/wiki/Amplitude) (signal strength) of the carrier wave is varied in proportion to that of the message signal being transmitted. The message signal is, for example, a function of the sound to be reproduced by a [loudspeaker](https://en.wikipedia.org/wiki/Loudspeaker), or the light intensity of pixels of a television screen. This technique contrasts with [frequency modulation](https://en.wikipedia.org/wiki/Frequency_modulation), in which the [frequency](https://en.wikipedia.org/wiki/Frequency) of the [carrier signal](https://en.wikipedia.org/wiki/Carrier_signal) is varied, and [phase modulation](https://en.wikipedia.org/wiki/Phase_modulation), in which its [phase](https://en.wikipedia.org/wiki/Phase_(waves)) is varied.

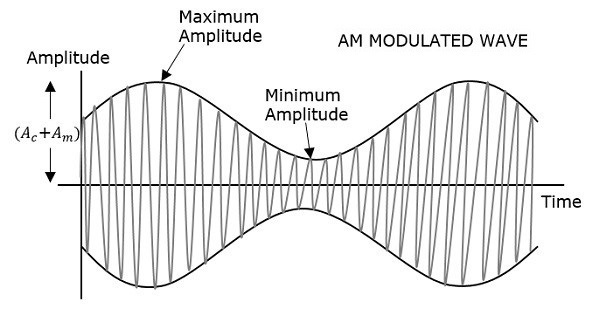


Figure 1 AM signal

## 

## 1.2 – time domain modulation equation

S(t) = (Ac+m(t)) \* cos(Wc\*t)

**Where**

S(t) = AM modulated signal .

AC = carrier amplitude.

M(t) = massage signal .

## 1.3 – modulation method

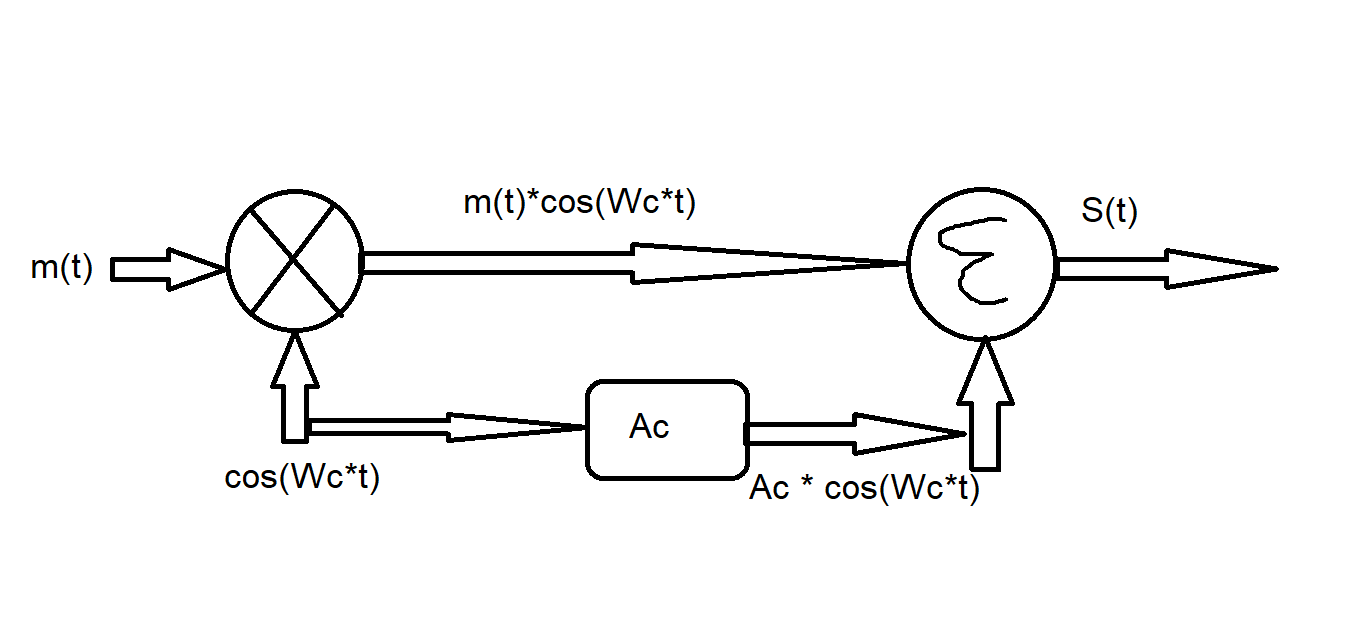


Figure 2 AM modulation method

## 1.4 – de-modulation method

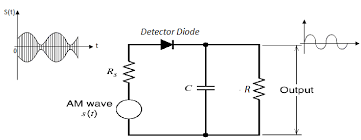


Figure 3 AM de-modulation method

## 1.5 – MATLAB code

### Set the code parameters

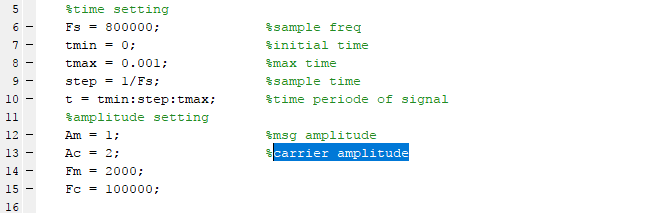


Figure 4 AM Set the code parameters

### Generate massage and carrier



Figure 5 AM Generate massage and carrier

### Plotting the massage and carrier

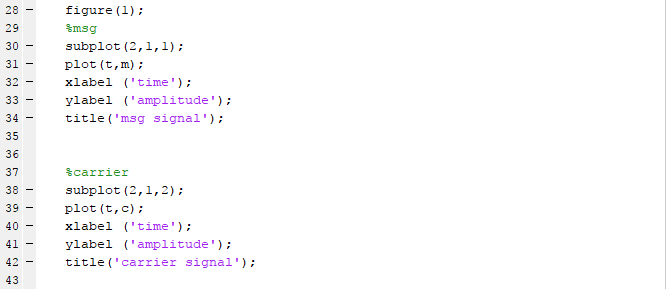


Figure 6 AM Plotting the massage and carrier

### massage and carrier

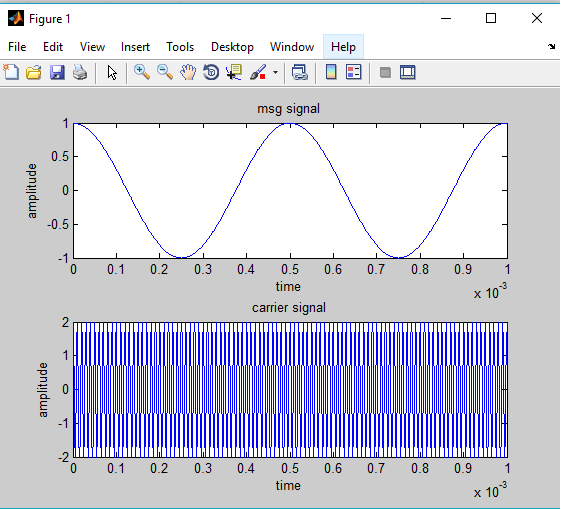


Figure 7 AM massage and carrier

### Modulation



Figure 8 AM Modulation equation

### Demodulation



Figure 9 AM Demodulation equation

### Plotting modulated and demodulated signals

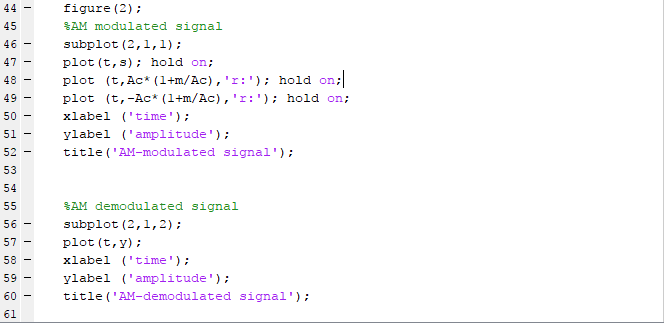


Figure 10 AM Plotting modulated and demodulated signals

### modulated and demodulated signals

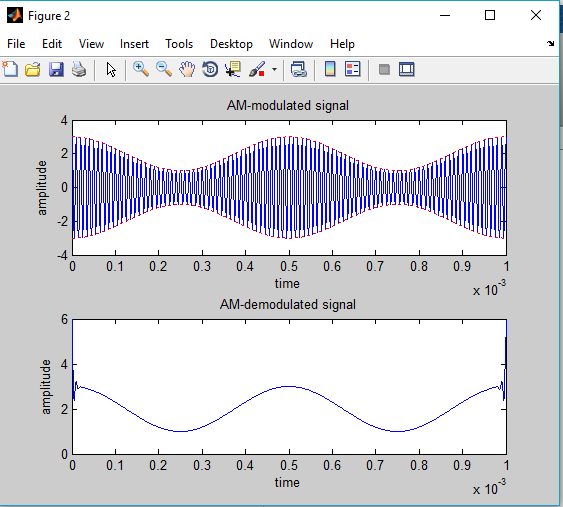


Figure 11 AM modulated and demodulated signals

# 2 - DSB-SC (Double-sideband suppressed-carrier transmission)

## 2.1 – introduction

 is [transmission](https://en.wikipedia.org/wiki/Transmission_(telecommunications)) in which frequencies produced by [amplitude modulation](https://en.wikipedia.org/wiki/Amplitude_modulation) (AM) are symmetrically spaced above and below the [carrier frequency](https://en.wikipedia.org/wiki/Carrier_frequency) and the carrier level is reduced to the lowest practical level, ideally being completely suppressed.

In the DSB-SC modulation, unlike in AM, the wave carrier is not transmitted; thus, much of the power is distributed between the side bands, which implies an increase of the cover in DSB-SC, compared to AM, for the same power used.

DSB-SC transmission is a special case of [double-sideband reduced carrier transmission](https://en.wikipedia.org/wiki/Double-sideband_reduced_carrier_transmission). It is used for [radio data systems](https://en.wikipedia.org/wiki/Radio_Data_System).

## 2.2 – time domain modulation equation

S(t) = m(t) \* Ac \* cos(Wc\*t)

**Where**

S(t) = DSB-SC modulated signal .

AC = carrier amplitude.

M(t) = massage signal .

## 2.3 – modulation method

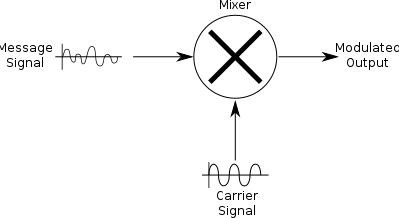


Figure 12 DSB-SC modulation method

## 2.4 – de-modulation method

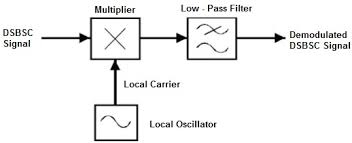


Figure 13 DSB-SC demodulation method

## 2.5 – MATLAB code

### Set the code parameters

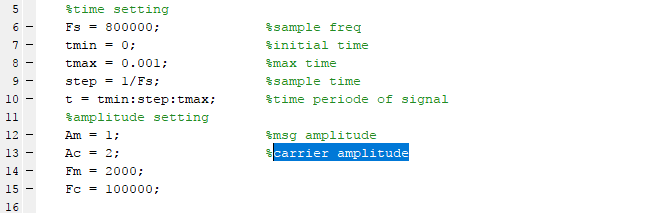


Figure 14 DCB-SC Set the code parameters

### Generate massage and carrier



Figure 15 DCB-SC Generate massage and carrier

### Plotting the massage and carrier

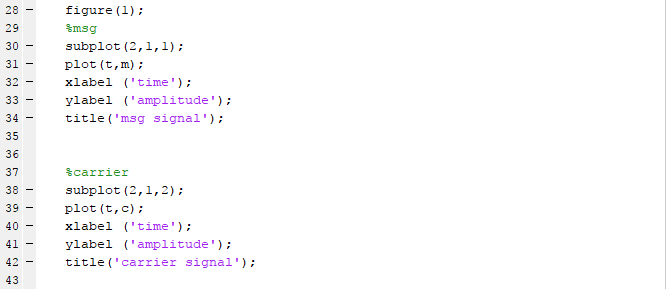


Figure 16 DSB-SC Plotting the massage and carrier

### massage and carrier

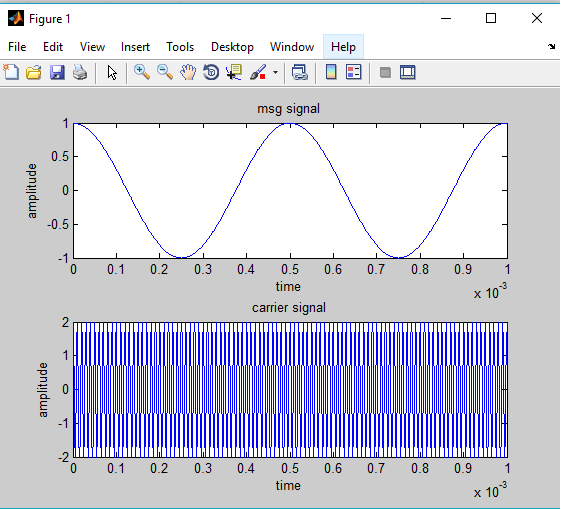


Figure 17 DCB-SC massage and carrier

### Modulation



Figure 18 DSB-SC Modulation equation

### Demodulation

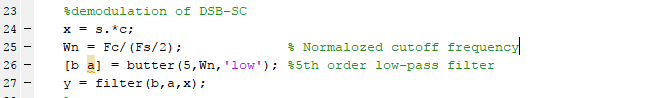


Figure 19 DSB-SC Demodulation equation

### Plotting modulated and demodulated signals

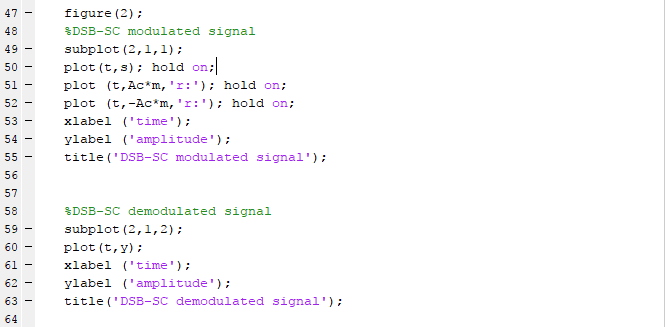


Figure 20 DSB-SC Plotting modulated and demodulated signals

### modulated and demodulated signals

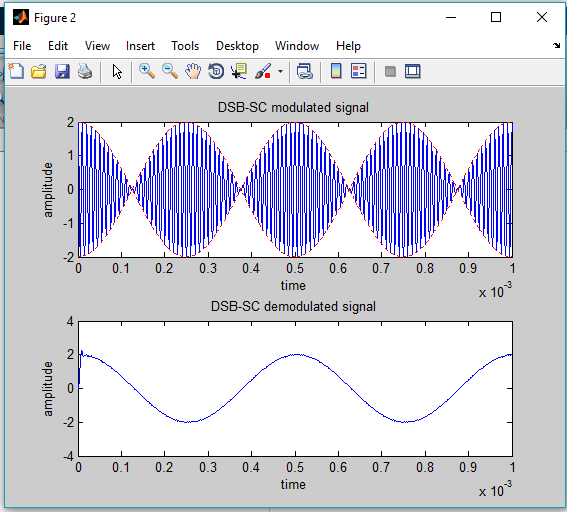


Figure 21 DSB-SC modulated and demodulated signals

# 3 – SSB (Single-sideband modulation)

## 3.1 – introduction

is a type of [modulation](https://en.wikipedia.org/wiki/Modulation), used to transmit information, such as an [audio signal](https://en.wikipedia.org/wiki/Audio_signal), by [radio waves](https://en.wikipedia.org/wiki/Radio_wave). A refinement of [amplitude modulation](https://en.wikipedia.org/wiki/Amplitude_modulation), it uses transmitter power and [bandwidth](https://en.wikipedia.org/wiki/Bandwidth_(signal_processing)) more efficiently. Amplitude modulation produces an output signal that has twice the bandwidth of the original baseband signal. Single-sideband modulation avoids this bandwidth doubling, and the power wasted on a carrier, at the cost of increased device complexity and more difficult tuning at the receiver.

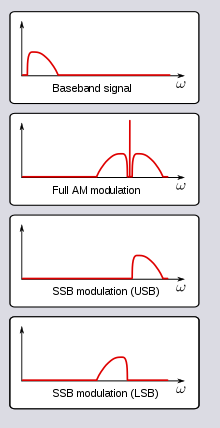


Figure 22 SSB signal

## 3.2 – time domain modulation equation

S(t) = m(t)\*cos(Wc\*t) – Mh(t)\*sin(Wc\*t) for USB (upper side band)

S(t) = m(t)\*cos(Wc\*t) + Mh(t)\*sin(Wc\*t) for LSB (lower side band)

**Where**

S(t) = DSB-SC modulated signal .

M(t) = massage signal .

Mh(t) = hilbert transform of m(t).

## 3.3 – modulation method

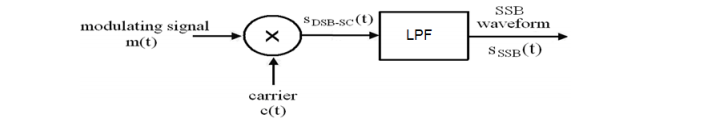


Figure 23 SSB modulation method 1

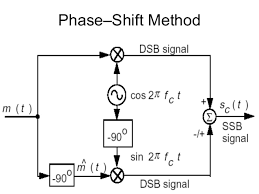


Figure 24 SSB modulation method 2

## 3.4 – de-modulation method

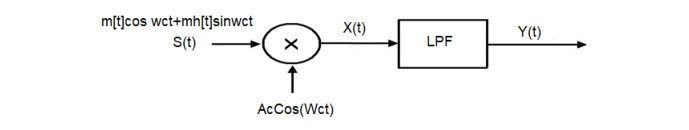


Figure 25 SSB de-modulation method

## 3.5 – MATLAB code

### Set the code parameters

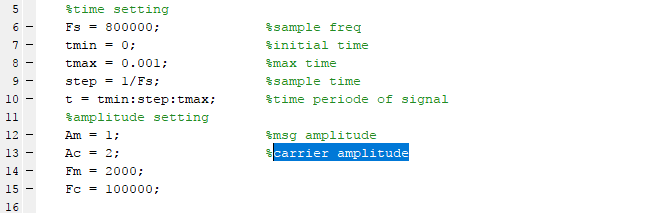


Figure 26 SSB Set the code parameters

### Generate massage and carrier

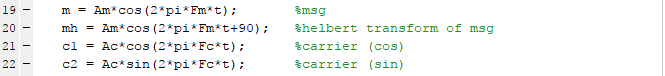


Figure 27 SSB Generate massage and carrier

### Plotting the massage and carrier

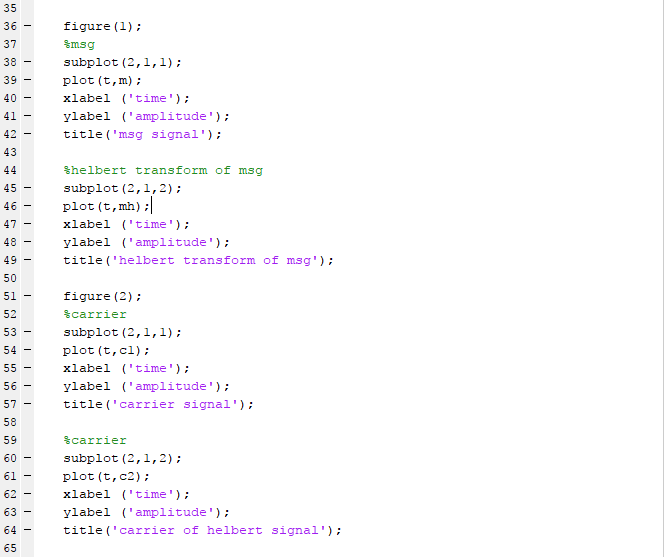


Figure 28 SSB Plotting the massage and carrier

### massage and carrier

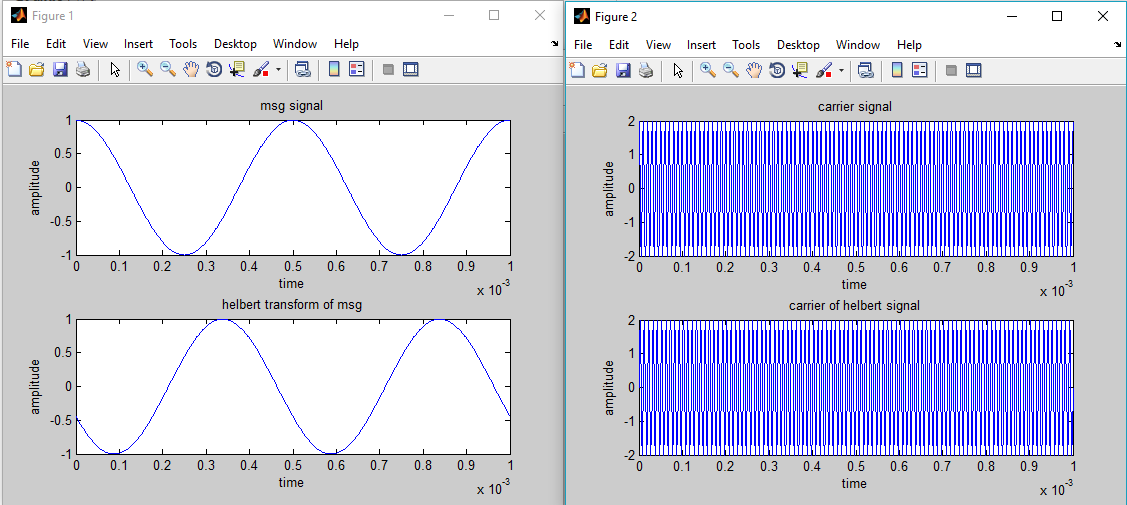


Figure 29 SSB massage and carrier

### Modulation



Figure 30 SSB(LSB) Modulation equation

### Demodulation

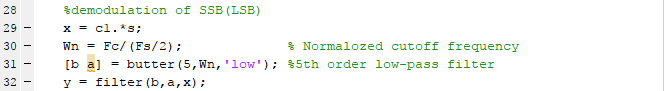


Figure 31 SSB(LSB) Demodulation equation

### Plotting modulated and demodulated signals

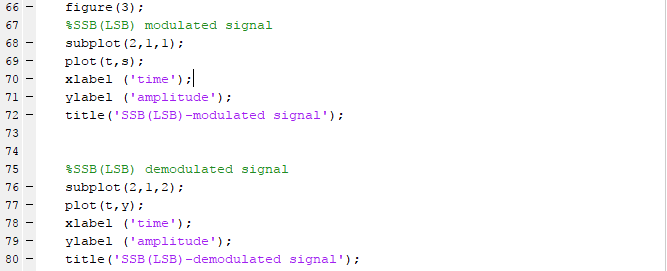


Figure 32 SSB(LSB) Plotting modulated and demodulated signals

### modulated and demodulated signals

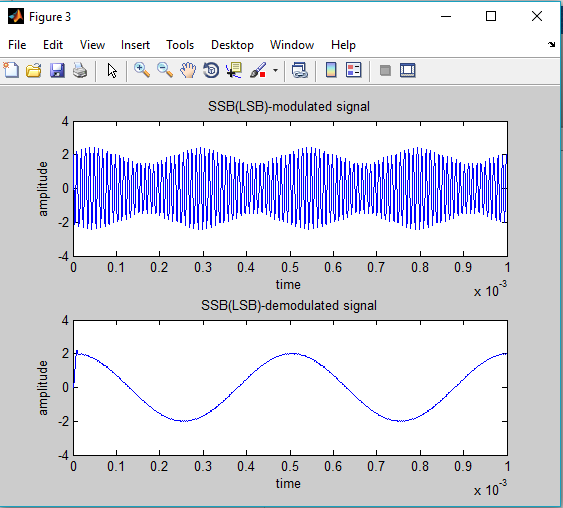


Figure 33 SSB(LSB) modulated and demodulated signals

# 4 – MATLAB used functions

## 4.1 amdemod

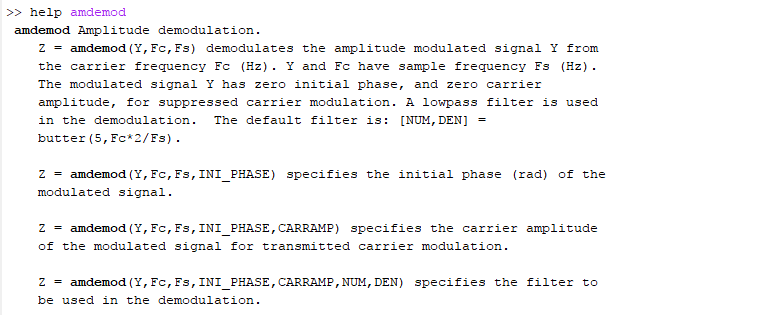


Figure 34 amdemod function

## 4.2 butter

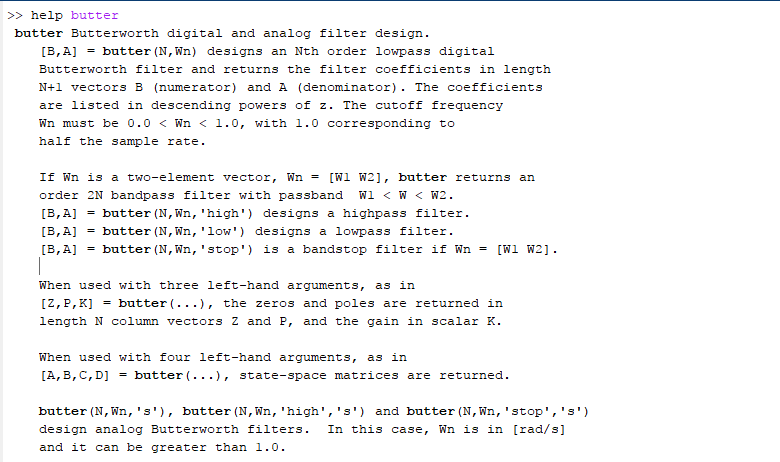


Figure 35 butter function