Dept. Of Electronics & Communication Engineering

Analog Communications Lab Manual (S/W)

(III ECE – I Sem)

Balaji Institute of Technology & Science

List of Experiments

1. **Amplitude Modulation & Demodulation**
2. **DSB-SC Modulation & Demodulation**
3. **SSB-SC Modulation & Demodulation**
4. **Frequency Division Multiplexing & Demultiplexing**
5. **Frequency Modulation & Demodulation**
6. **PLL as FM Demodulator**
7. **Spectral Characteristics of AM &FM**
8. **Verification of Sampling Theorem**
9. **Pulse Amplitude Modulation & Demodulation**
10. **Time Division Multiplexing & Demultiplexing**
11. **Pulse Width Modulation**
12. **Pulse Position Modulation & Demodulation**

1.Amplitude Modulation & Demodulation

Aim

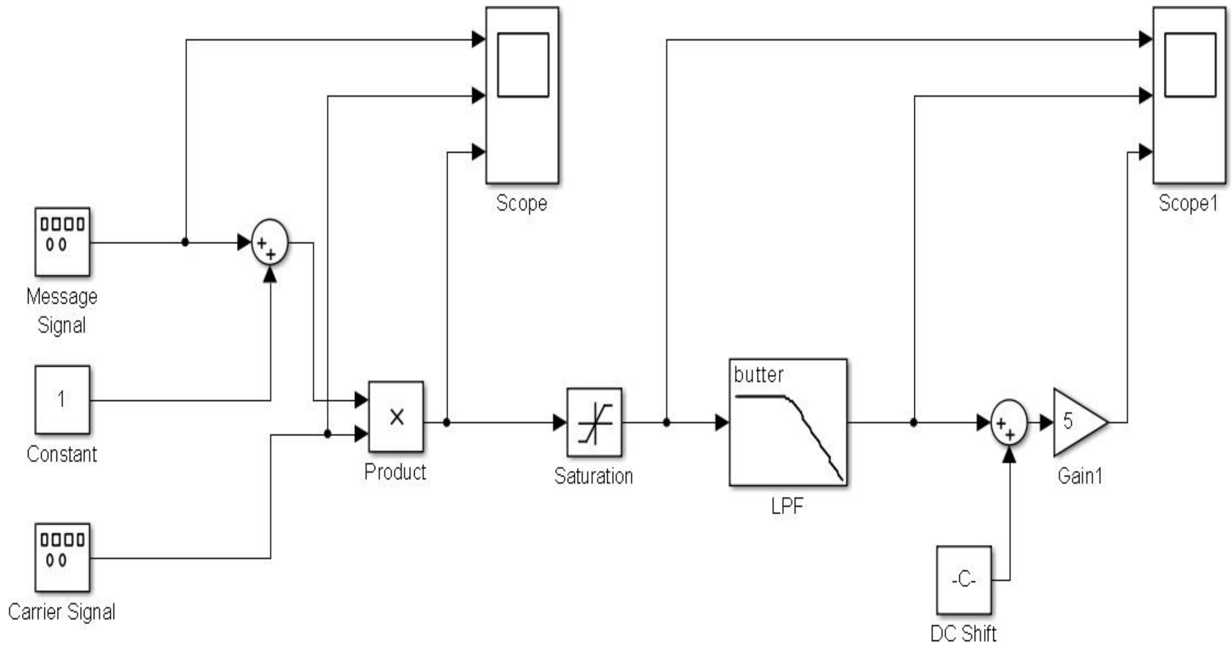
To study the function of Amplitude Modulation & Demodulation (Under modulation, Perfect modulation & Over modulation) using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 and above version

Simulink model

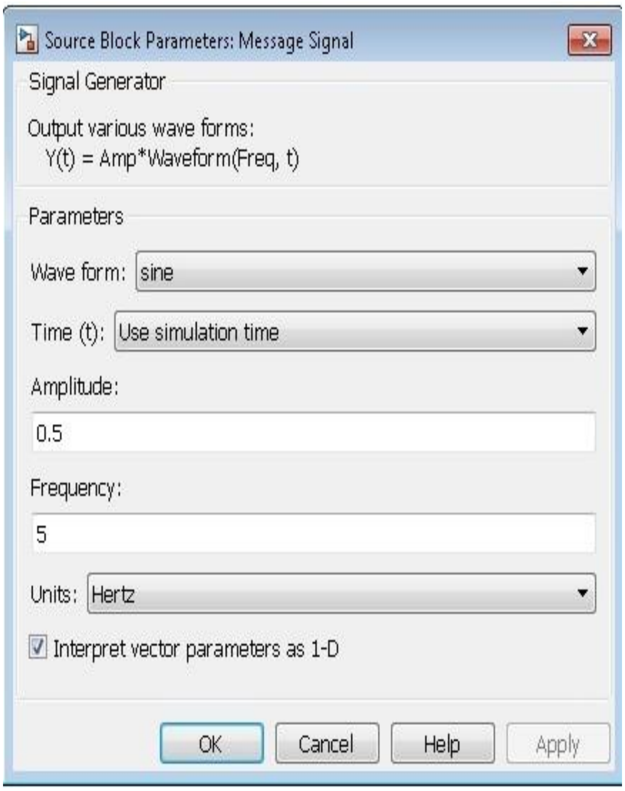


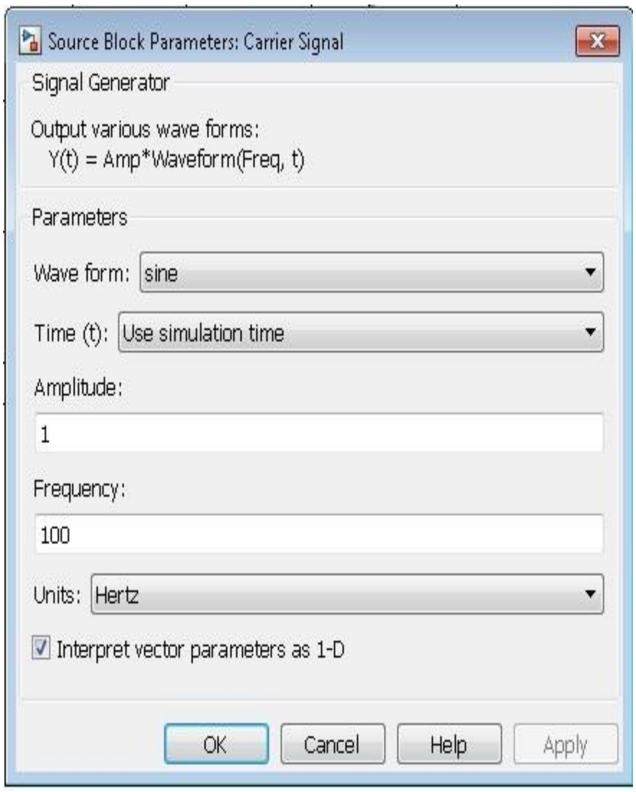
Procedure

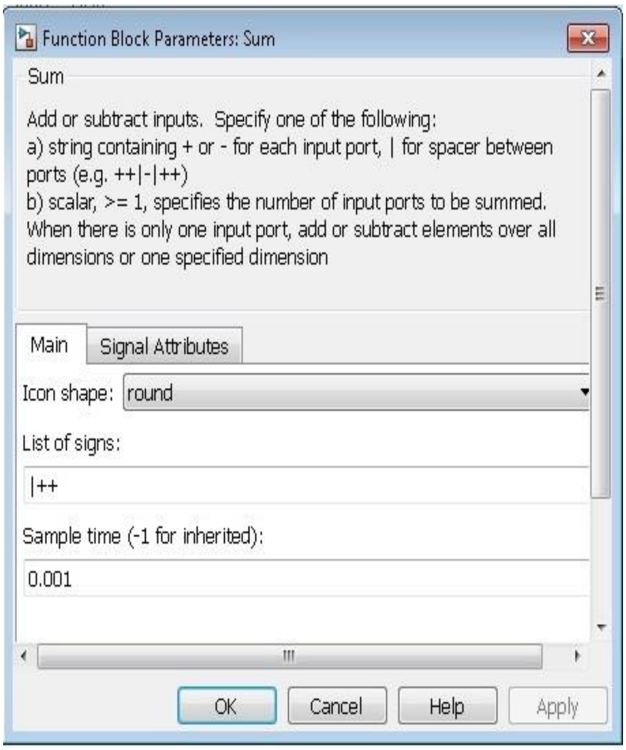
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon  . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

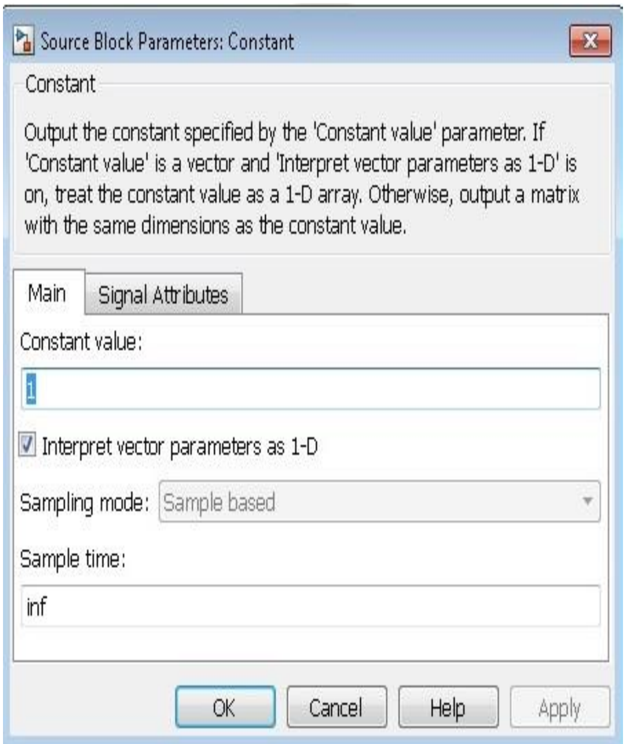
Parameters

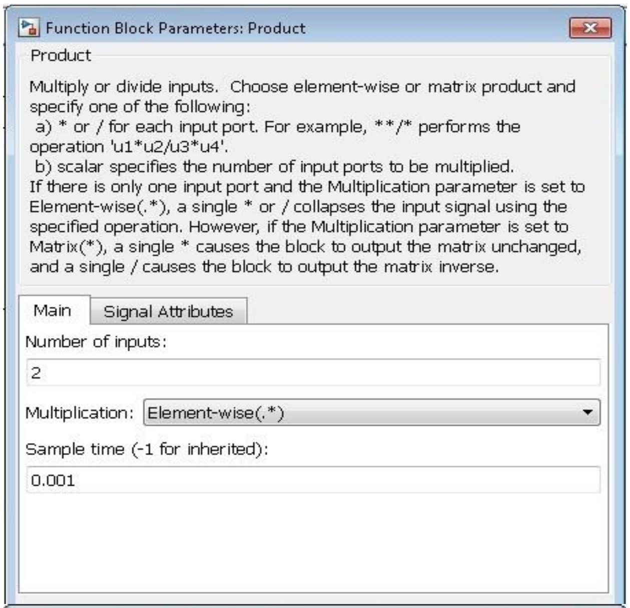
Under Modulation

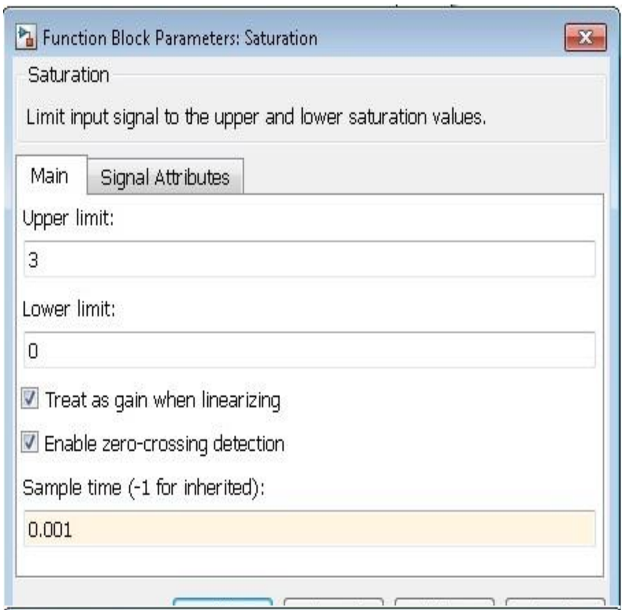


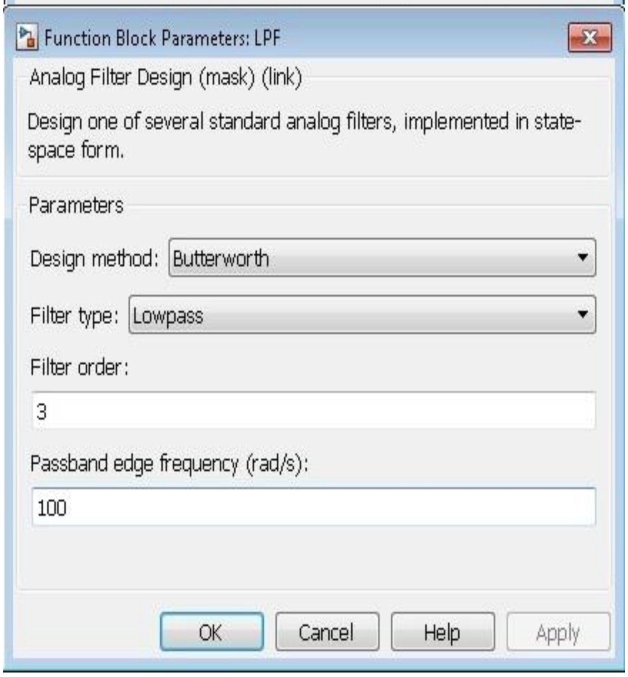


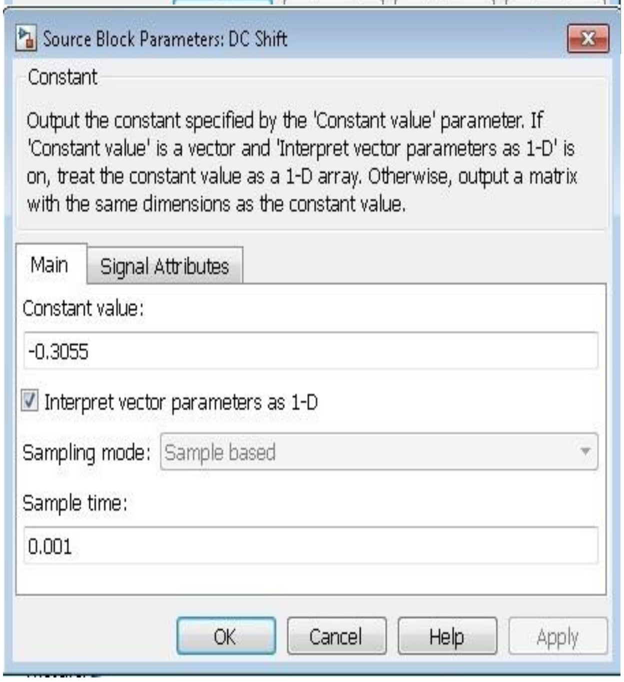


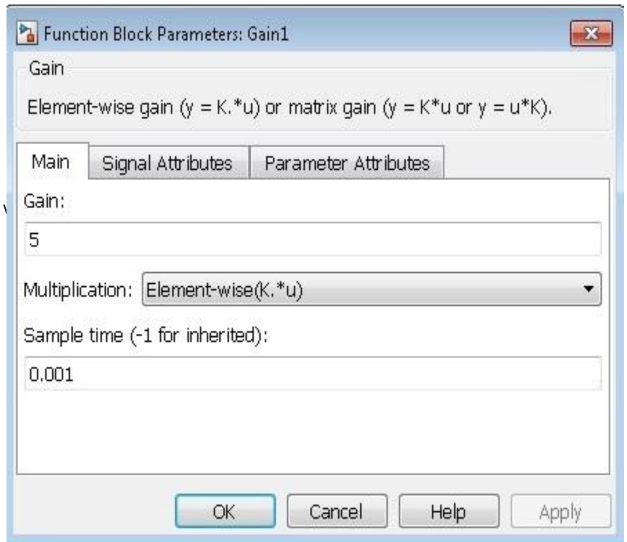



Function Block Parameters: Product
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
b) scalar specifies the number of input ports to be multiplied.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
2
Multiplication:
Element-wise(.*)
Sample time (-1 for inherited):
0.001

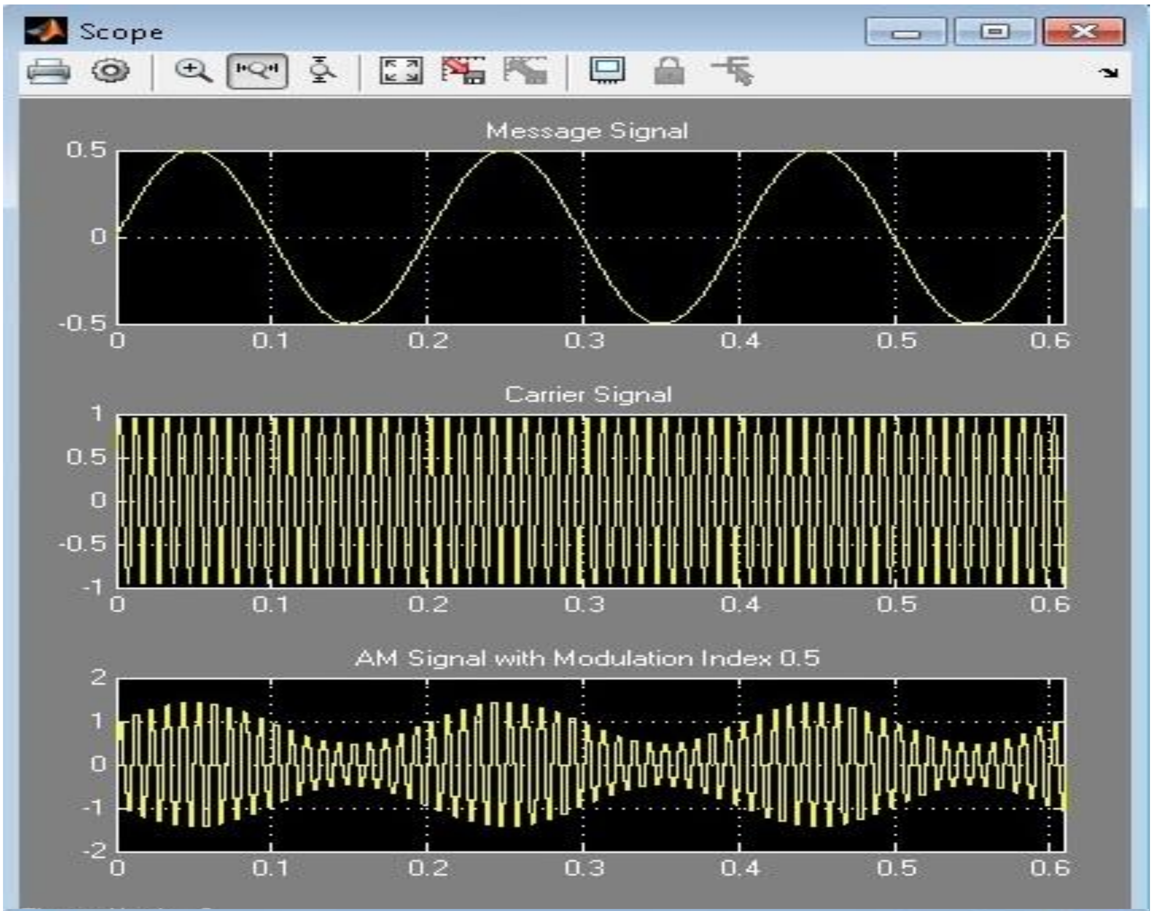

Function Block Parameters: Saturation
Saturation
Limit input signal to the upper and lower saturation values.
Main
Signal Attributes
Upper limit:
3
Lower limit:
0
Treat as gain when linearizing
Enable zero-crossing detection
Sample time (-1 for inherited):
0.001

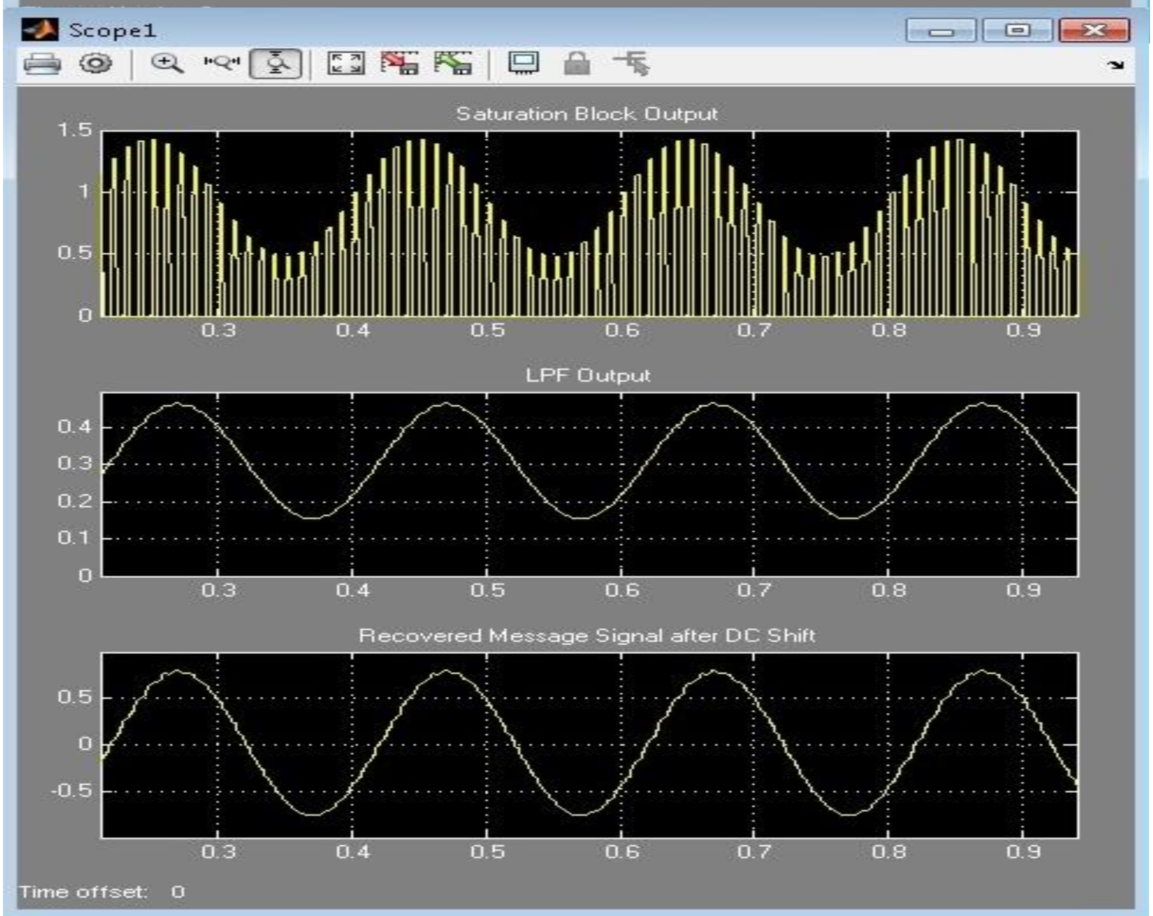

Function Block Parameters: LPF
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method:
Butterworth
Filter type:
Lowpass
Filter order:
3
Passband edge frequency (rad/s):
100
OK
Cancel
Help
Apply


Source Block Parameters: DC Shift
Constant
Output the constant specified by the 'Constant value' parameter. If 'Constant value' is a vector and 'Interpret vector parameters as 1-D' is on, treat the constant value as a 1-D array. Otherwise, output a matrix with the same dimensions as the constant value.
Main
Signal Attributes
Constant value:
-0.3055
Interpret vector parameters as 1-D
Sampling mode:
Sample based
Sample time:
0.001
OK
Cancel
Help
Apply


Function Block Parameters: Gain1
Gain
Element-wise gain (y = K.*u) or matrix gain (y = K*u or y = u*K).
Main
Signal Attributes
Parameter Attributes
Gain:
5
Multiplication:
Element-wise(K.*u)
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

Output

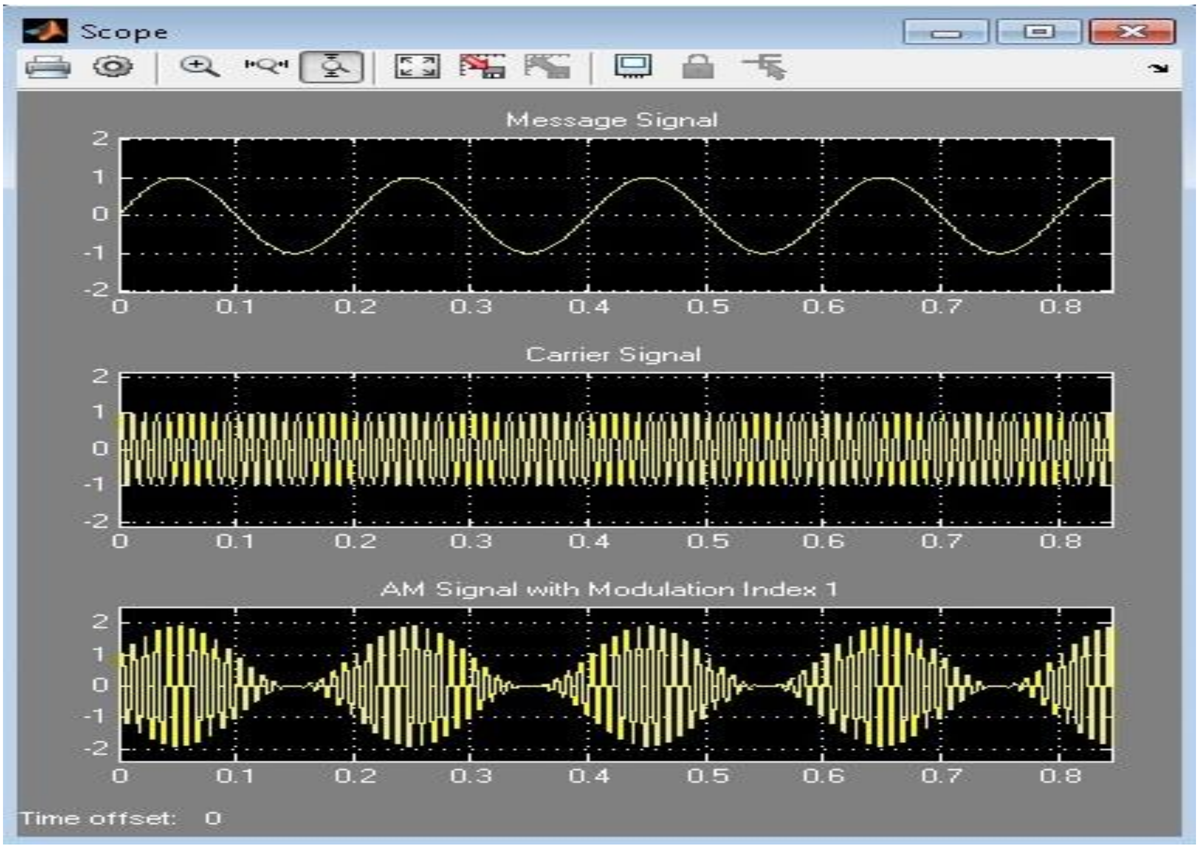

Scope
Message Signal
Carrier Signal
AM Signal with Modulation Index 0.5

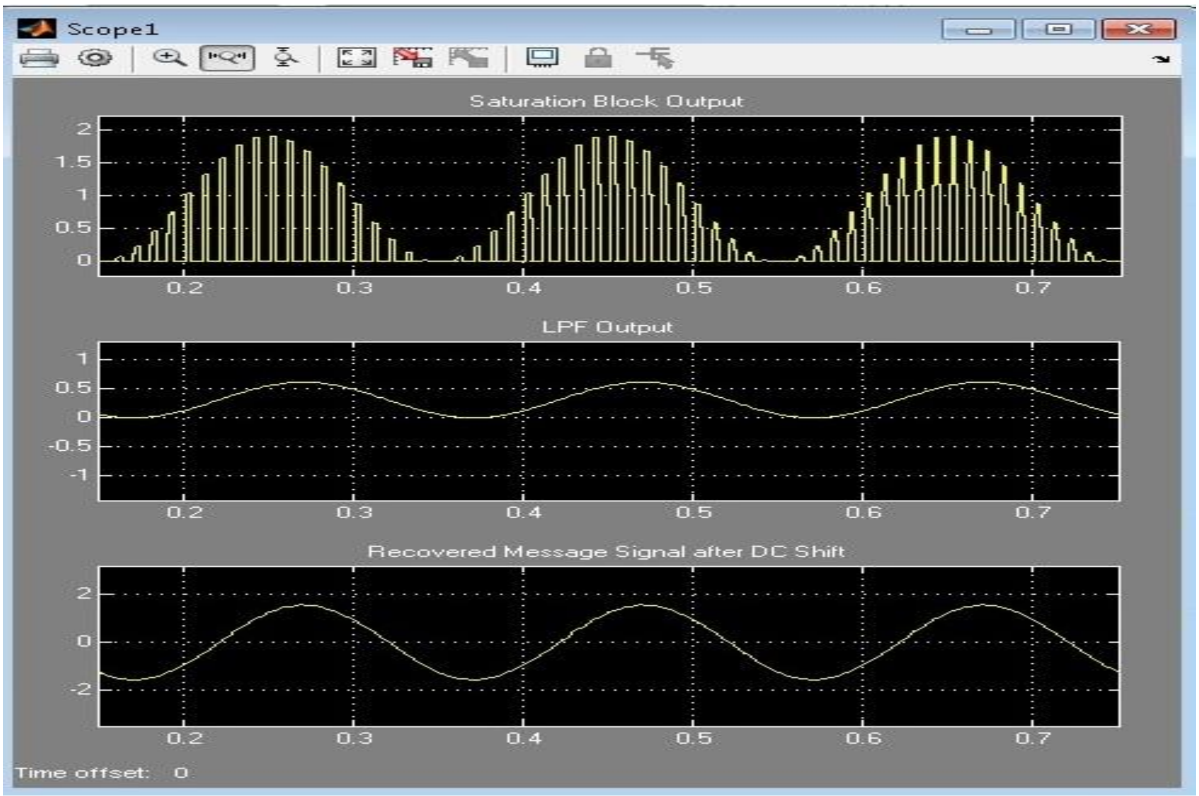

Scope1
Saturation Block Output
LPF Output
Recovered Message Signal after DC Shift
Time offset: 0

100% Modulation

Change Message signal amplitude to 1Volt.

Change DC Shift to -0.31

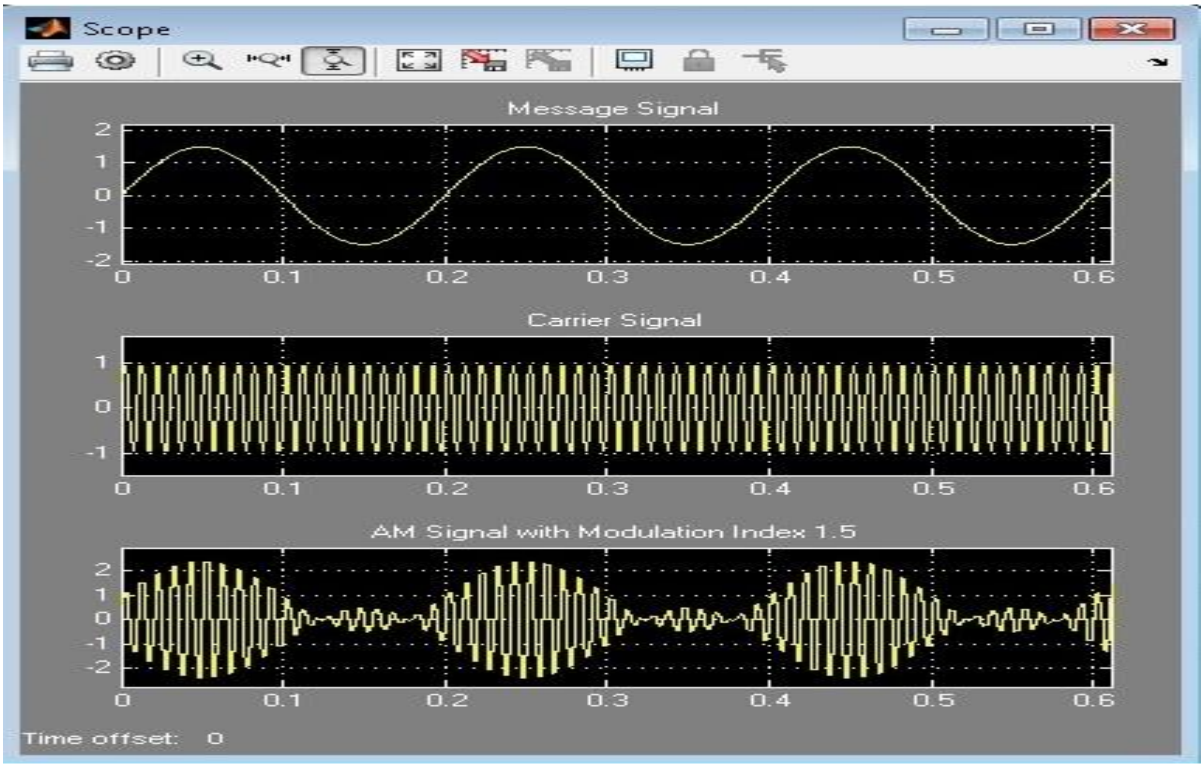


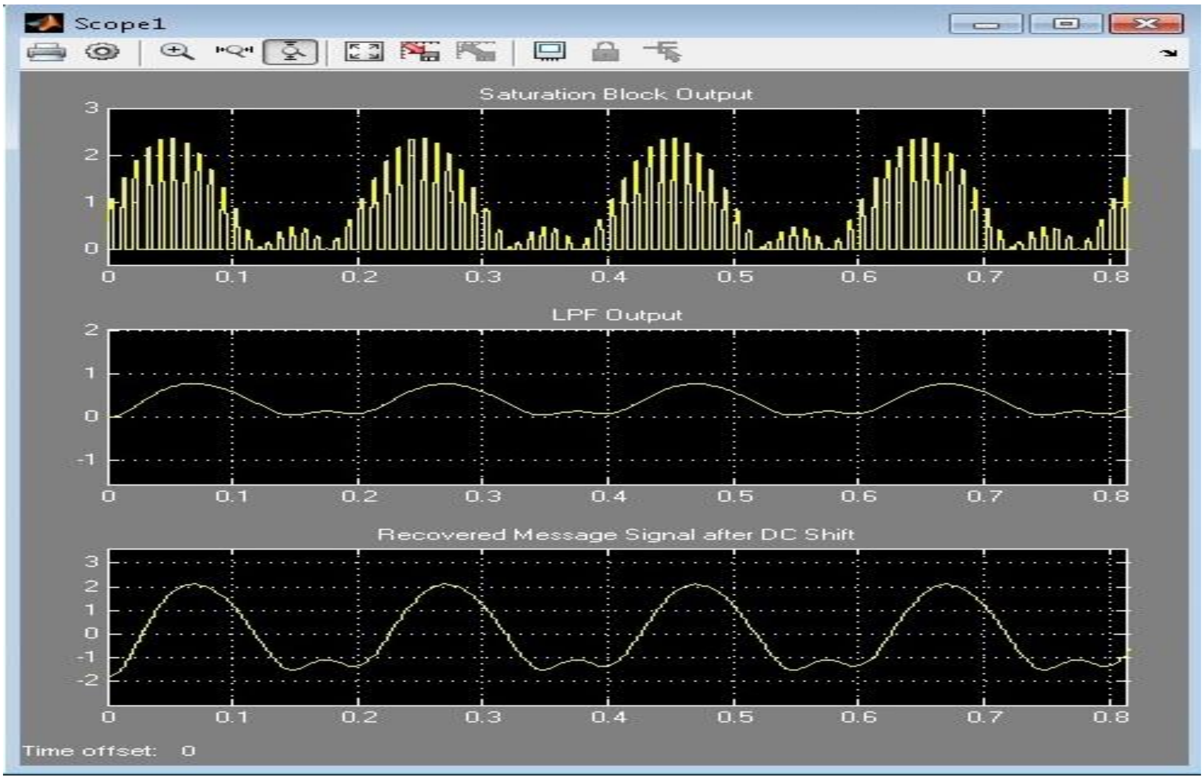


Over Modulation:

Change Message signal amplitude to 1Volt.

Change DC Shift to -0.35





Result

Viva Questions

1. Define AM and draw its spectrum?
2. Draw the phasor representation of an amplitude modulated wave?
3. Give the significance of modulation index?
4. What are the different degrees of modulation?
5. What are the limitations of square law modulator?
6. Compare linear and nonlinear modulators?
7. Compare base modulation and emitter modulation?
8. Explain how AM wave is detected?
9. Define detection process?
10. What are the different types of distortions that occur in an envelop detector? How can they be eliminated?
11. What is the condition of for over modulation?
12. Define modulation & demodulation?
13. What are the different types of linear modulation techniques?
14. Explain the working of carrier wave generator.
15. Explain the working of modulator circuit.

Applications

1. Radio Broadcasting.
2. Picture transmission in a TV system.
3. AM is used in computer modems, VHF aircraft radio, and in portable two-way radio
4. Used to carry message signals in early telephone lines.
5. Used to transmit Morse code using radio and other communication systems.
6. Used in Navy and Aviation for communications as AM signals can travel longer distances.

Advantages of Amplitude Modulation:

- Because of amplitude modulation wavelength, AM signals can propagate longer distances.
- For amplitude modulation, we use simple and low cost circuit; we don’t need any special equipment and complex circuits that are used in frequency modulation.
- The Amplitude modulation receiver will be wider when compared to the FM receiver. Because, atmospheric propagation is good for amplitude modulated signals.
- Bandwidths limit is also big advantage for Amplitude modulation, which doesn’t have in frequency modulation.
- Transmitter and receiver are simple in Amplitude modulation. When we take a demodulation unit of AM receiver, it consists of RC filter and a diode which will demodulate the message signal or modulating signal from modulated AM signal, which is unlike in Frequency modulation.

- Zero crossing in Amplitude modulation is equidistant.

Disadvantages of Amplitude Modulation:

- Adding of noise for amplitude modulated signal will be more when compared to frequency modulated signals. Data loss is also more in amplitude modulation due to noise addition. Demodulators cannot reproduce the exact message signal or modulating signal due to noise.
- More power is required during modulation because Amplitude modulated signal frequency should be double than modulating signal or message signal frequency. Due to this reason more power is required for amplitude modulation.
- Sidebands are also transmitted during the transmission of carrier signal. More chances of getting different signal interfaces and adding of noise is more when compared to frequency modulation. Noise addition and signal interferences are less for frequency modulation. That is why Amplitude modulation is not used for broadcasting songs or music.

2. AM-DSB-SC Modulation & Demodulation

Aim

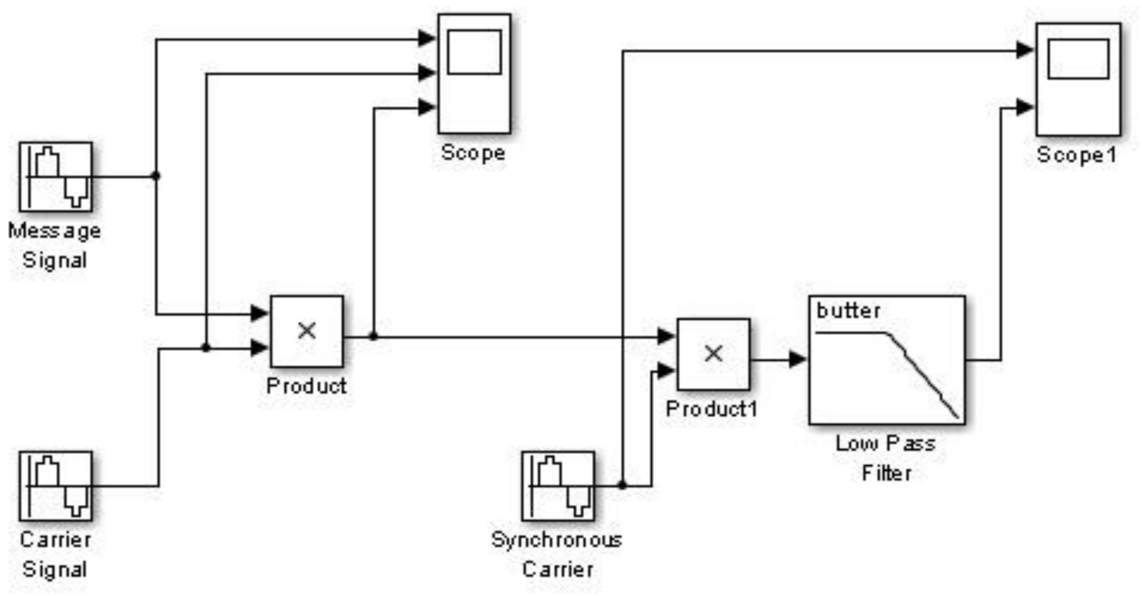
To perform the AM DSB-SC signal Generation and Detection using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7 or Upgraded version

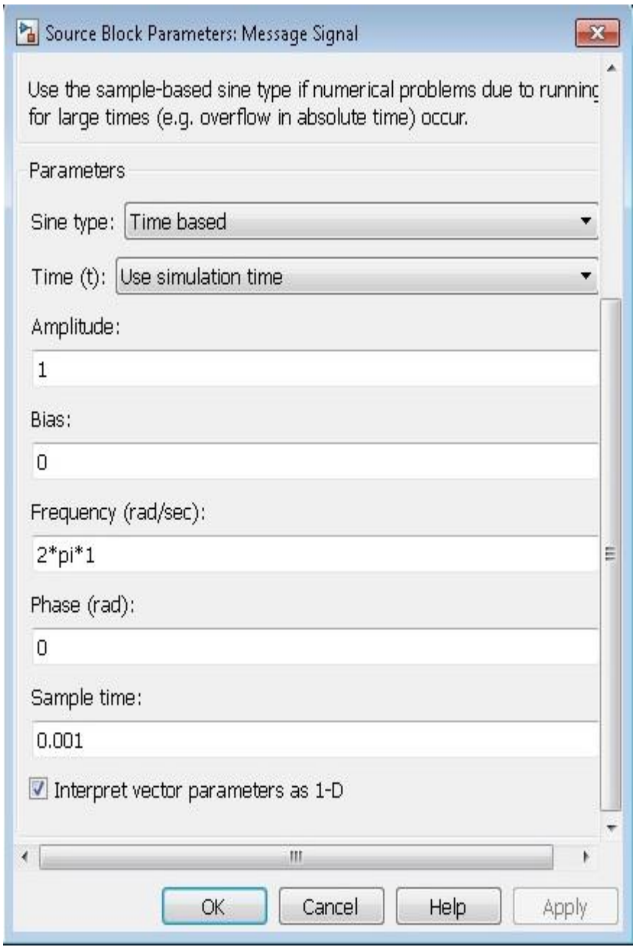
Simulink Model

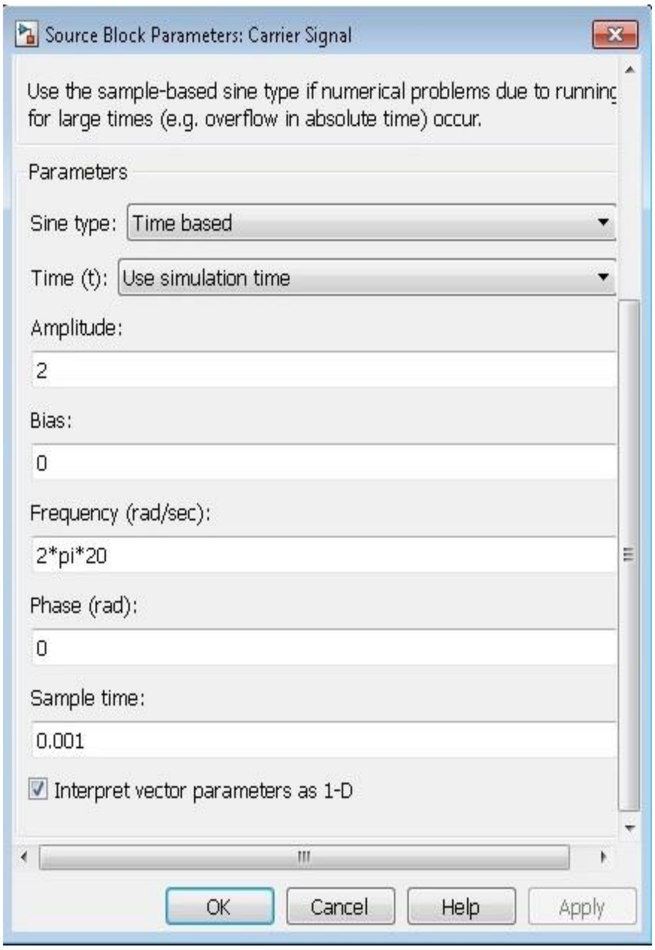


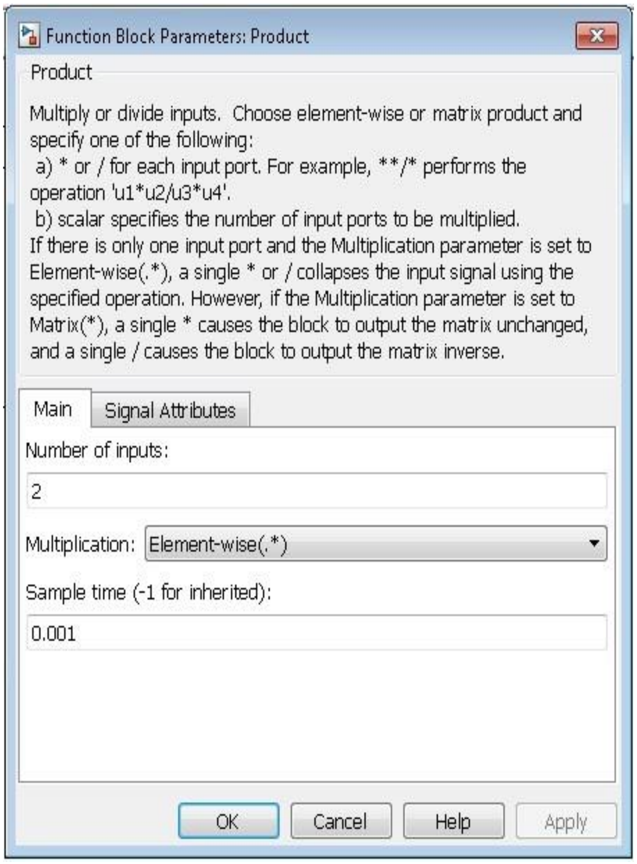
Procedure

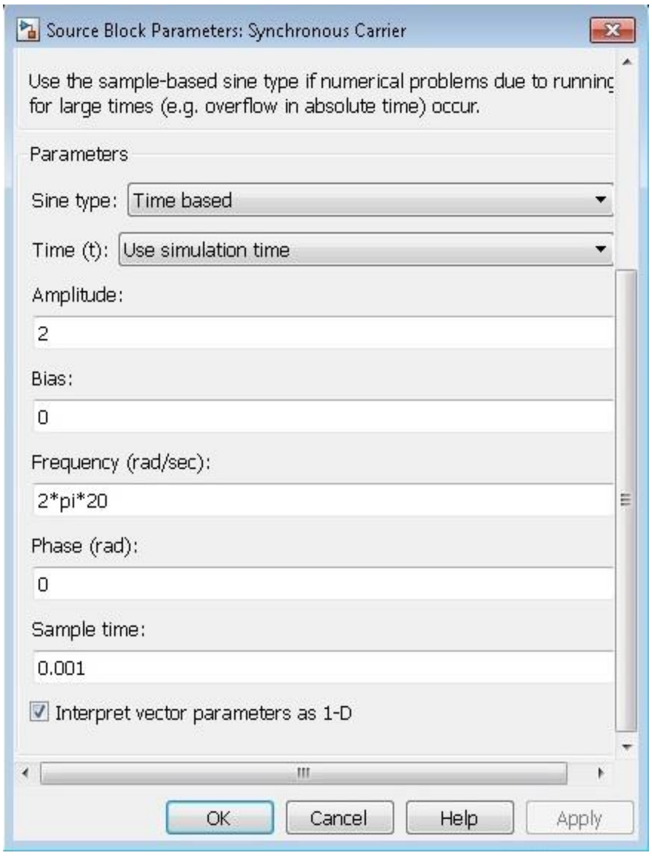
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

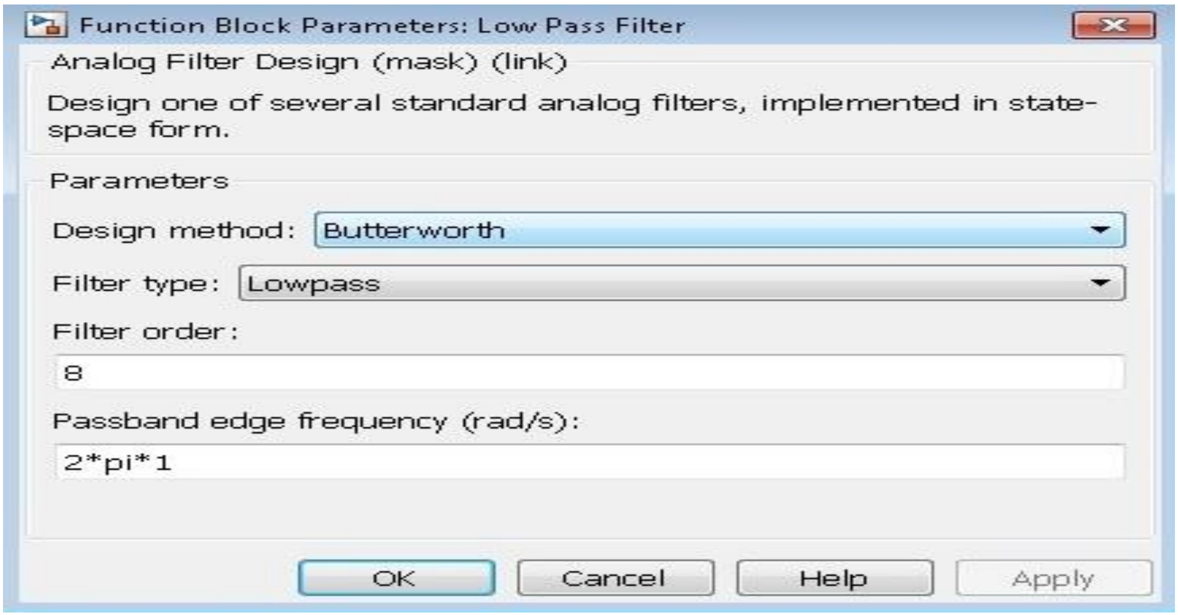
Parameters


Source Block Parameters: Message Signal
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*1
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

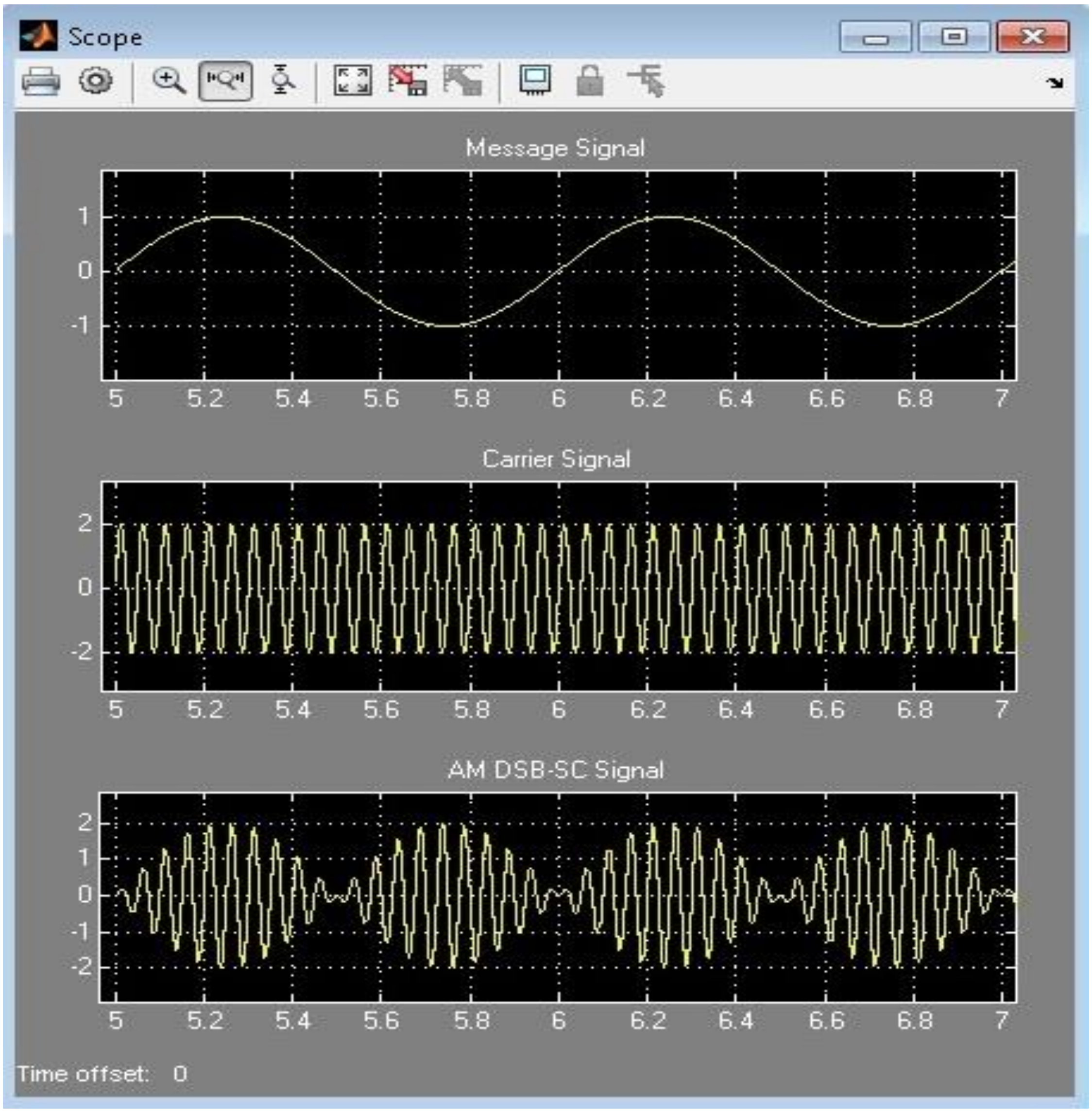

Source Block Parameters: Carrier Signal
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
2
Bias:
0
Frequency (rad/sec):
2*pi*20
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

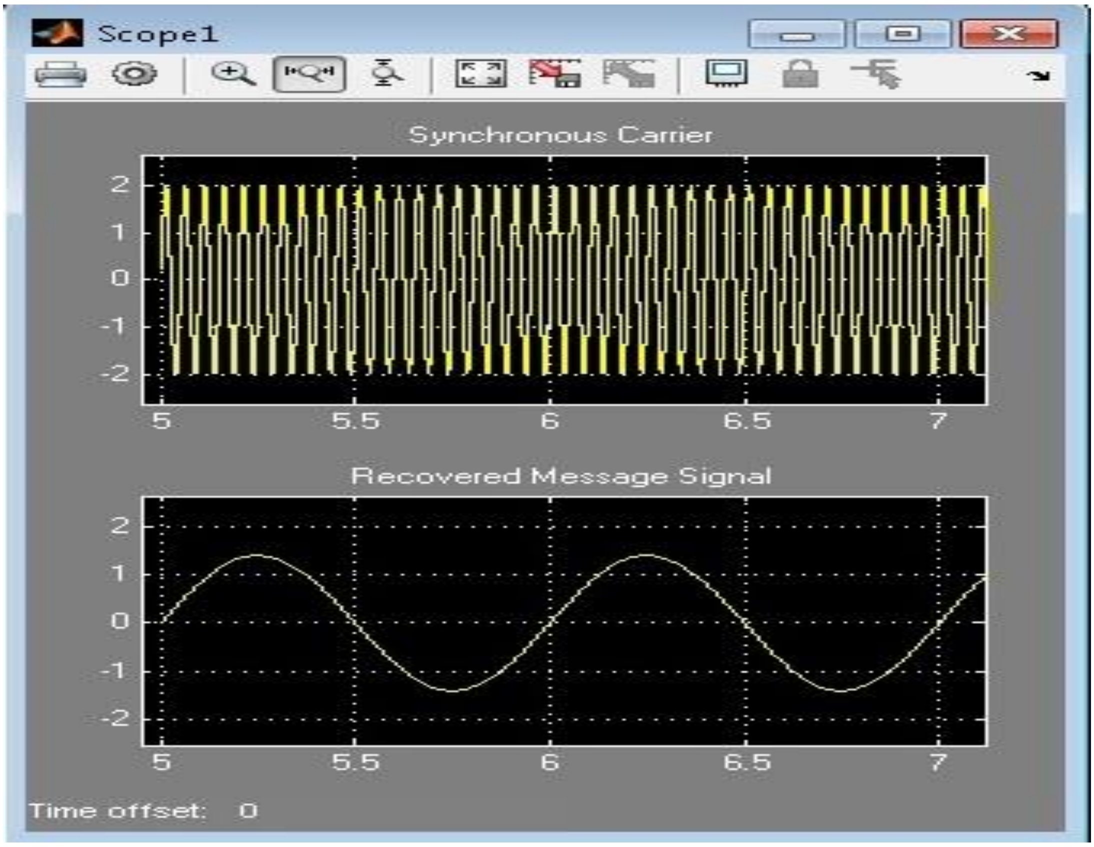

Function Block Parameters: Product
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
b) scalar specifies the number of input ports to be multiplied.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
2
Multiplication: Element-wise(.*)
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply


Source Block Parameters: Synchronous Carrier
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
2
Bias:
0
Frequency (rad/sec):
2*pi*20
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply


Function Block Parameters: Low Pass Filter
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method:
Butterworth
Filter type:
Lowpass
Filter order:
8
Passband edge frequency (rad/s):
2*pi*1
OK
Cancel
Help
Apply

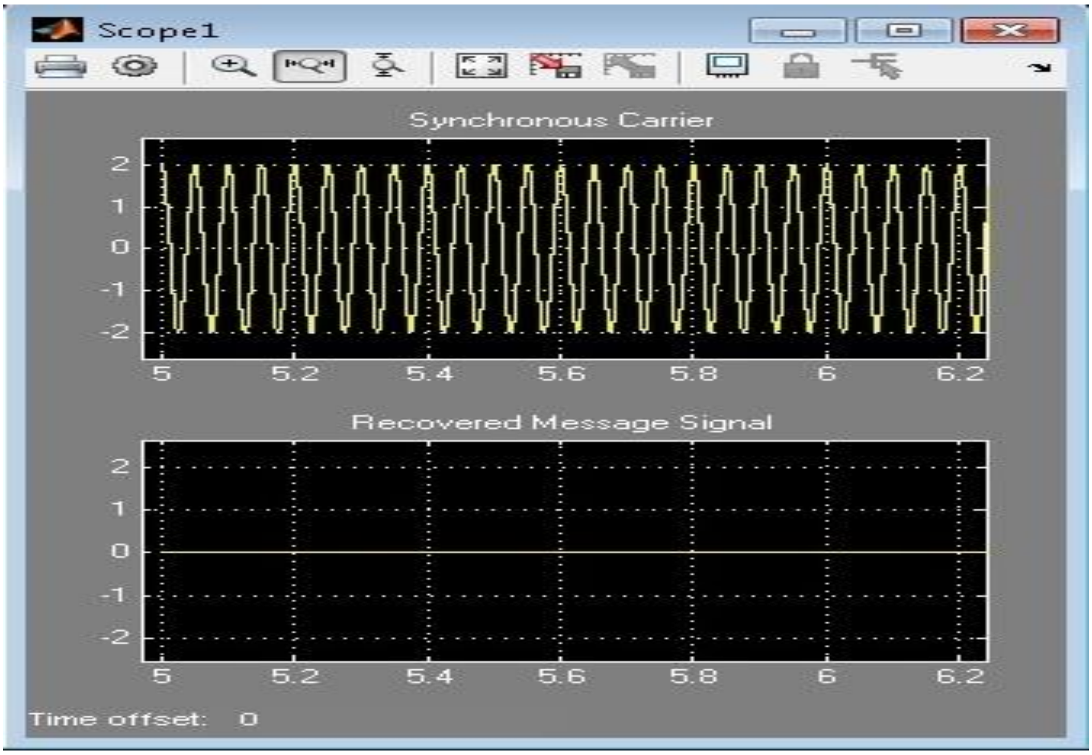
Output


Scope
Message Signal
Carrier Signal
AM DSB-SC Signal
Time offset: 0



Quadrature Null Effect

- Change Synchronous carrier Signal Phase(rad) to **pi/2**



Result

Viva Questions

1. What are the two ways of generating DSB_SC?
2. What are the applications of balanced modulator?
3. What are the advantages of suppressing the carrier?
4. What are the advantages of balanced modulator?
5. What are the advantages of Ring modulator?
6. Write the expression for the output voltage of a balanced modulator?
7. Explain the working of balanced modulator and Ring Modulator using diodes.

Applications

1. Analog TV systems to transmit colour information.
2. Used in Point-to-Point communication.
3. Used in applications where power requirements are low.
4. Used in Linear Radio Communication

3. AM-SSB-SC Modulation & Demodulation

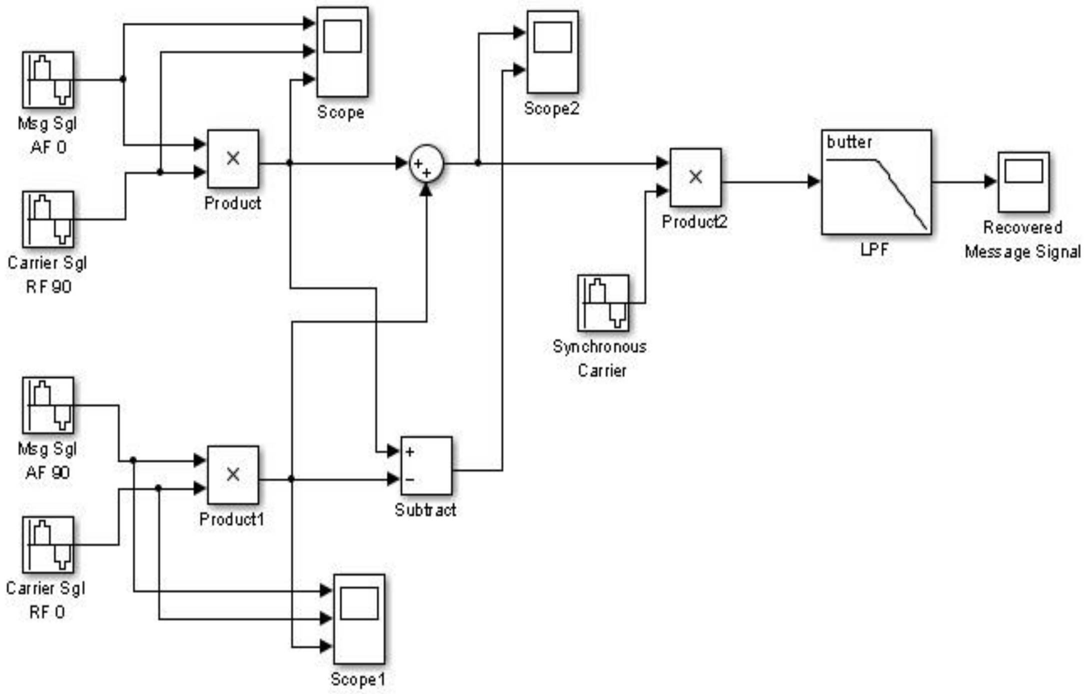
Aim

To perform the AM SSB-SC signal Generation and Detection using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system
b) Software Tool: MATLAB 7.0 and above version

Simulink Model



Procedure

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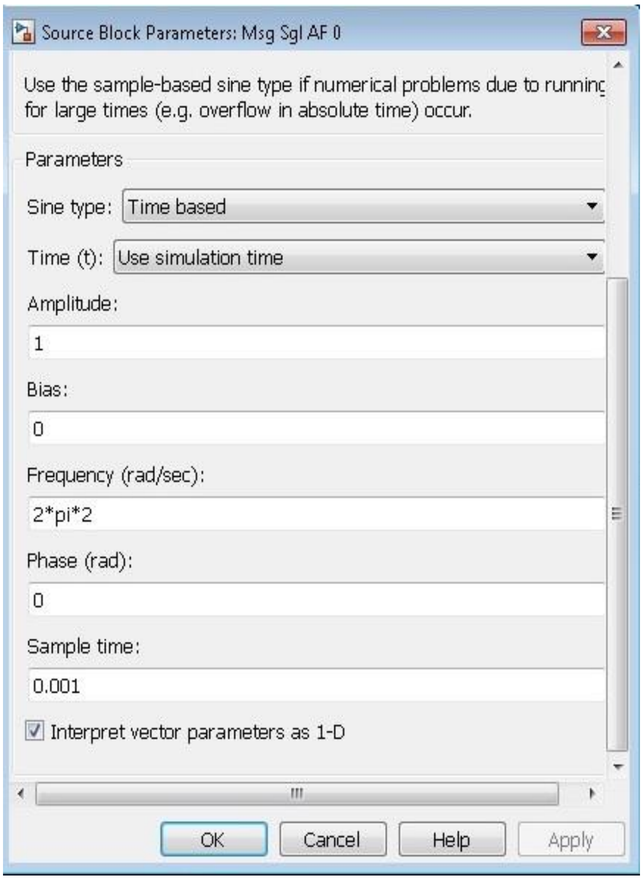
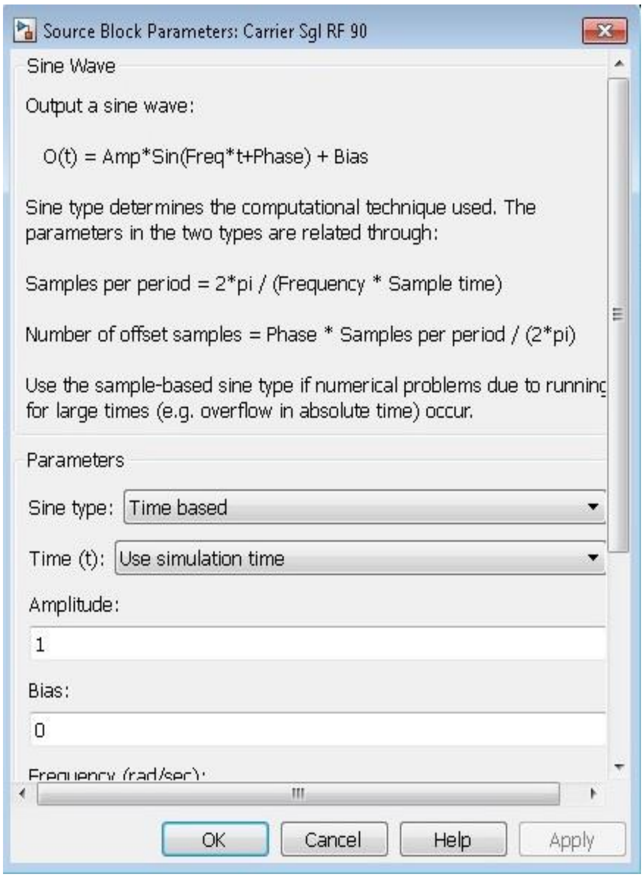
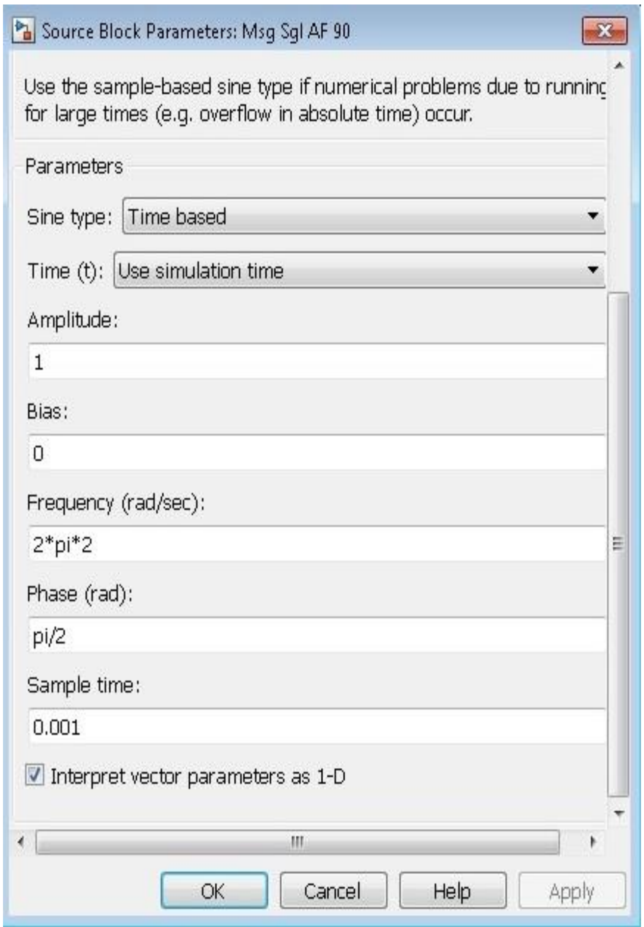
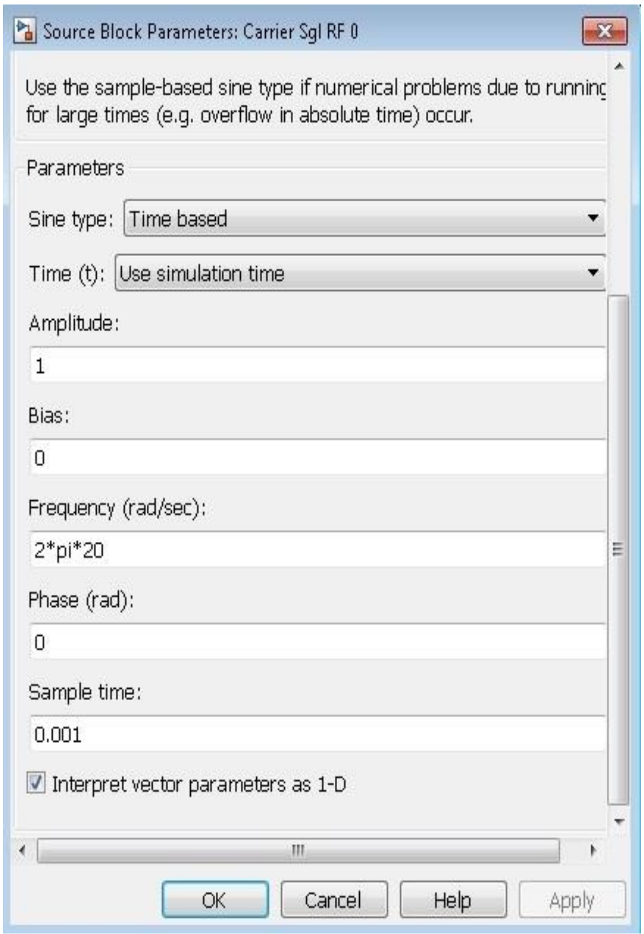
5. Observe the outputs on scope.

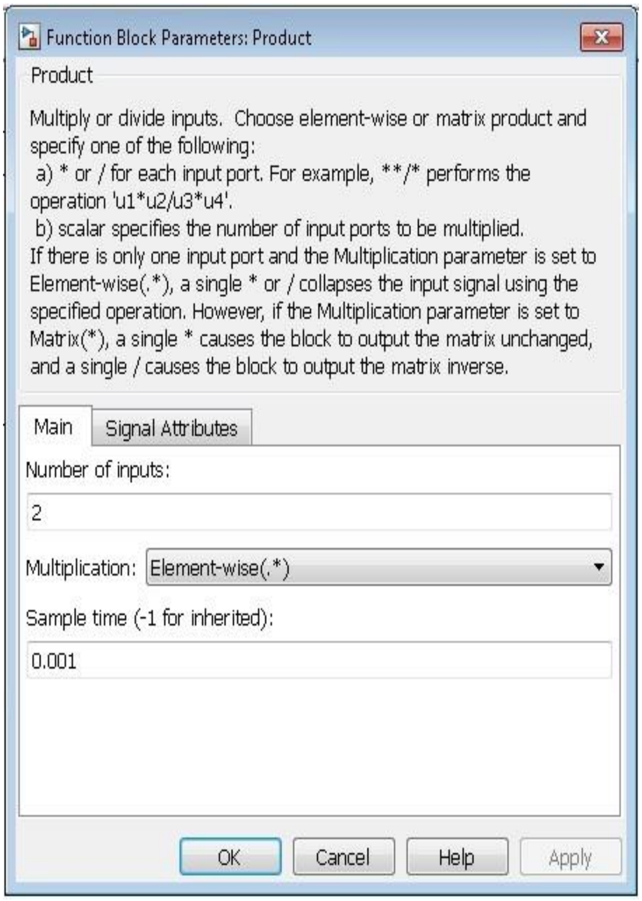
Parameters

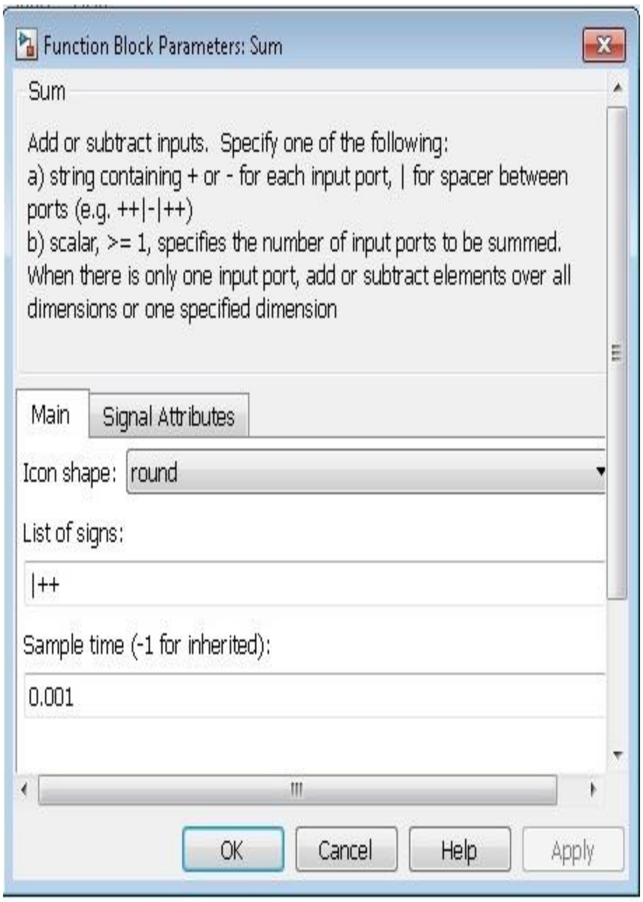

Source Block Parameters: Msg Sgl AF 0
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*2
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

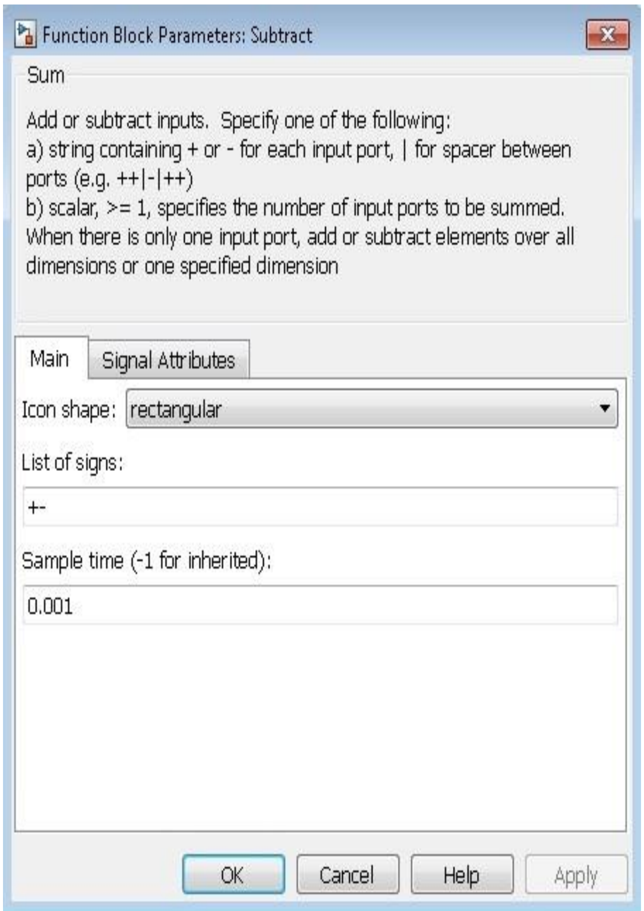

Source Block Parameters: Carrier Sgl RF 90
Sine Wave
Output a sine wave:
O(t) = Amp*Sin(Freq*t+Phase) + Bias
Sine type determines the computational technique used. The parameters in the two types are related through:
Samples per period = 2*pi / (Frequency * Sample time)
Number of offset samples = Phase * Samples per period / (2*pi)
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
OK
Cancel
Help
Apply

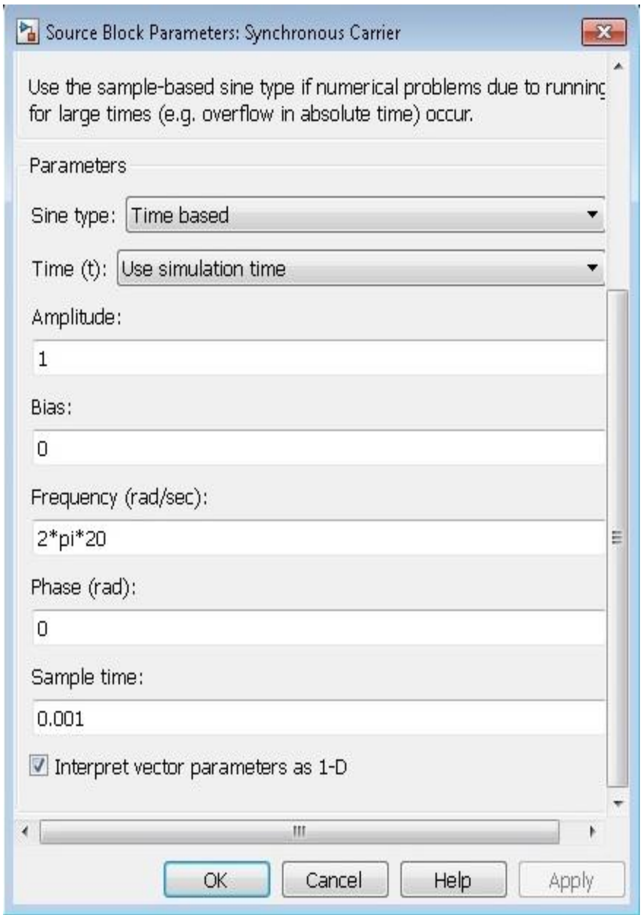

Source Block Parameters: Msg Sgl AF 90
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*2
Phase (rad):
pi/2
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

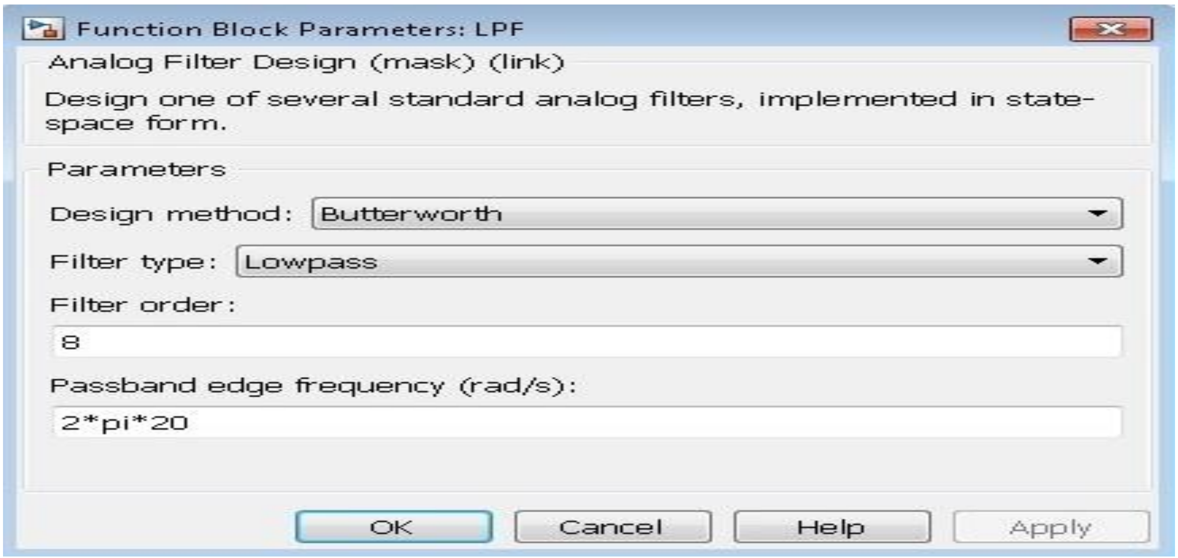

Source Block Parameters: Carrier Sgl RF 0
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*20
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply


Function Block Parameters: Product
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
b) scalar specifies the number of input ports to be multiplied.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
2
Multiplication:
Element-wise(.*)
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

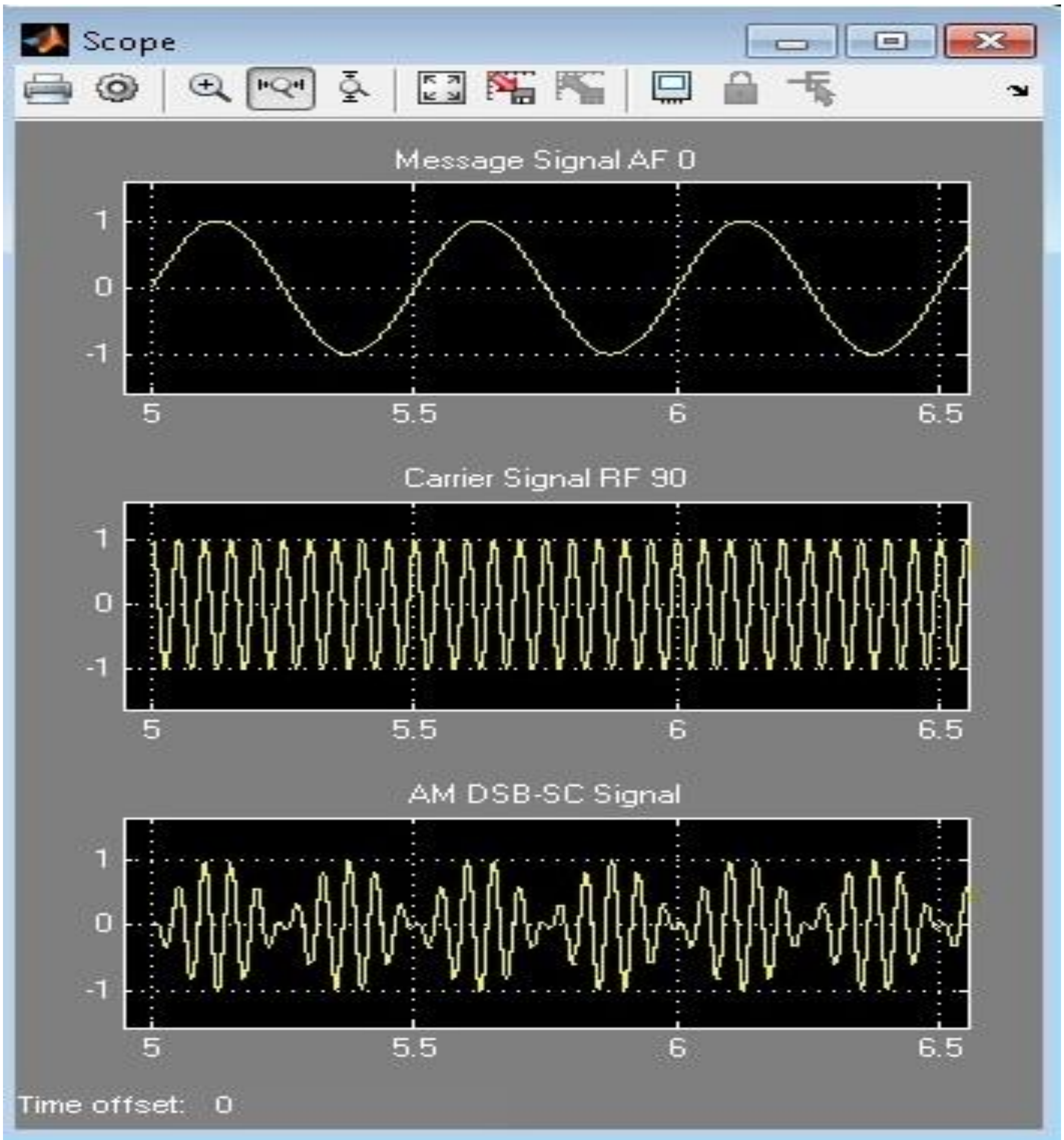

Function Block Parameters: Sum
Sum
Add or subtract inputs. Specify one of the following:
a) string containing + or - for each input port, | for spacer between ports (e.g. ++|-|++)
b) scalar, >= 1, specifies the number of input ports to be summed.
When there is only one input port, add or subtract elements over all dimensions or one specified dimension
Main
Signal Attributes
Icon shape:
round
List of signs:
|++
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

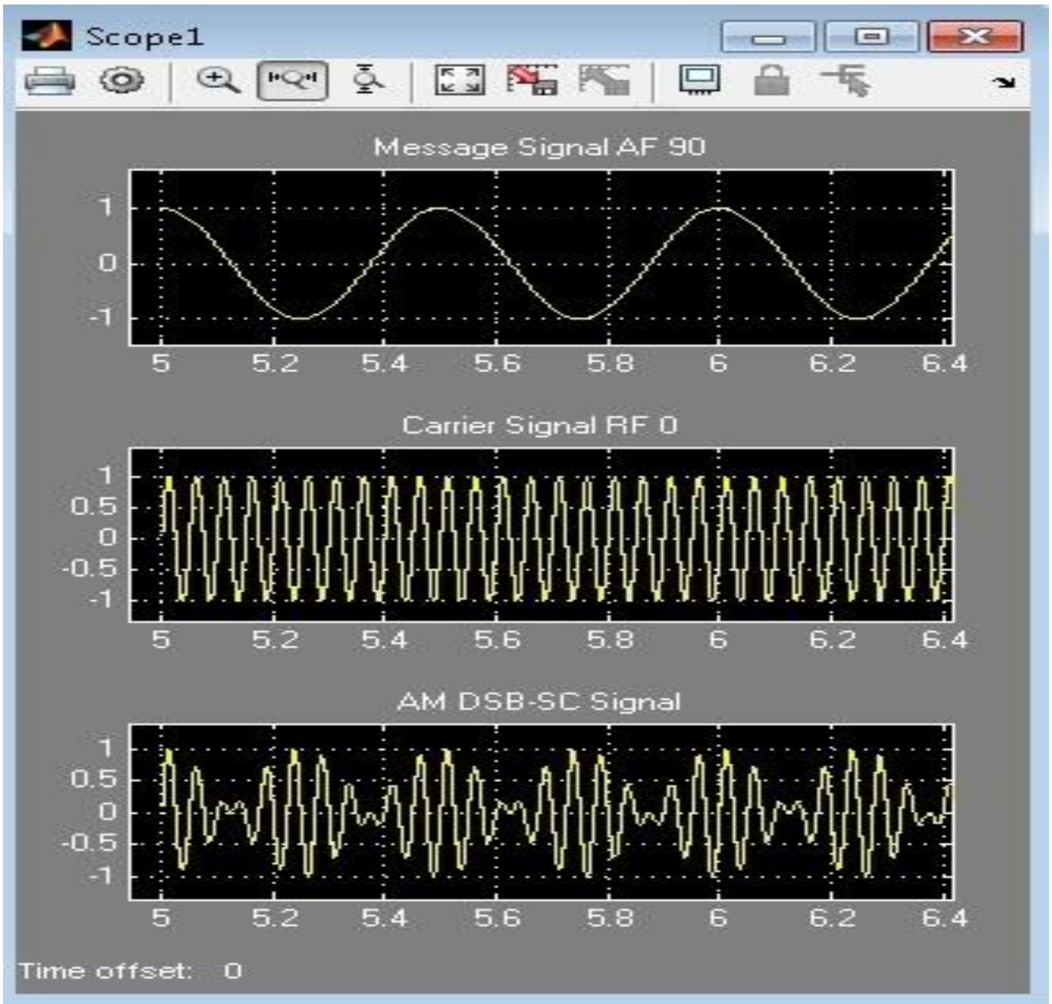

Function Block Parameters: Subtract
Sum
Add or subtract inputs. Specify one of the following:
a) string containing + or - for each input port, | for spacer between ports (e.g. ++|-|++)
b) scalar, >= 1, specifies the number of input ports to be summed.
When there is only one input port, add or subtract elements over all dimensions or one specified dimension
Main
Signal Attributes
Icon shape:
rectangular
List of signs:
+-
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

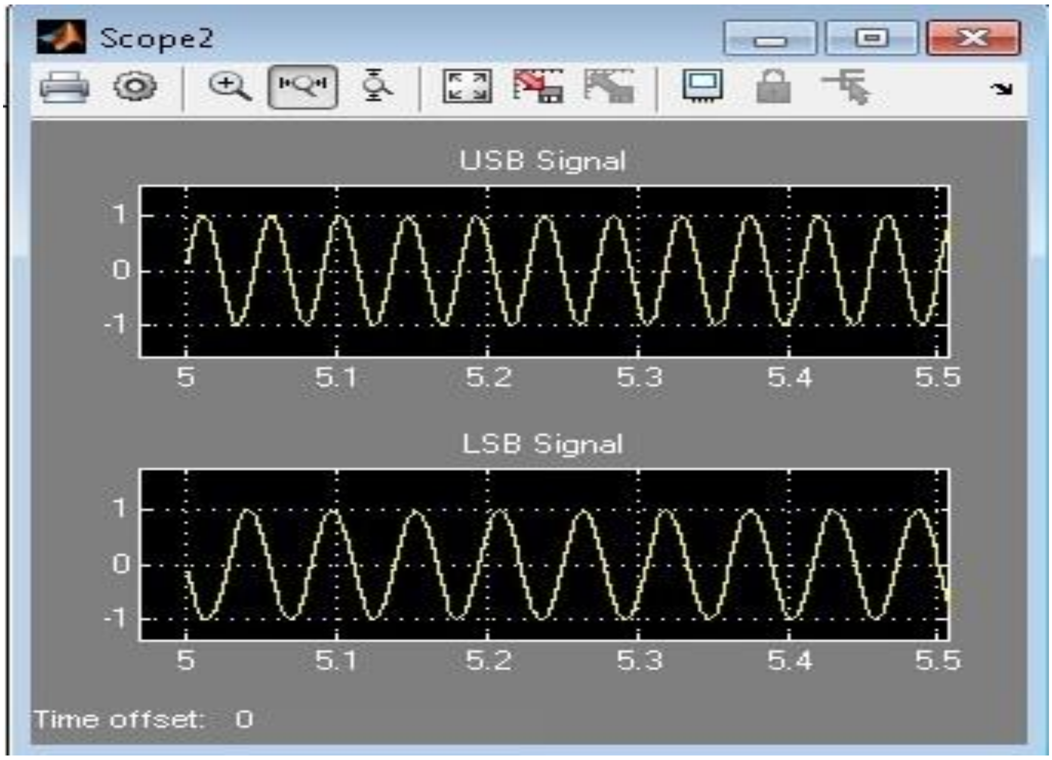

Source Block Parameters: Synchronous Carrier
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type:
Time based
Time (t):
Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*20
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

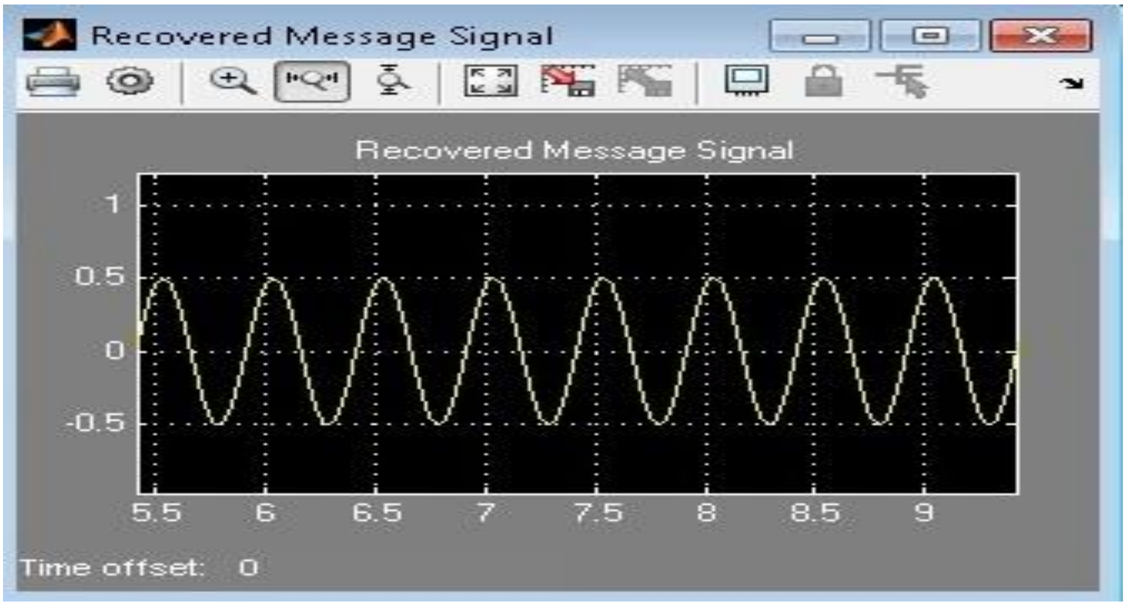

Function Block Parameters: LPF
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
8
Passband edge frequency (rad/s):
2*pi*20
OK
Cancel
Help
Apply

Output


Scope
Message Signal AF 0
1
0
-1
5
5.5
6
6.5
Carrier Signal RF 90
1
0
-1
5
5.5
6
6.5
AM DSB-SC Signal
1
0
-1
5
5.5
6
6.5
Time offset: 0


Scope1
Message Signal AF 90
Carrier Signal RF 0
AM DSB-SC Signal
Time offset: 0


Scope2
USB Signal
LSB Signal
Time offset: 0



Result

Viva Questions

1. What are the different methods to generate SSB-SC signal?
2. What is the advantage of SSB-SC over DSB-SC?
3. Explain Phase Shift method for SSB generation.
4. Why SSB is not used for broadcasting?
5. Give the circuit for synchronous detector?
6. What are the uses of synchronous or coherent detector?
7. Give the block diagram of synchronous detector?
8. Why the name synchronous detector?

Applications

1. SSB transmission is used in applications where the Power saving is required in Mobile systems.
2. SSB is also used in applications in which bandwidth requirements are low

   Ex: Point-to-Point Communication
   Land, Air and Maritime Mobile communications
   TV, Telemetry and Military communications
   Radio Navigation & Amateur Radio

4. Frequency Division Multiplexing & DeMultiplexing (with DSB-SC)

Aim

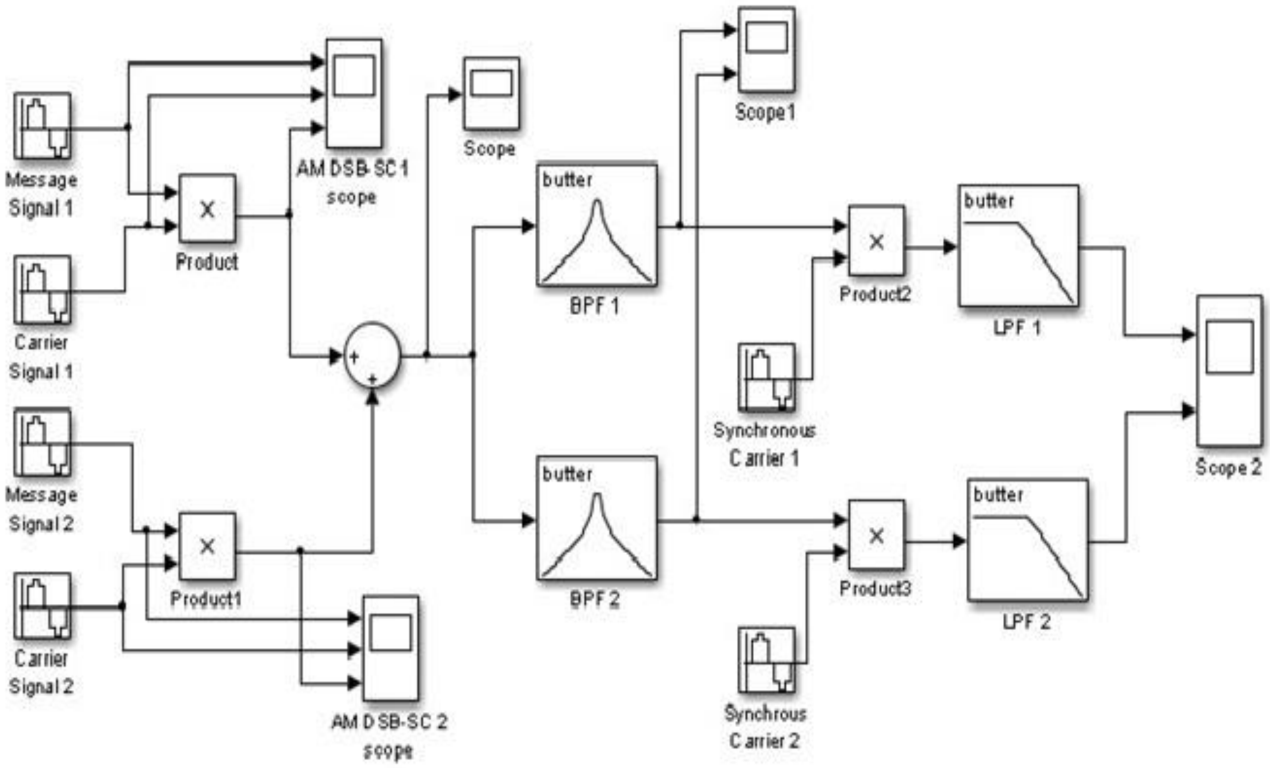
To perform the Frequency Division Multiplexing with AM DSB-SC signals using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 and above version

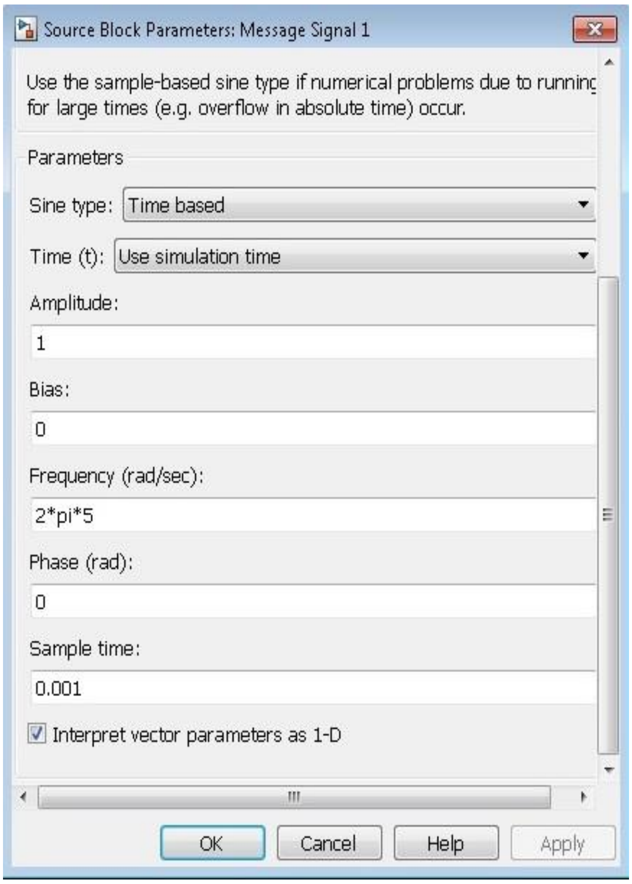
Simulink Model

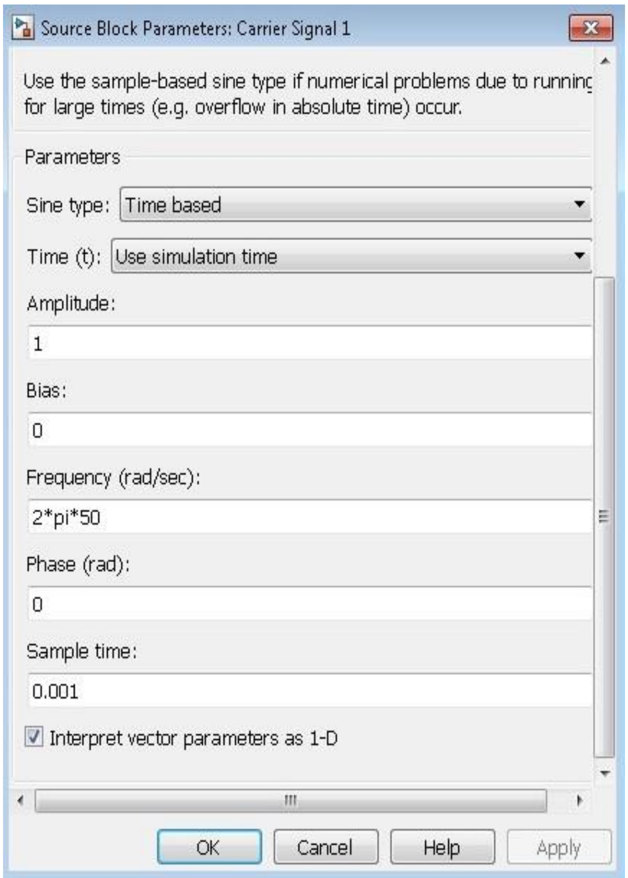


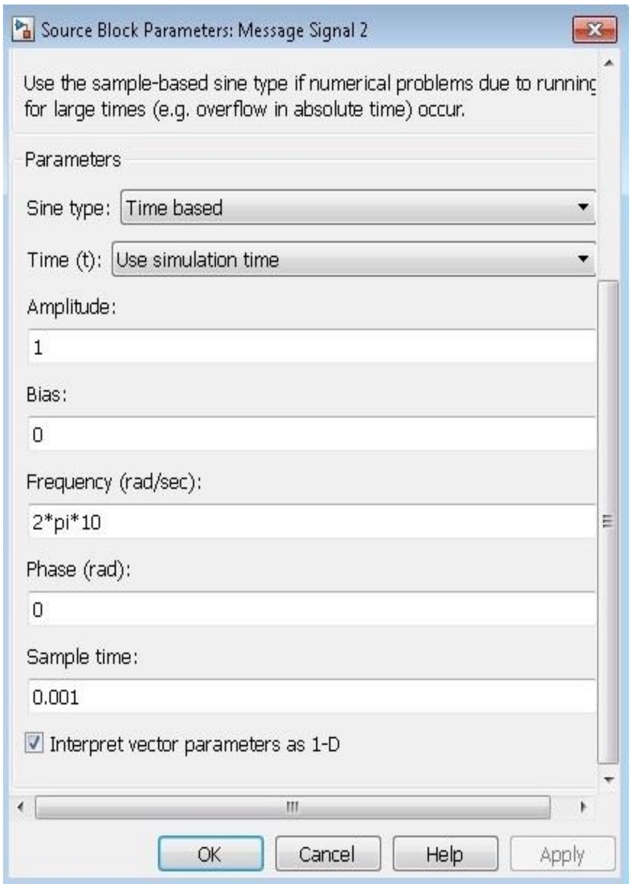
Procedure

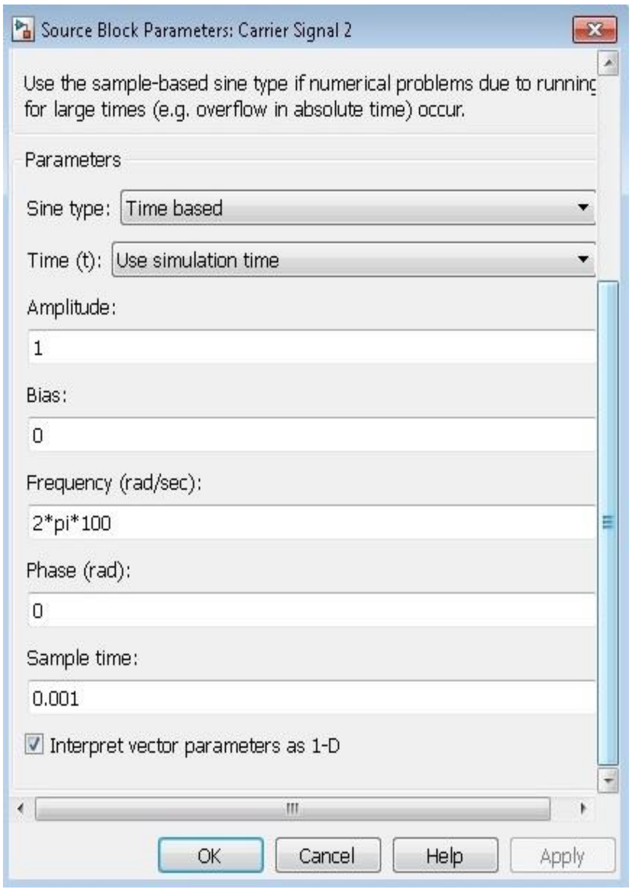
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

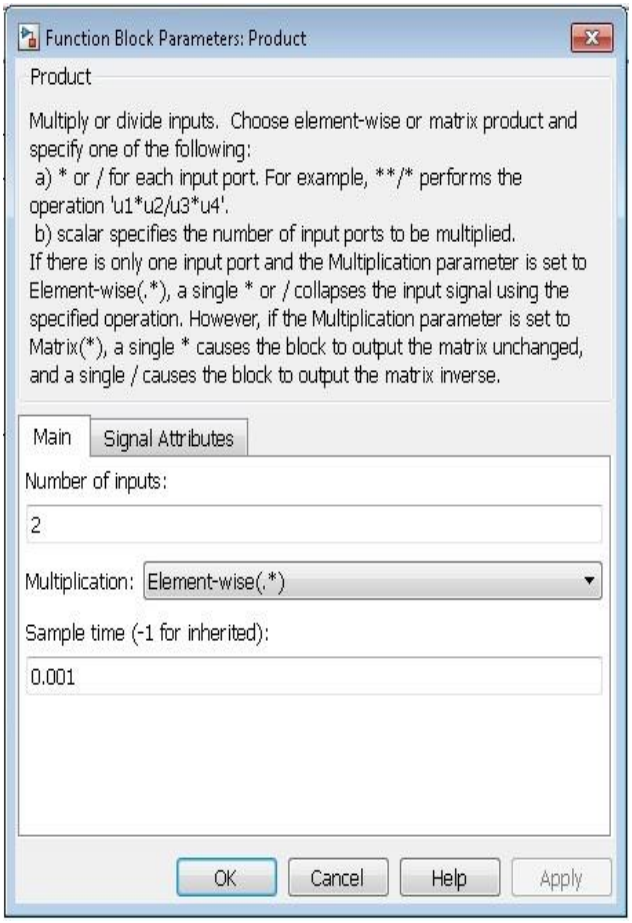
Parameters

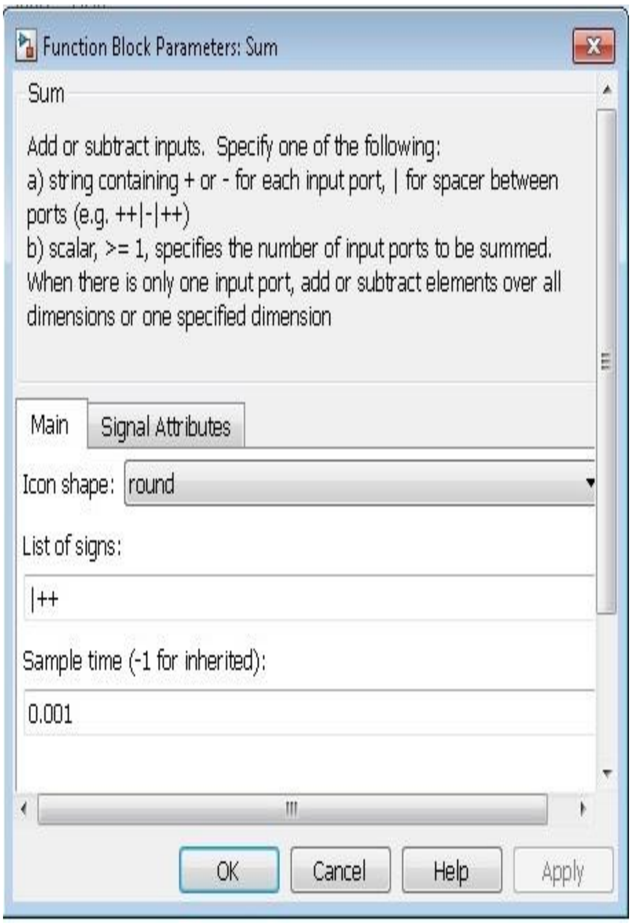

Source Block Parameters: Message Signal 1
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*5
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

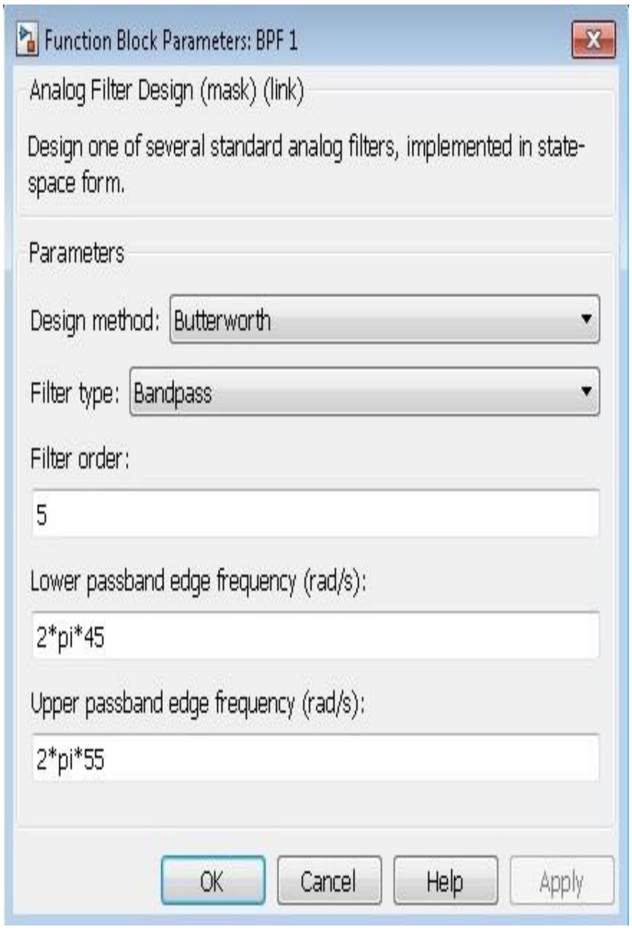

Source Block Parameters: Carrier Signal 1
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*50
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

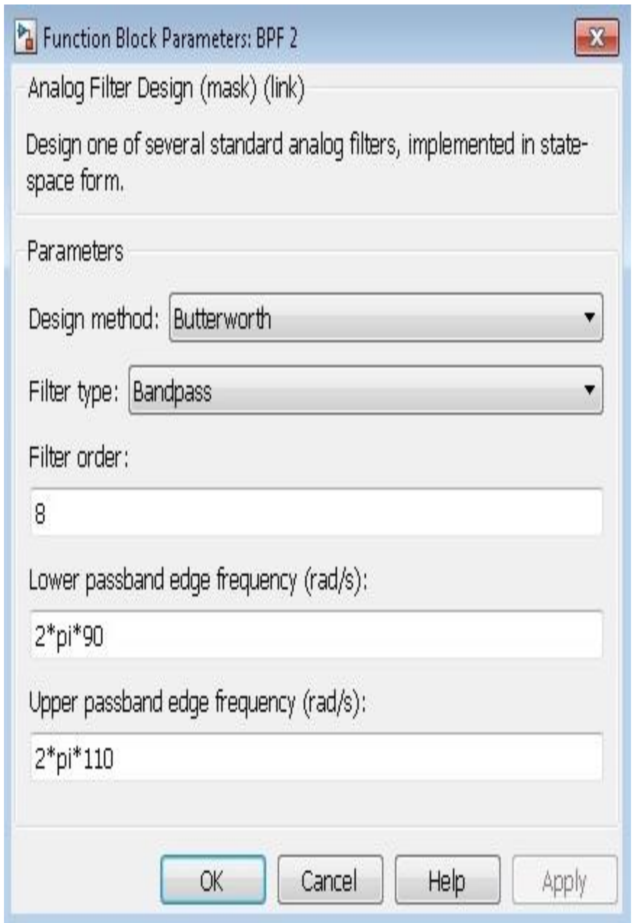

Source Block Parameters: Message Signal 2
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*10
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

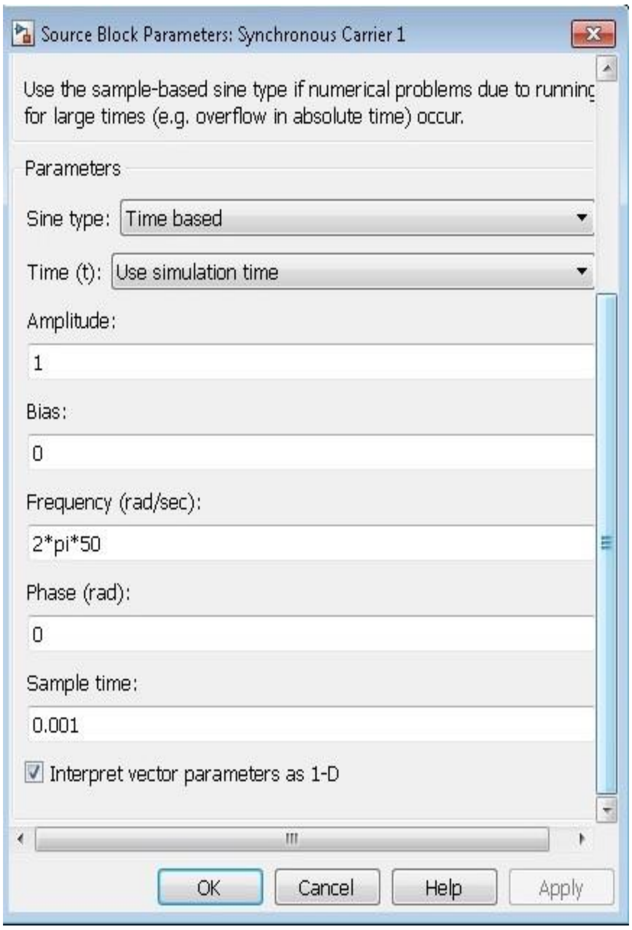

Source Block Parameters: Carrier Signal 2
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*100
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

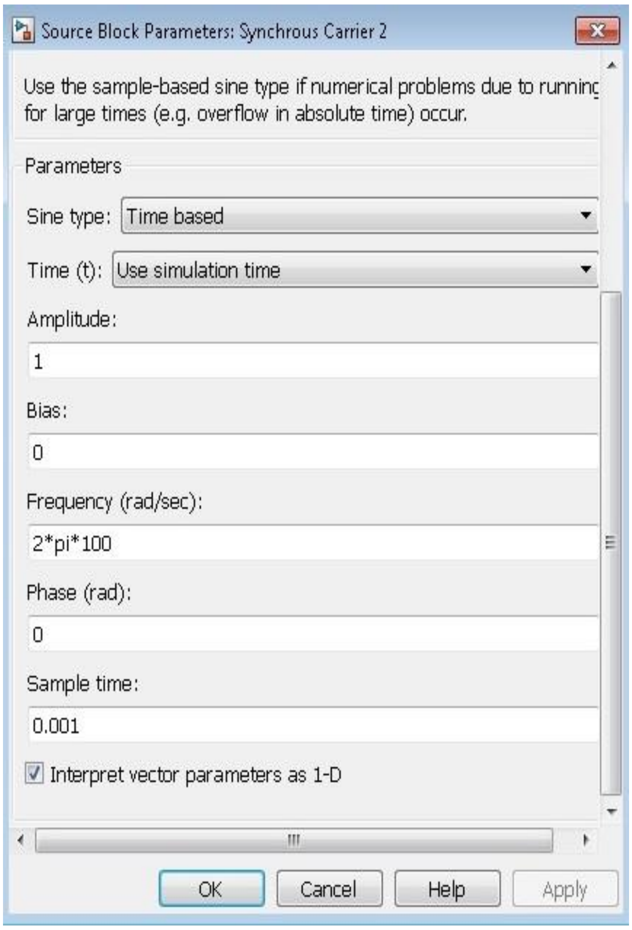

Function Block Parameters: Product
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
b) scalar specifies the number of input ports to be multiplied.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
2
Multiplication:
Element-wise(.*)
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

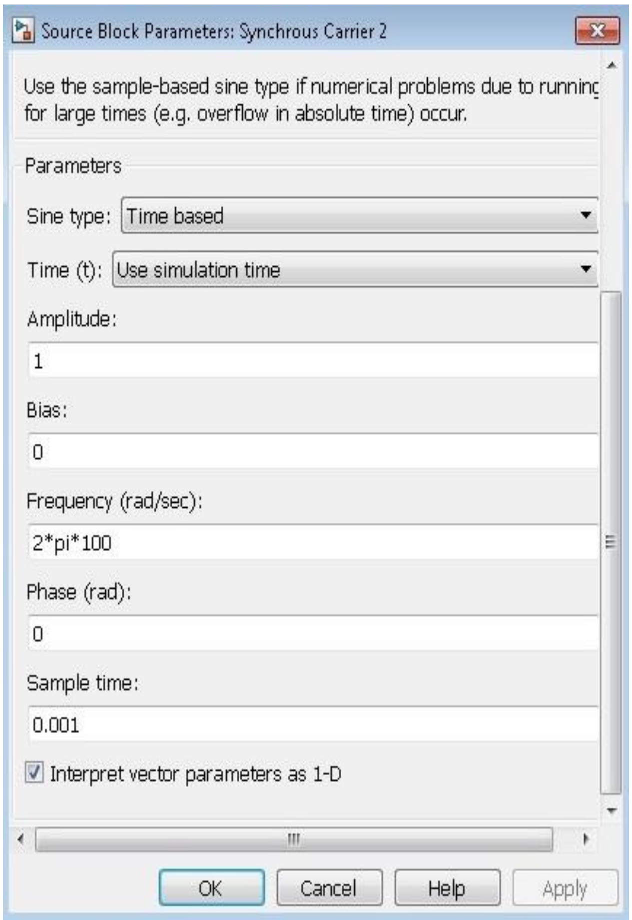

Function Block Parameters: Sum
Sum
Add or subtract inputs. Specify one of the following:
a) string containing + or - for each input port, | for spacer between ports (e.g. ++|-|++)
b) scalar, >= 1, specifies the number of input ports to be summed.
When there is only one input port, add or subtract elements over all dimensions or one specified dimension
Main
Signal Attributes
Icon shape:
round
List of signs:
|++
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

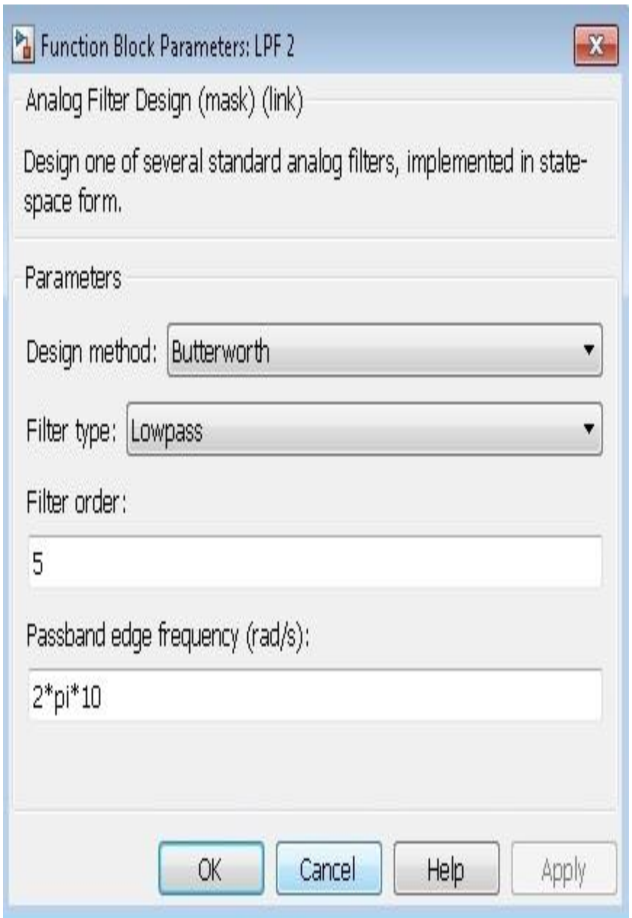

Function Block Parameters: BPF 1
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method:
Butterworth
Filter type:
Bandpass
Filter order:
5
Lower passband edge frequency (rad/s):
2*pi*45
Upper passband edge frequency (rad/s):
2*pi*55
OK
Cancel
Help
Apply


Function Block Parameters: BPF 2
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method:
Butterworth
Filter type:
Bandpass
Filter order:
8
Lower passband edge frequency (rad/s):
2*pi*90
Upper passband edge frequency (rad/s):
2*pi*110
OK
Cancel
Help
Apply

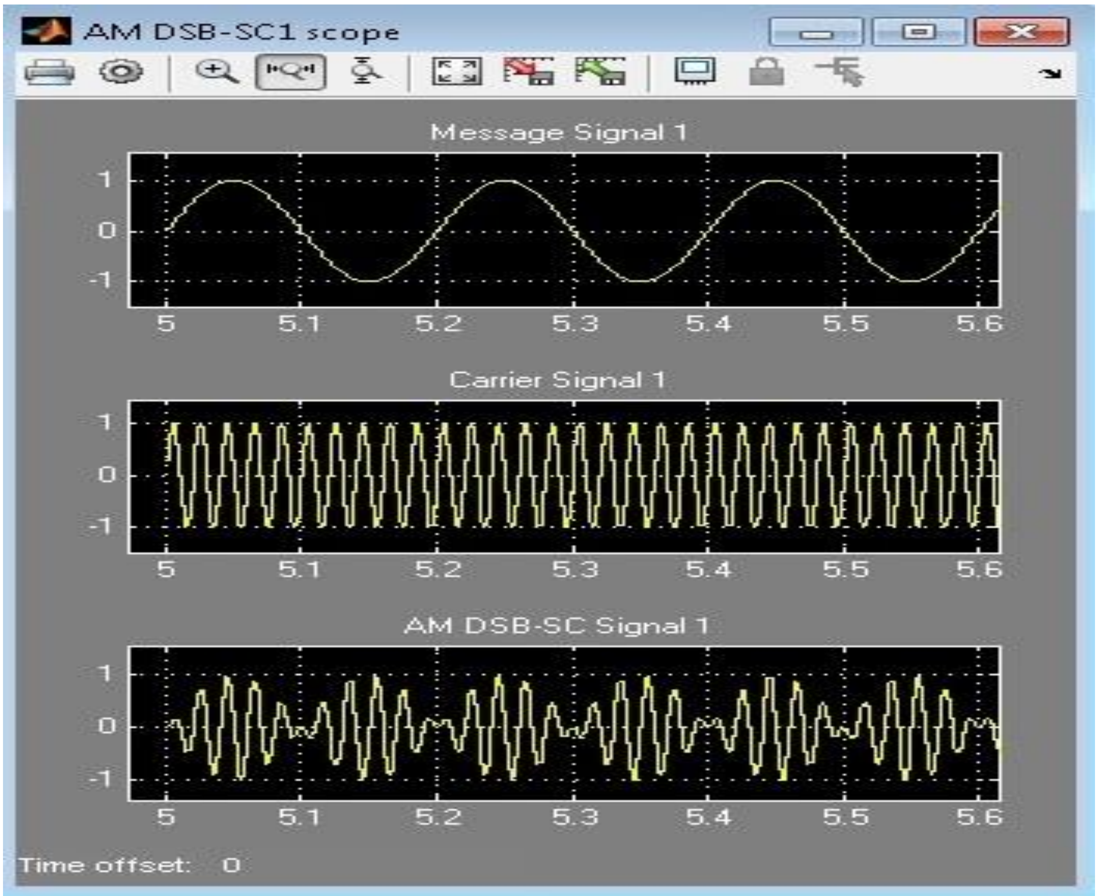

Source Block Parameters: Synchronous Carrier 1
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*50
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

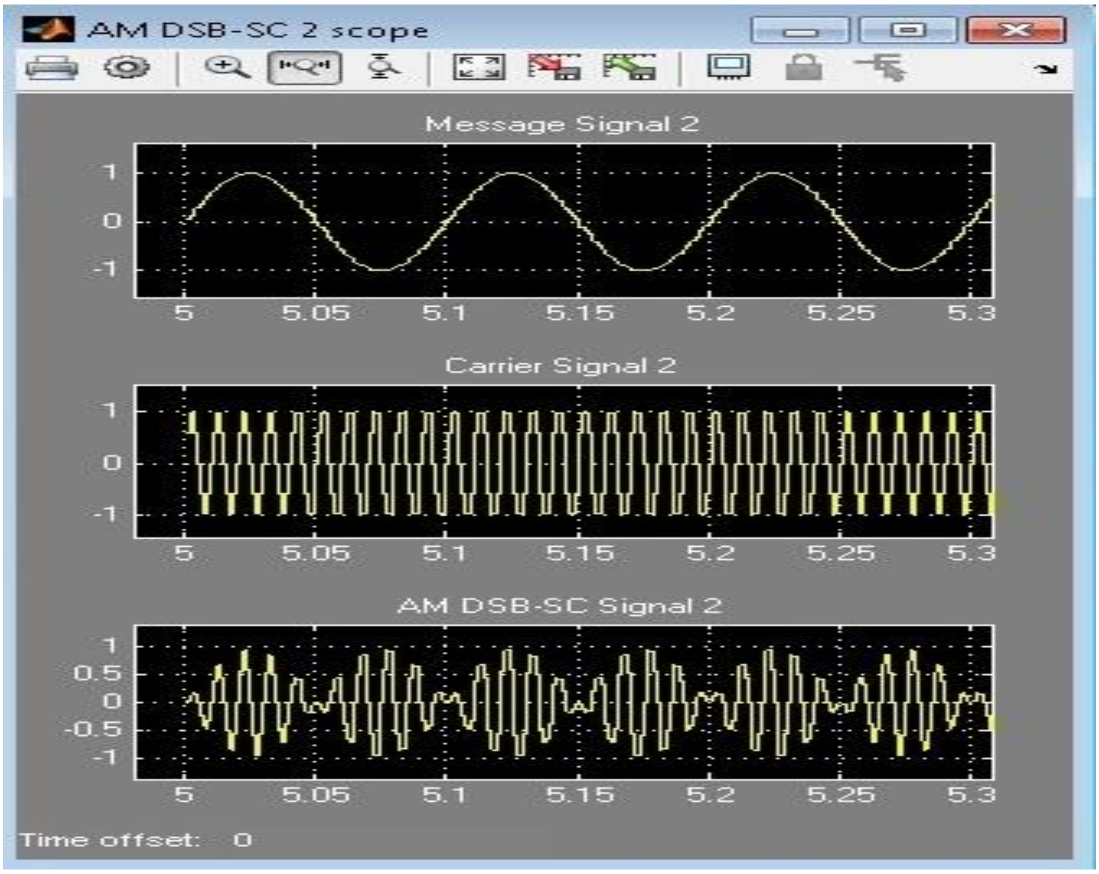

Source Block Parameters: Synchrous Carrier 2
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*100
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

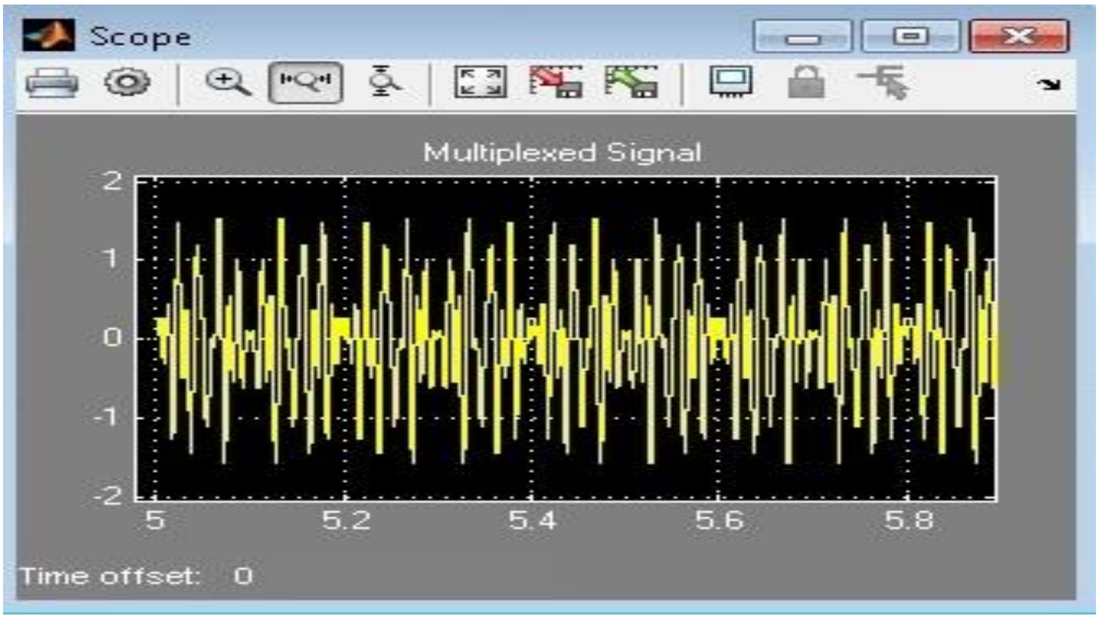

Source Block Parameters: Synchrous Carrier 2
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*100
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

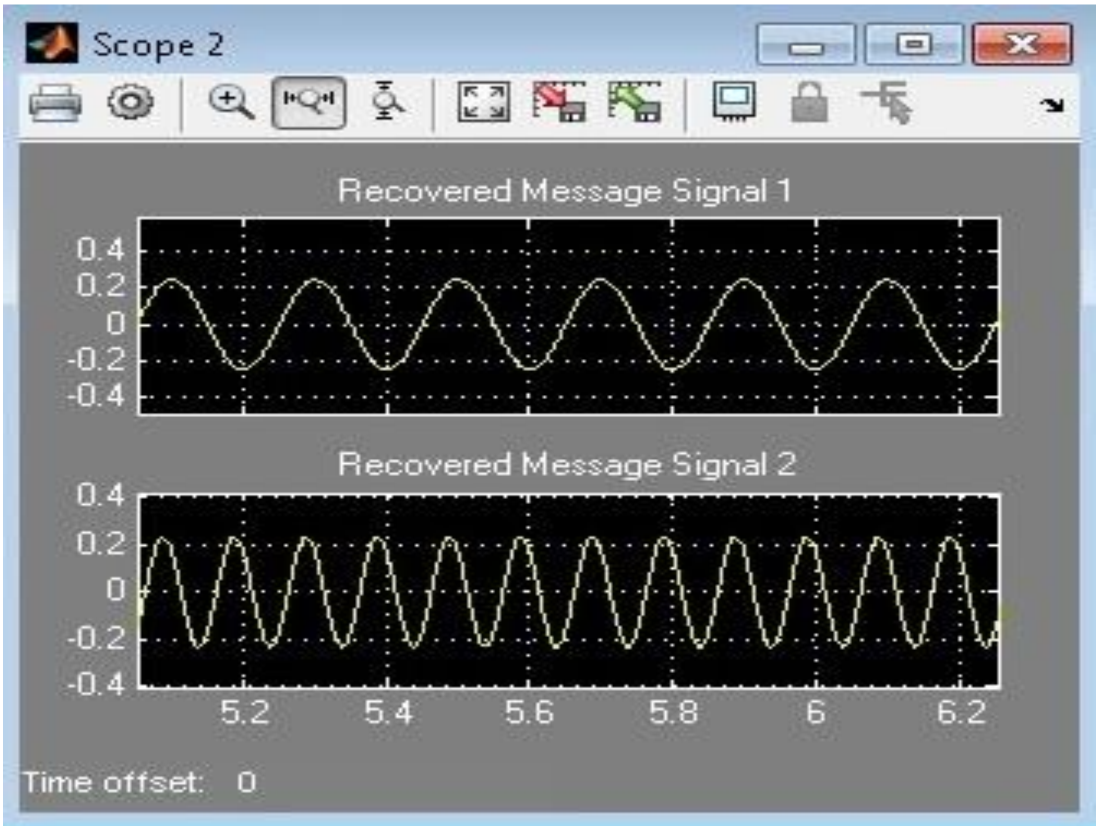

Function Block Parameters: LPF 2
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
5
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply

Output


AM DSB-SC1 scope
Message Signal 1
1
0
-1
5
5.1
5.2
5.3
5.4
5.5
5.6
Carrier Signal 1
AM DSB-SC Signal 1
Time offset: 0


AM DSB-SC 2 scope
Message Signal 2
1
0
-1
5
5.05
5.1
5.15
5.2
5.25
5.3
Carrier Signal 2
AM DSB-SC Signal 2
0.5
-0.5
Time offset: 0


Scope
Multiplexed Signal
2
1
0
-1
-2
5
5.2
5.4
5.6
5.8
Time offset: 0


Scope 2
Recovered Message Signal 1
0.4
0.2
0
-0.2
-0.4
Recovered Message Signal 2
0.4
0.2
0
-0.2
-0.4
5.2
5.4
5.6
5.8
6
6.2
Time offset: 0

Result

Viva Questions

1. What is Multiplexing?
2. What are the different types of Multiplexing techniques?
3. What is the difference between FDM and TDM?
4. What are the advantages and disadvantages of FDM?
5. What is the difficult part in FDM?
6. What is the overall bandwidth if N number of signals are multiplexed?
7. Why AM SSB-SC is preferred for FDM?
8. What is Demultiplexing?

Applications

1. FDM is used for FM & AM radio broadcasting. AM broadcasting uses a bandwidth of 550-1650 KHz, where as FM broadcasting used a bandwidth of 88-108 MHz
2. FDM is used in Television broadcasting.
3. First generation Cellular telephone also uses FDM.
4. Used in Stereo FM transmissions.
5. Twentieth century telephone companies used FDM for long-distance connections to multiplex thousands of voice signals through co-axial cable systems.
6. Telemetry
   a. Used to send feedback from multiple sensors over a single channel
7. Telephone Systems
   a. Had been used for decades to send multiple telephone conversations over a minimum number of cables
   b. The multiplexing process is used at multiple levels to send 10,800 phone calls over a single channel
8. Cable TV
   a. Multiple TV signals are multiplexed on a common coaxial cable

5. Frequency Modulation & Demodulation

Aim

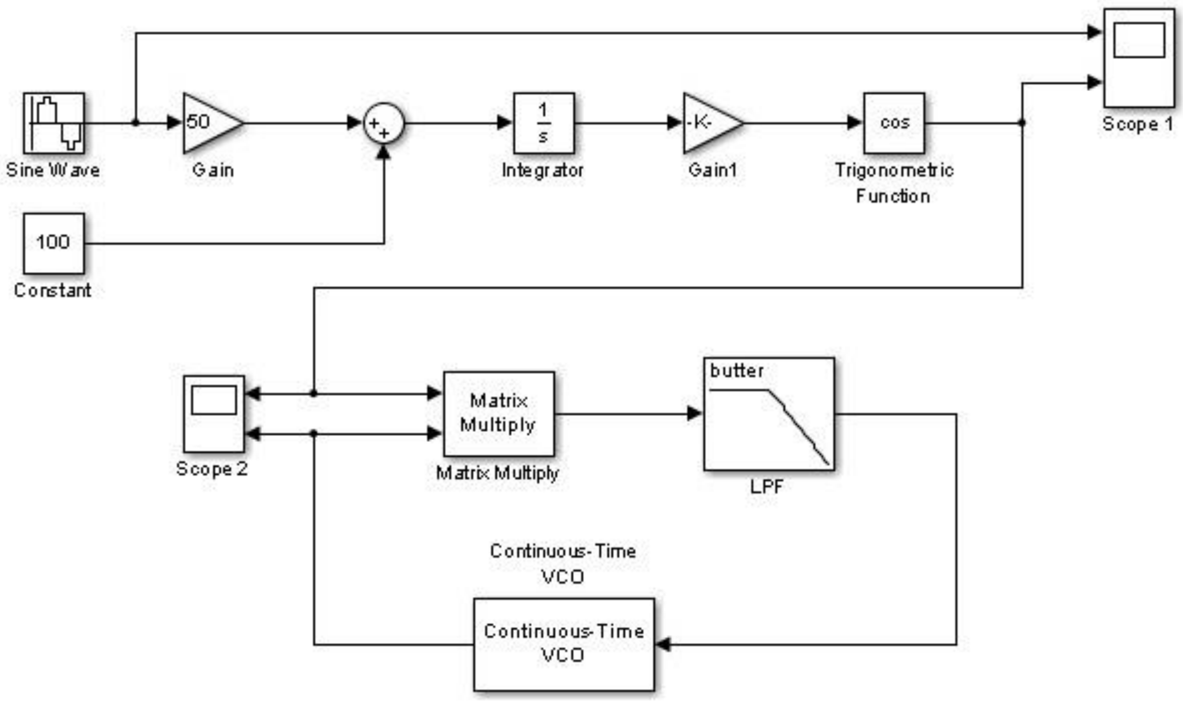
To perform the Frequency Modulation signal Generation and Detection using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 and above version.

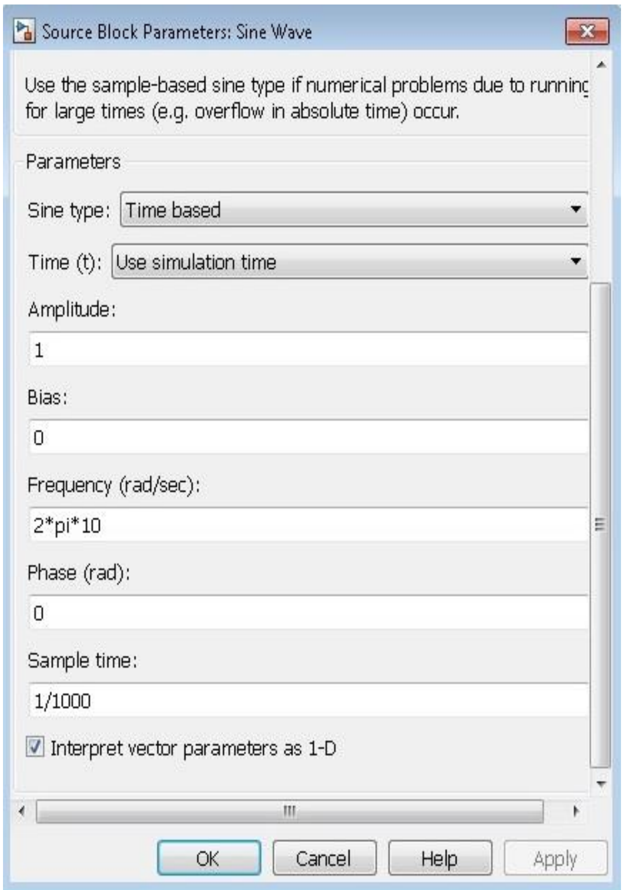
Simulink Model

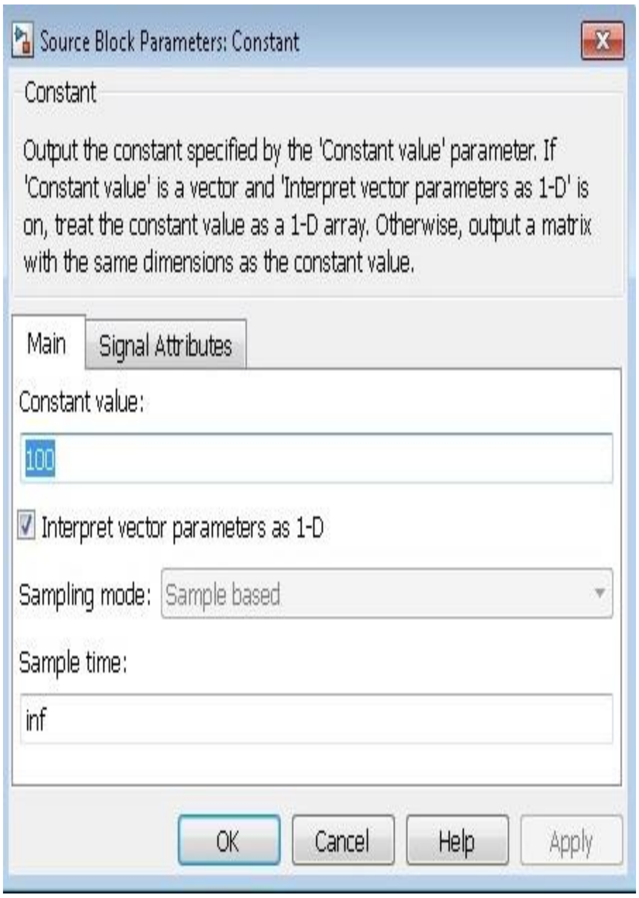


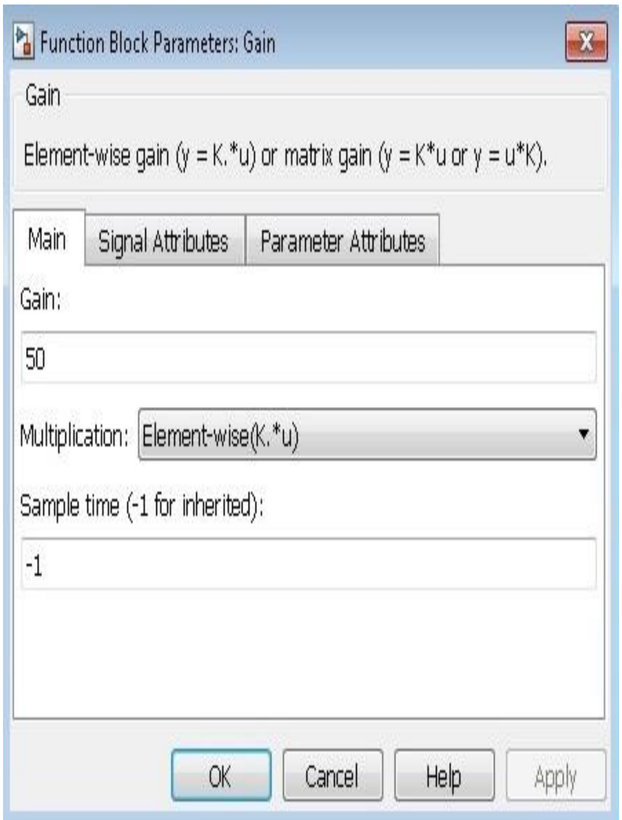
Procedure

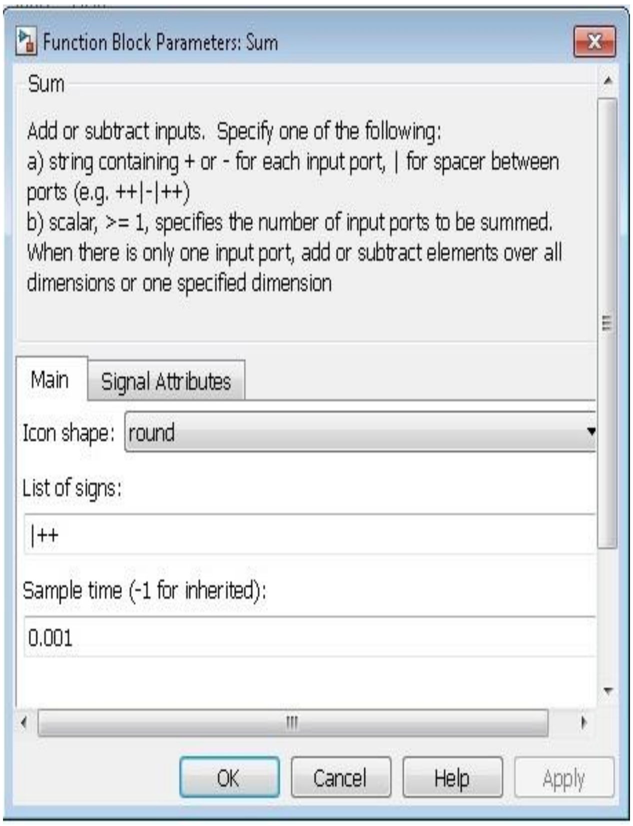
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

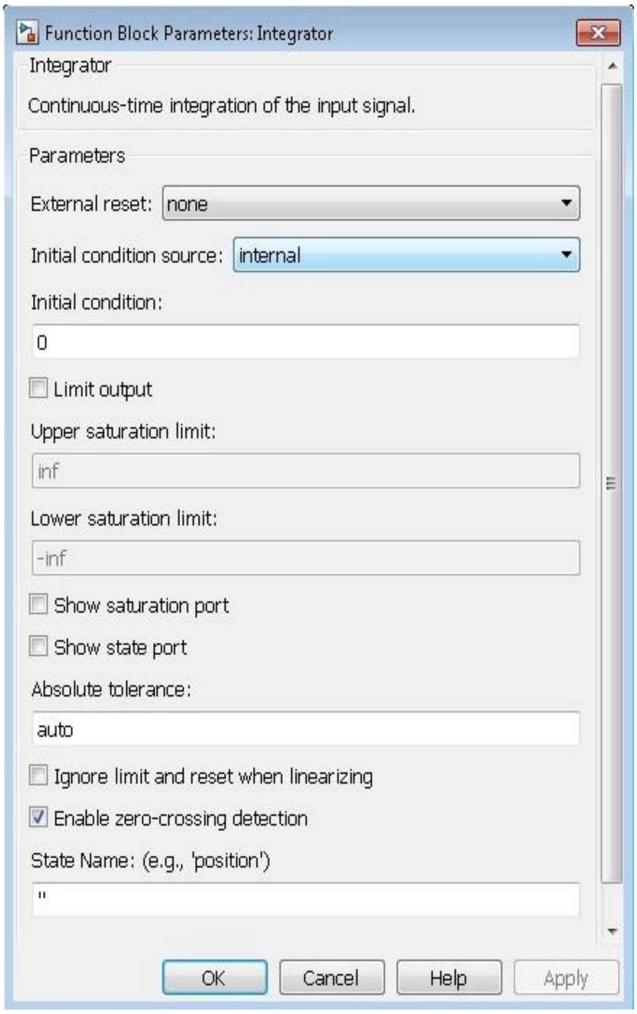
Parameters

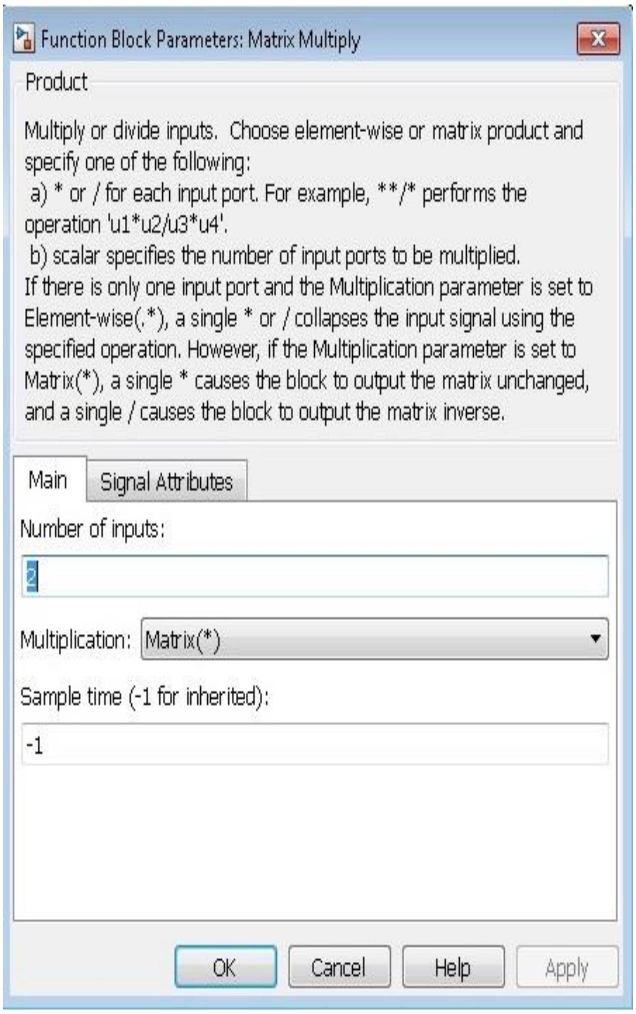

Source Block Parameters: Sine Wave
Use the sample-based sine type if numerical problems due to runninc for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*10
Phase (rad):
0
Sample time:
1/1000
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

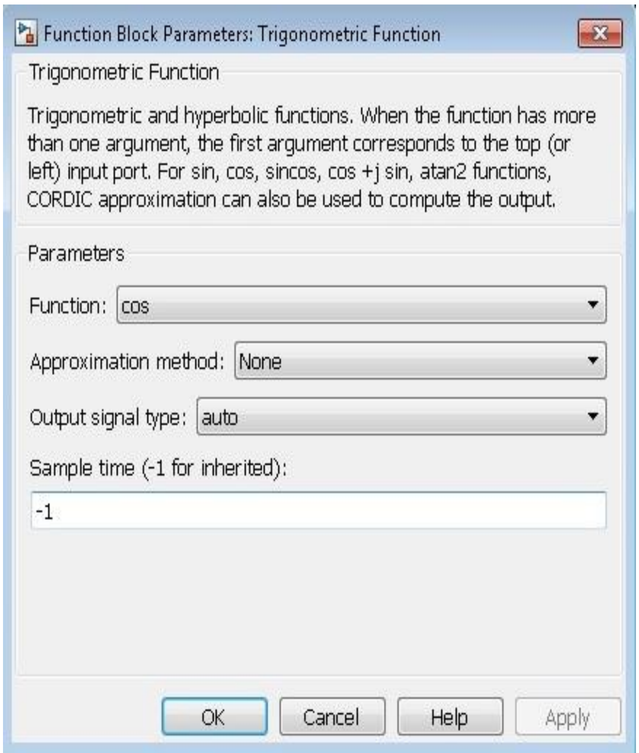

Source Block Parameters: Constant
Constant
Output the constant specified by the 'Constant value' parameter. If 'Constant value' is a vector and 'Interpret vector parameters as 1-D' is on, treat the constant value as a 1-D array. Otherwise, output a matrix with the same dimensions as the constant value.
Main
Signal Attributes
Constant value:
100
Interpret vector parameters as 1-D
Sampling mode: Sample based
Sample time:
inf
OK
Cancel
Help
Apply

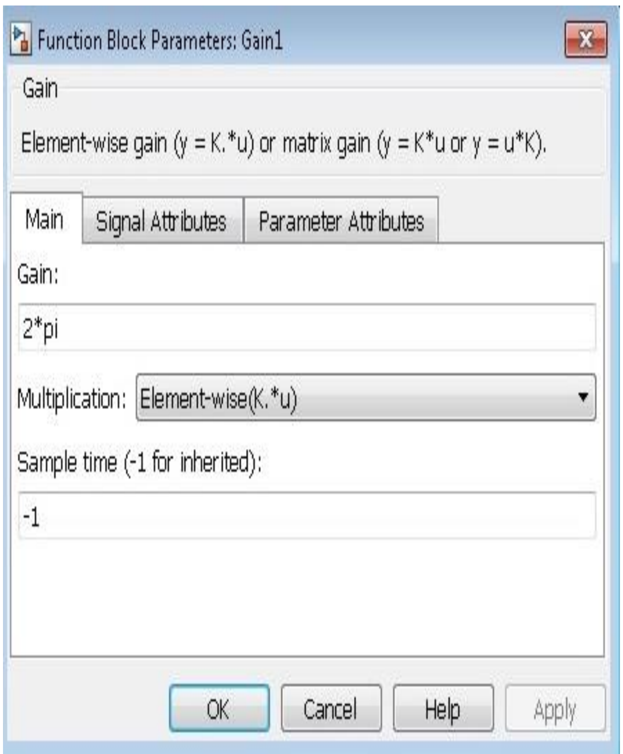

Function Block Parameters: Gain
Gain
Element-wise gain (y = K.*u) or matrix gain (y = K*u or y = u*K).
Main
Signal Attributes
Parameter Attributes
Gain:
50
Multiplication: Element-wise(K.*u)
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply

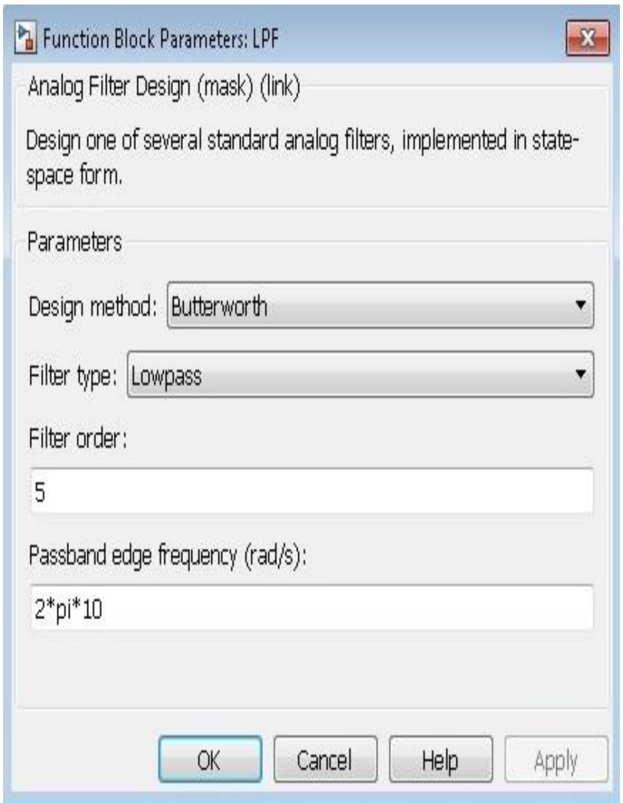

Function Block Parameters: Sum
Sum
Add or subtract inputs. Specify one of the following:
a) string containing + or - for each input port, | for spacer between ports (e.g. ++|-|++)
b) scalar, >= 1, specifies the number of input ports to be summed.
When there is only one input port, add or subtract elements over all dimensions or one specified dimension
Main
Signal Attributes
Icon shape: round
List of signs:
|++
Sample time (-1 for inherited):
0.001
OK
Cancel
Help
Apply

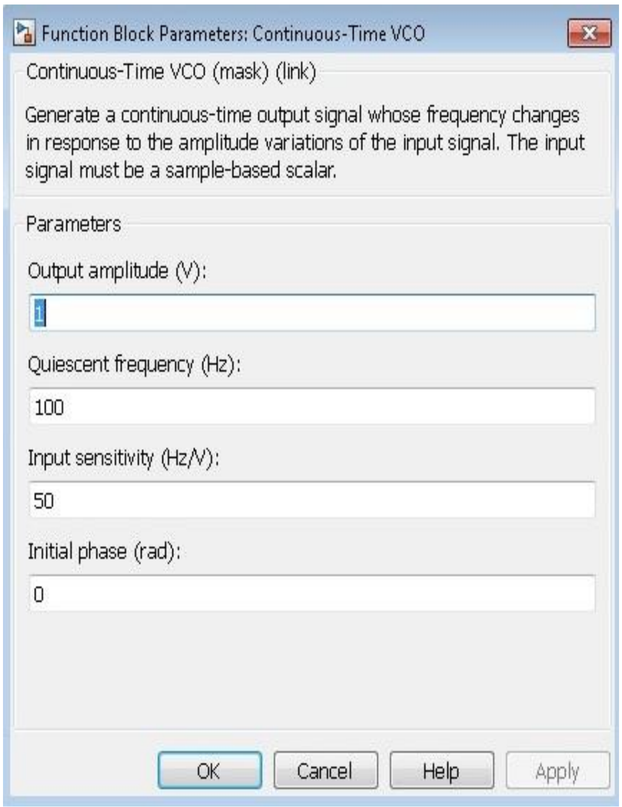

Function Block Parameters: Integrator
Integrator
Continuous-time integration of the input signal.
Parameters
External reset: none
Initial condition source: internal
Initial condition:
0
Limit output
Upper saturation limit:
inf
Lower saturation limit:
-inf
Show saturation port
Show state port
Absolute tolerance:
auto
Ignore limit and reset when linearizing
Enable zero-crossing detection
State Name: (e.g., 'position')
''
OK
Cancel
Help
Apply


Function Block Parameters: Matrix Multiply
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
b) scalar specifies the number of input ports to be multiplied.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
2
Multiplication: Matrix(*)
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply

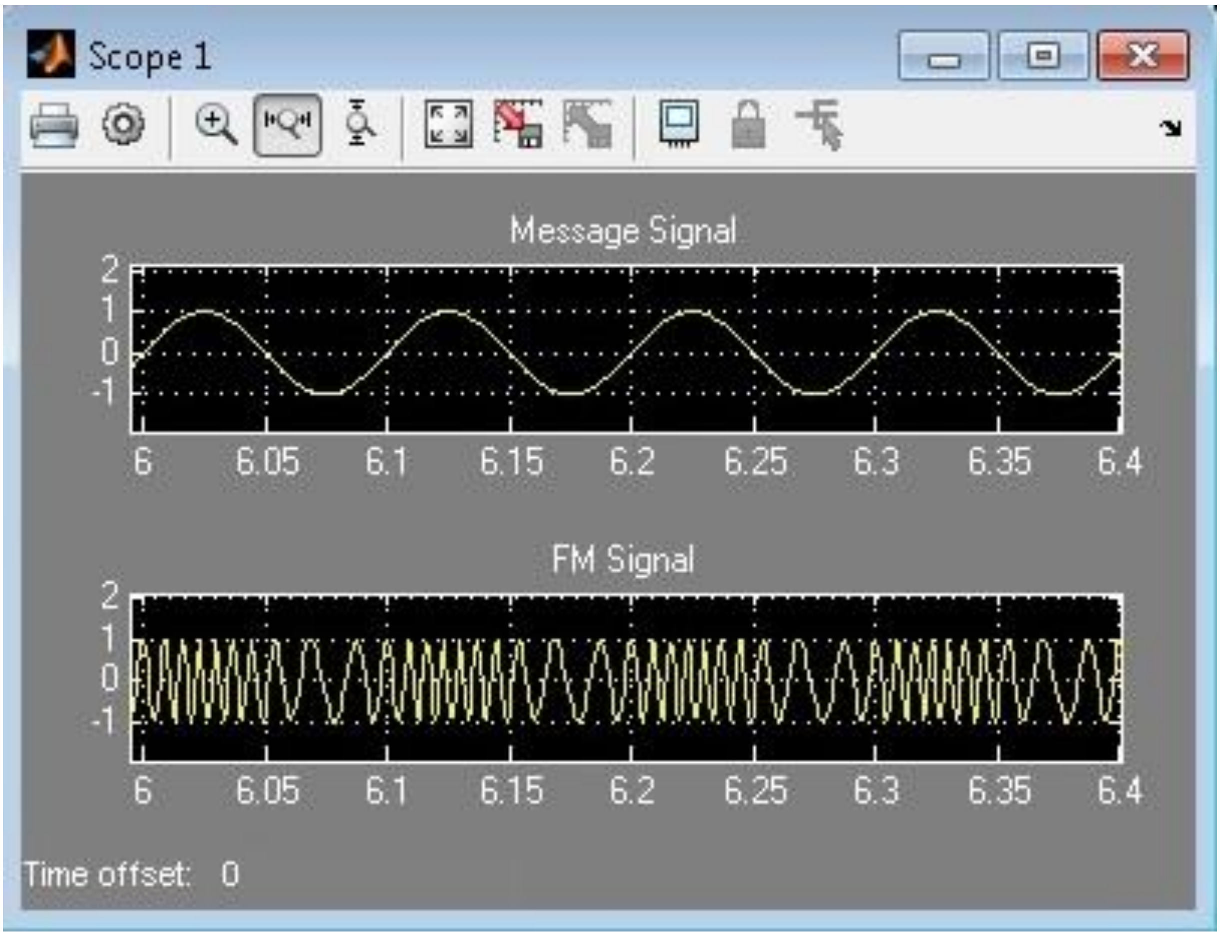

Function Block Parameters: Trigonometric Function
Trigonometric Function
Trigonometric and hyperbolic functions. When the function has more than one argument, the first argument corresponds to the top (or left) input port. For sin, cos, sincos, cos +j sin, atan2 functions, CORDIC approximation can also be used to compute the output.
Parameters
Function: cos
Approximation method: None
Output signal type: auto
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply

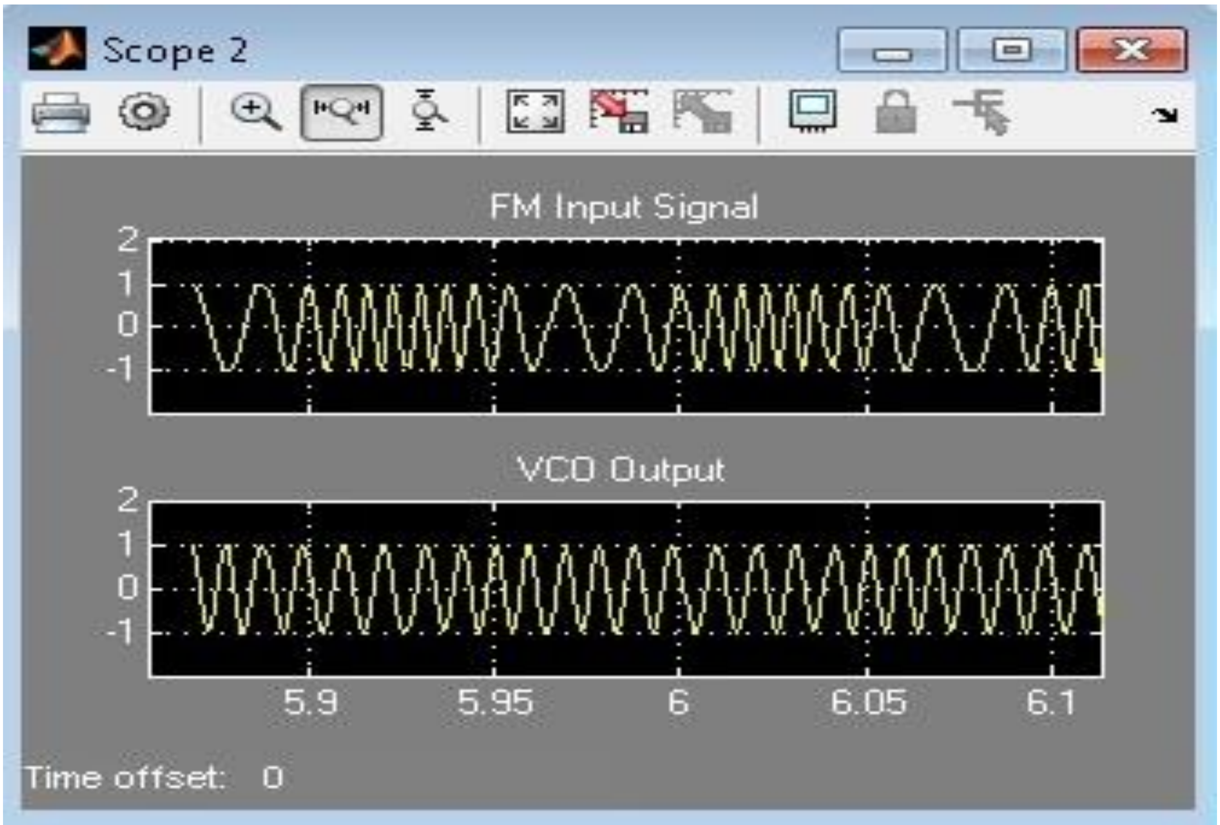

Function Block Parameters: Gain1
Gain
Element-wise gain (y = K.*u) or matrix gain (y = K*u or y = u*K).
Main
Signal Attributes
Parameter Attributes
Gain:
2*pi
Multiplication: Element-wise(K.*u)
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply


Function Block Parameters: LPF
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
5
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply


Function Block Parameters: Continuous-Time VCO
Continuous-Time VCO (mask) (link)
Generate a continuous-time output signal whose frequency changes in response to the amplitude variations of the input signal. The input signal must be a sample-based scalar.
Parameters
Output amplitude (V):
1
Quiescent frequency (Hz):
100
Input sensitivity (Hz/V):
50
Initial phase (rad):
0
OK
Cancel
Help
Apply

Output


Scope 1
Message Signal
2
1
0
-1
6
6.05
6.1
6.15
6.2
6.25
6.3
6.35
6.4
FM Signal
2
1
0
-1
6
6.05
6.1
6.15
6.2
6.25
6.3
6.35
6.4
Time offset: 0



Result

Viva Questions

1. Define FM & PM.

2. What are the advantages of Angle modulation over amplitude modulation?

3. What is the relationship between PM and FM?

4. With a neat block diagram explain how PM is generated using FM.

Applications

1. Used for high quality music transmission
2. Entertainment broadcasting.
3. Used in two way Radio Communication links
4. Mobile Radio Communications
5. Used for broadcasting music and speech, magnetic tape recording systems, two way radio systems and video transmission systems.
6. When noise occurs naturally in radio systems, frequency modulation with sufficient bandwidth provides an advantage in cancelling the noise.
7. Frequency modulation is used in audio frequencies to synthesize sound.
8. For recording the video signals by VCR systems, frequency modulation is used for intermediate frequencies.

Advantages of Frequency Modulation:

- Frequency modulation has more noise resistivity when compared to other modulation techniques. That’s why they are mainly used in broadcasting and radio communications. And we are all well aware that radio communication use mainly frequency modulation for transmission. We know that noise will occur mainly to the amplitude of the signal. In frequency modulation, amplitude is made constant and only frequency is varied, so we can easily find out the noise in the amplitude by using a limiter.
- The frequency modulation is having greater resistance to rapid signal strength variation, which we will use in FM radios even while we are travelling and frequency modulation is also mainly used in mobile communication purposes.
- For transmitting messages in frequency modulation, it does not require special equipments like linear amplifiers or repeaters and transmission levels or higher when compared to other modulation techniques. It does not require any class C or B amplifiers for increasing the efficiency.
- Transmission rate is good for frequency modulation when compared to other modulation that is frequency modulation can transmit around 1200 to 2400 bits per second.
- Frequency modulation has a special effect called capture effect in which high frequency signal will capture the channel and discard the low frequency or weak signals from interference.

Disadvantages of Frequency Modulation:

- In the transmission section, we don’t need any special equipment but in the reception, we need more complicated demodulators for demodulating the carrier signal from message or modulating signal.
- Frequency modulation cannot be used to find out the speed and velocity of a moving object. Static interferences are more when compared to phase modulation. Outside interference is one of the biggest disadvantages in the frequency modulation. There may be mixing because of nearby radio stations, pagers, construction walkie-talkies etc.
- To limit the bandwidth in the frequency modulation, we use some filter which will again introduce some distortions in the signal.
- Transmitters and receiver should be in same channel and one free channel must be there between the systems.
- Spectrum space is limit for the frequency modulation and careful controlling the deviation ration.

6. PLL as FM Demodulator

Aim

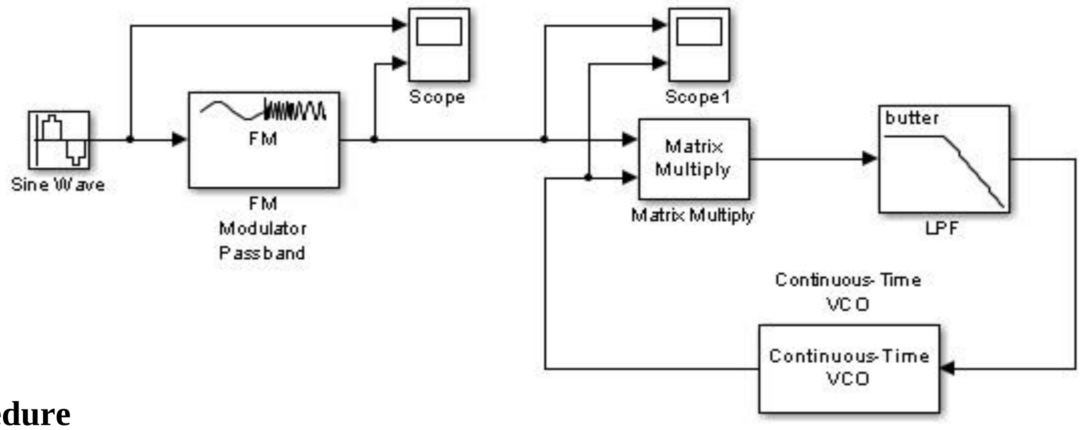
To perform the operation of FM Demodulation with PLL using Matlab Simulink.

Apparatus Required:

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 or Upgraded version.

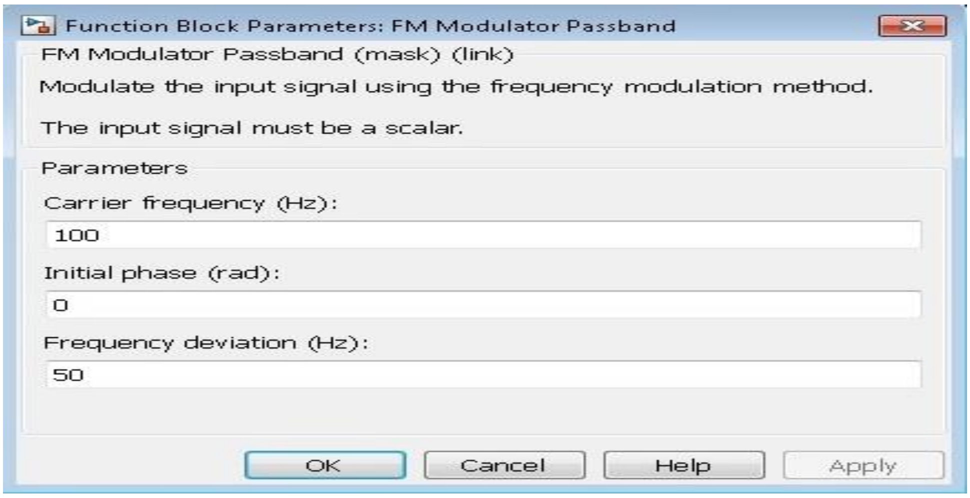
Simulink Model

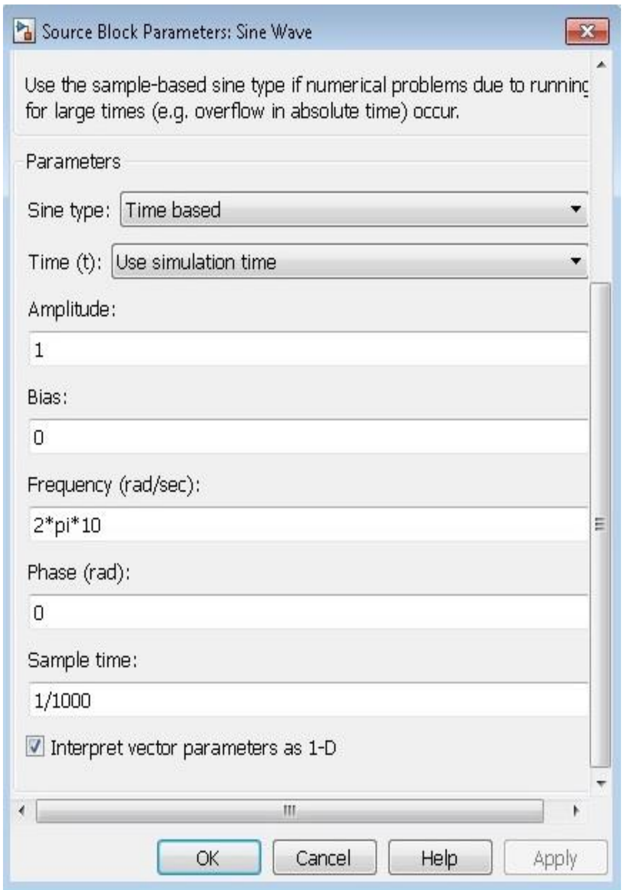


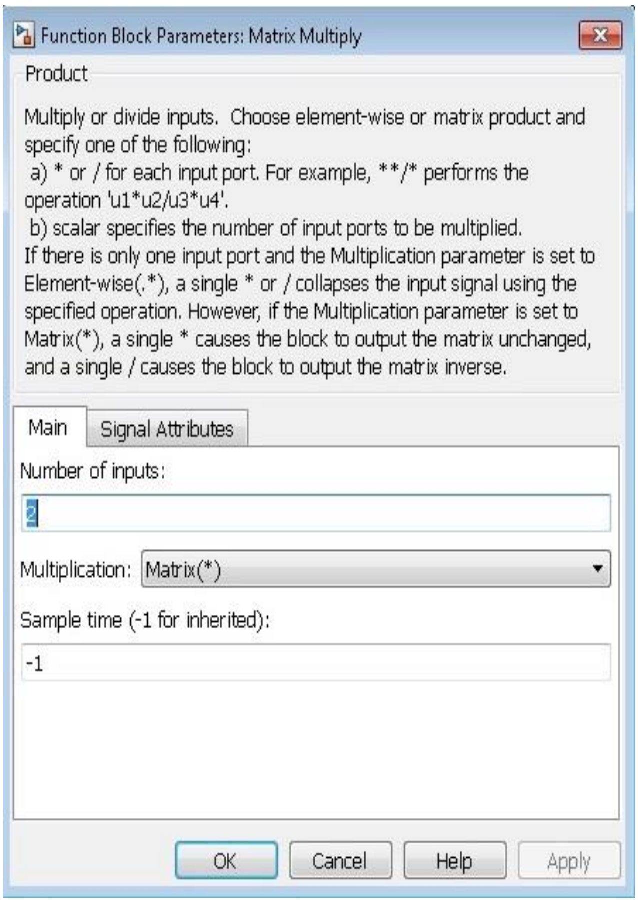
Procedure

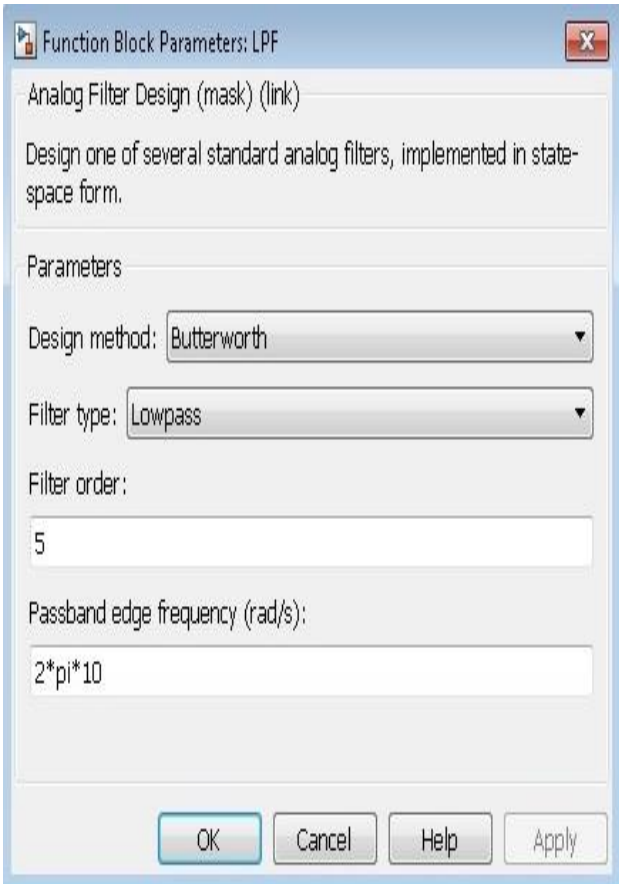
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

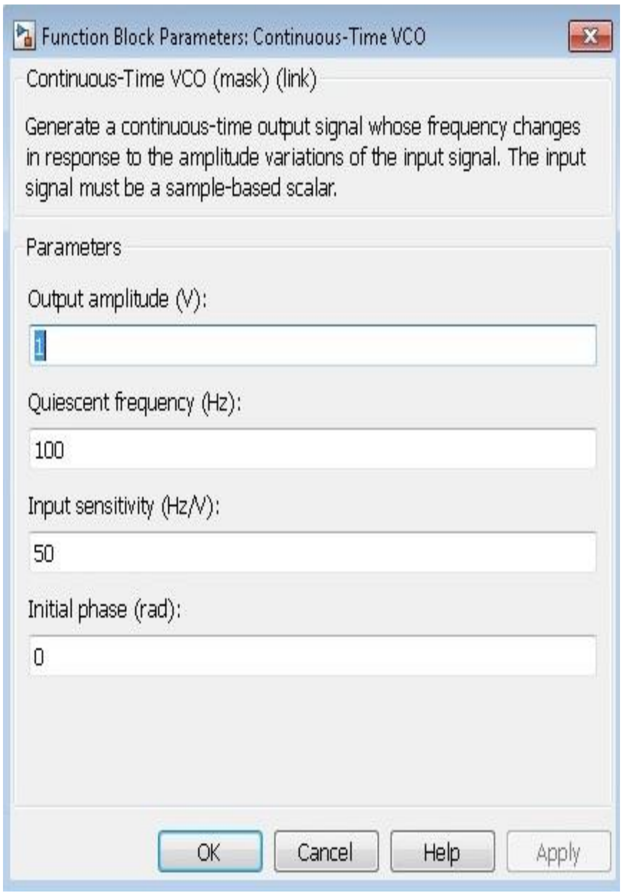
Parameters

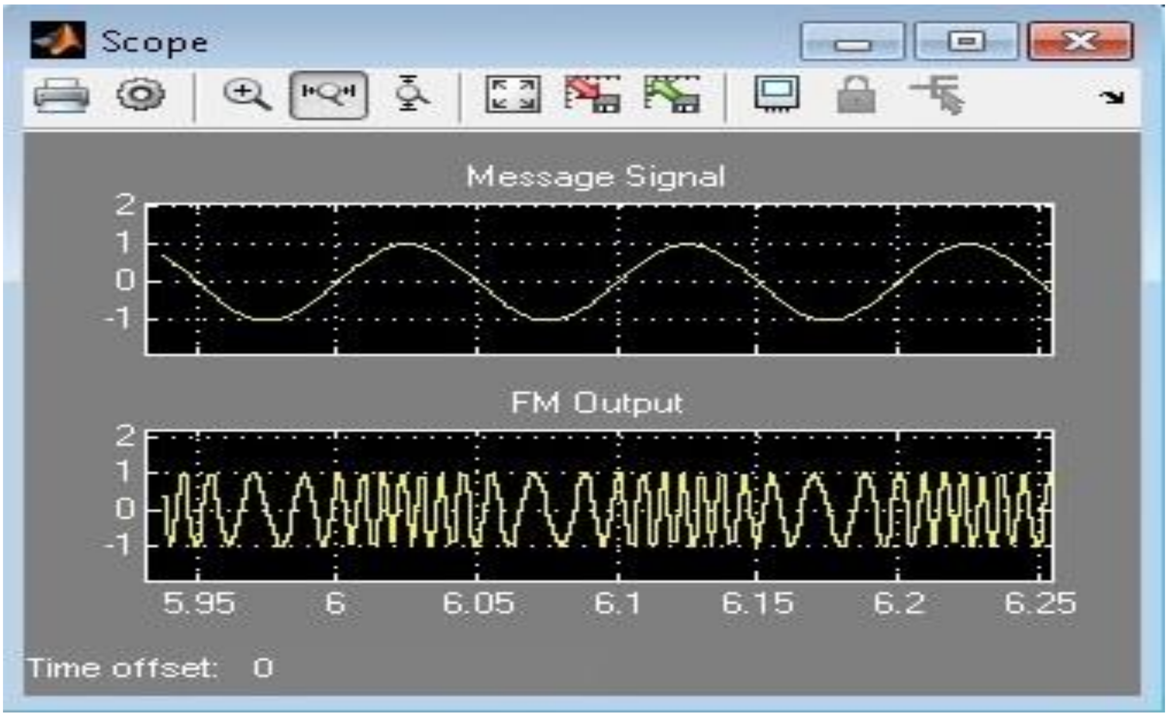


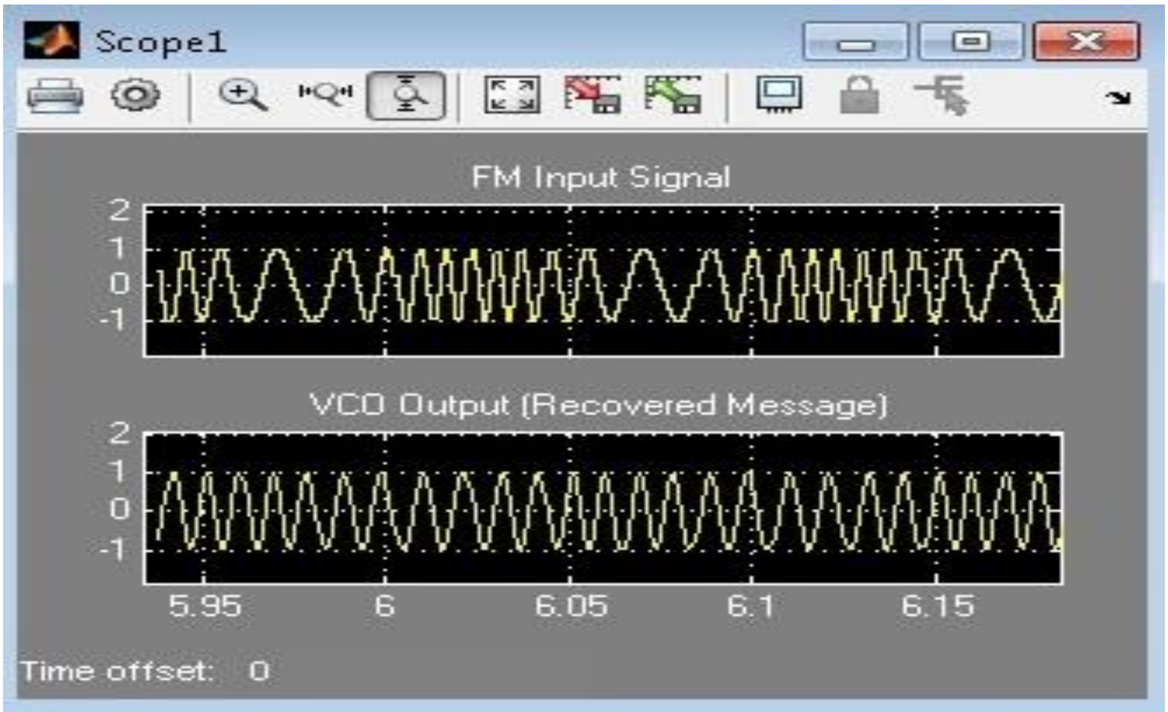

Source Block Parameters: Sine Wave
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*10
Phase (rad):
0
Sample time:
1/1000
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply


Function Block Parameters: Matrix Multiply
Product
Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:
a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
b) scalar specifies the number of input ports to be multiplied.
If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix(*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.
Main
Signal Attributes
Number of inputs:
2
Multiplication: Matrix(*)
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply


Function Block Parameters: LPF
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
5
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply


Function Block Parameters: Continuous-Time VCO
Continuous-Time VCO (mask) (link)
Generate a continuous-time output signal whose frequency changes in response to the amplitude variations of the input signal. The input signal must be a sample-based scalar.
Parameters
Output amplitude (V):
1
Quiescent frequency (Hz):
100
Input sensitivity (Hz/V):
50
Initial phase (rad):
0
OK
Cancel
Help
Apply


Scope
Message Signal
FM Output
5.95
6
6.05
6.1
6.15
6.2
6.25
Time offset: 0


Scope1
FM Input Signal
VCO Output (Recovered Message)
5.95
6
6.05
6.1
6.15
Time offset: 0

Result

Viva Questions

1. What is PLL?
2. What are the applications of PLL?
3. What is the free running frequency?
4. What is the function of VCO?
5. What is the function of Low Pass Filter in PLL?
6. What is the function of Phase Detector?

7. Spectral Characteristics of AM & FM

Aim

To verify the Spectral Components of AM and FM using Matlab Simulink.

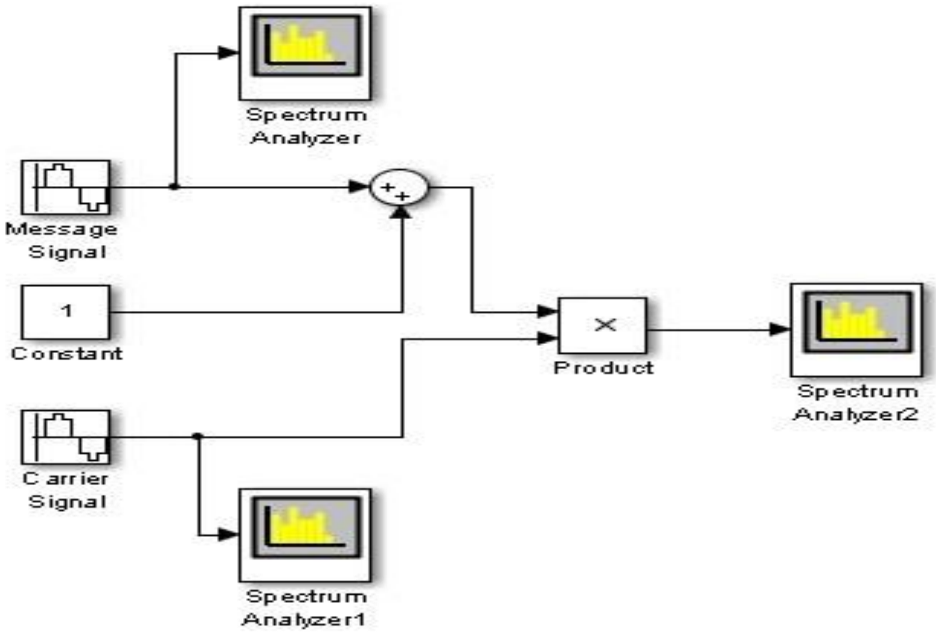
Apparatus Required

a) Hardware Tools: Computer system

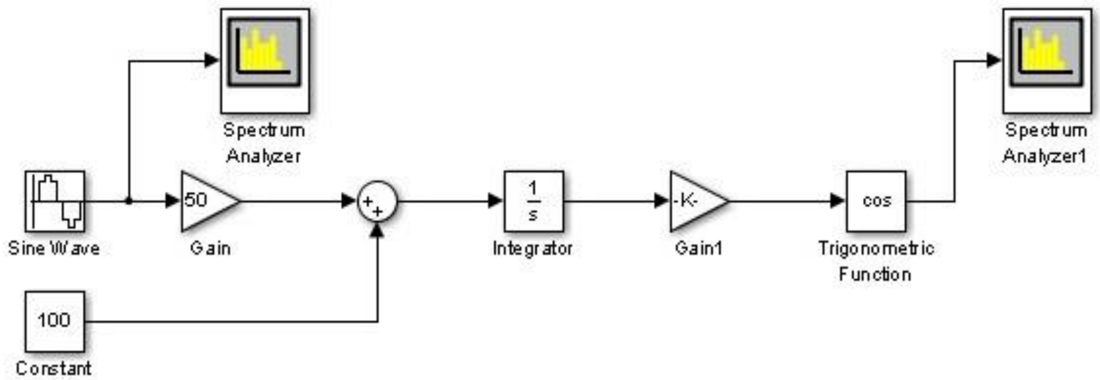
b) Software Tool: MATLAB 7.0 or Upgraded version.

Simulink Model

Amplitude Modulation Setup



Frequency Modulation Setup



Procedure

1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

Parameters

For Amplitude Modulation:

Set the Message signal amplitude = 1V and frequency = 50 Hz

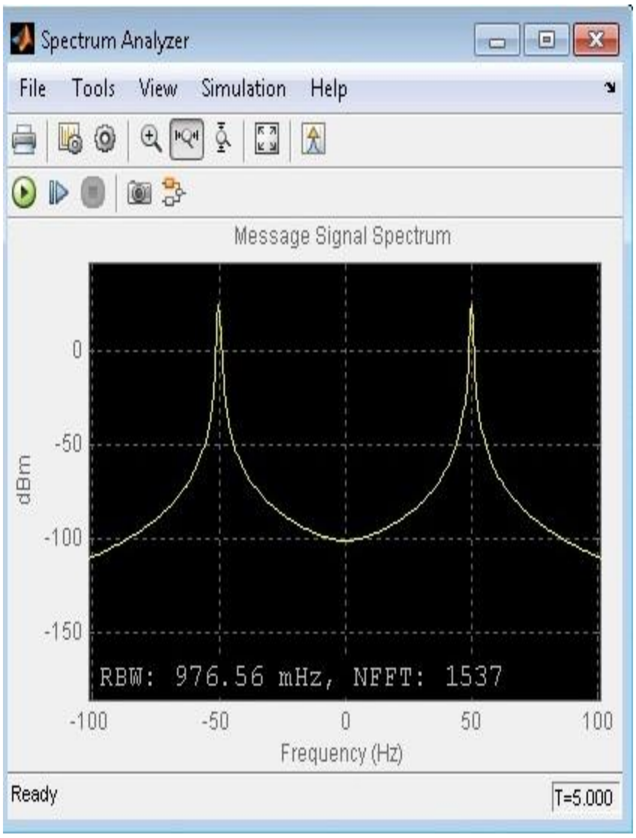
Set the Carrier signal amplitude = 1V and frequency = 300 Hz

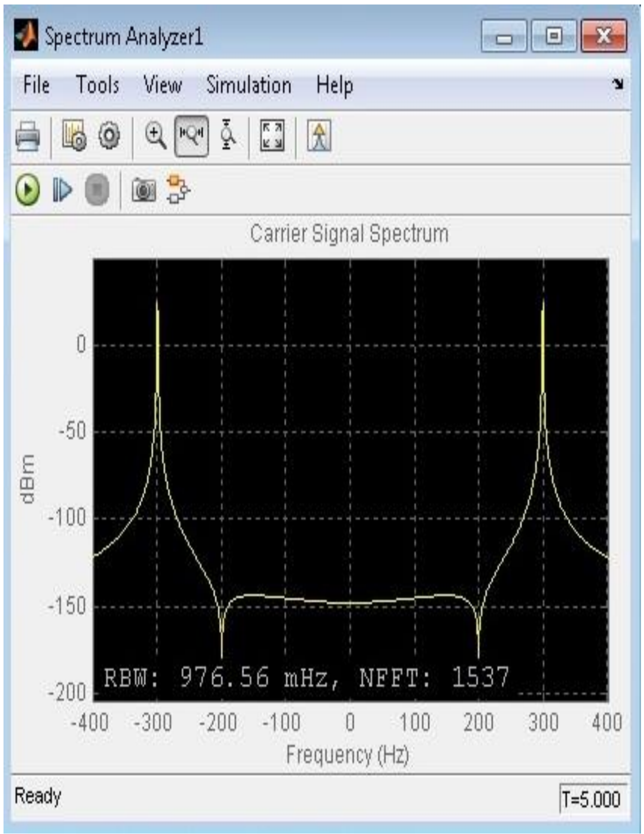
For Amplitude Modulation:

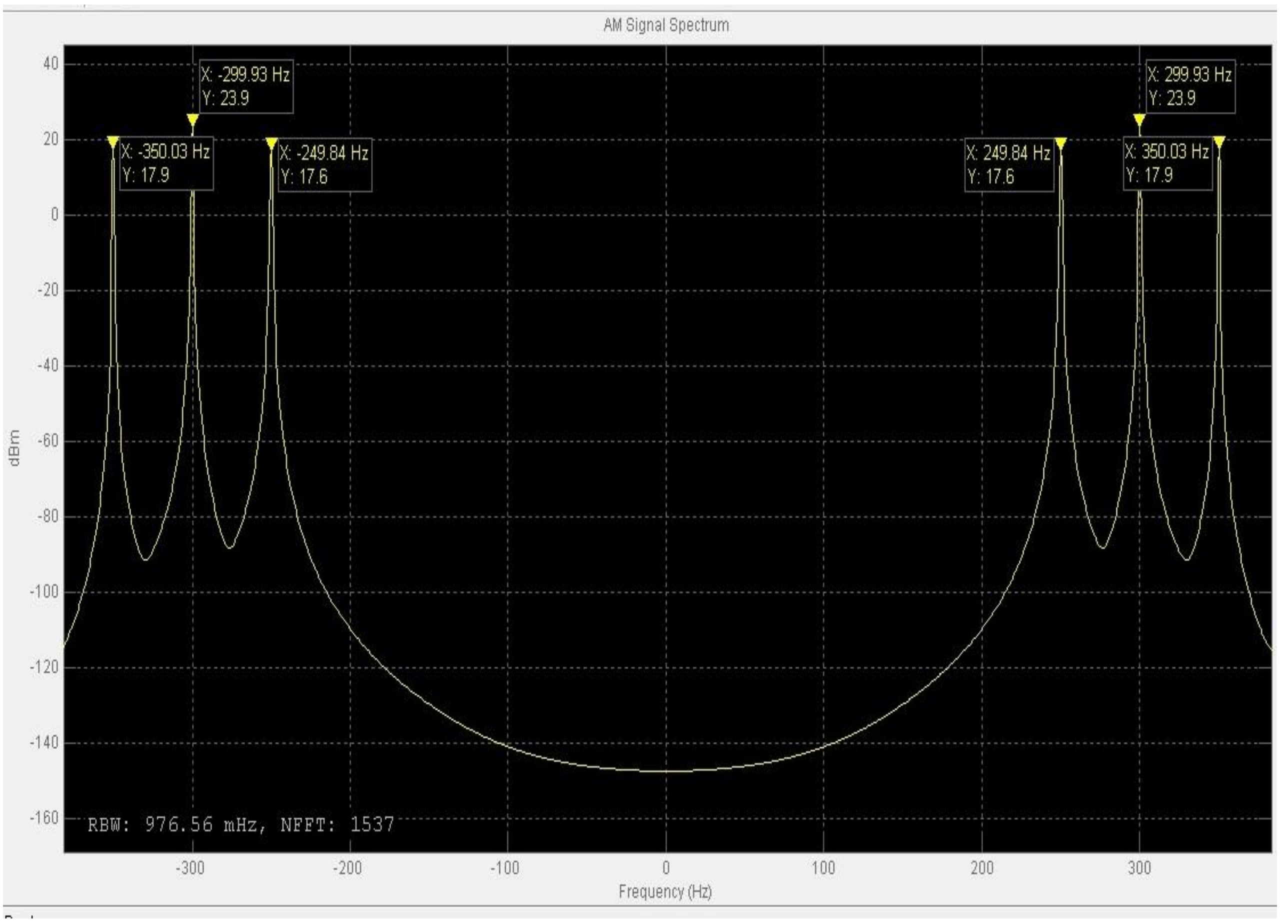
As per the setting of Frequency Modulation setup of Experiment No. 5

Output

<u>For AM</u>

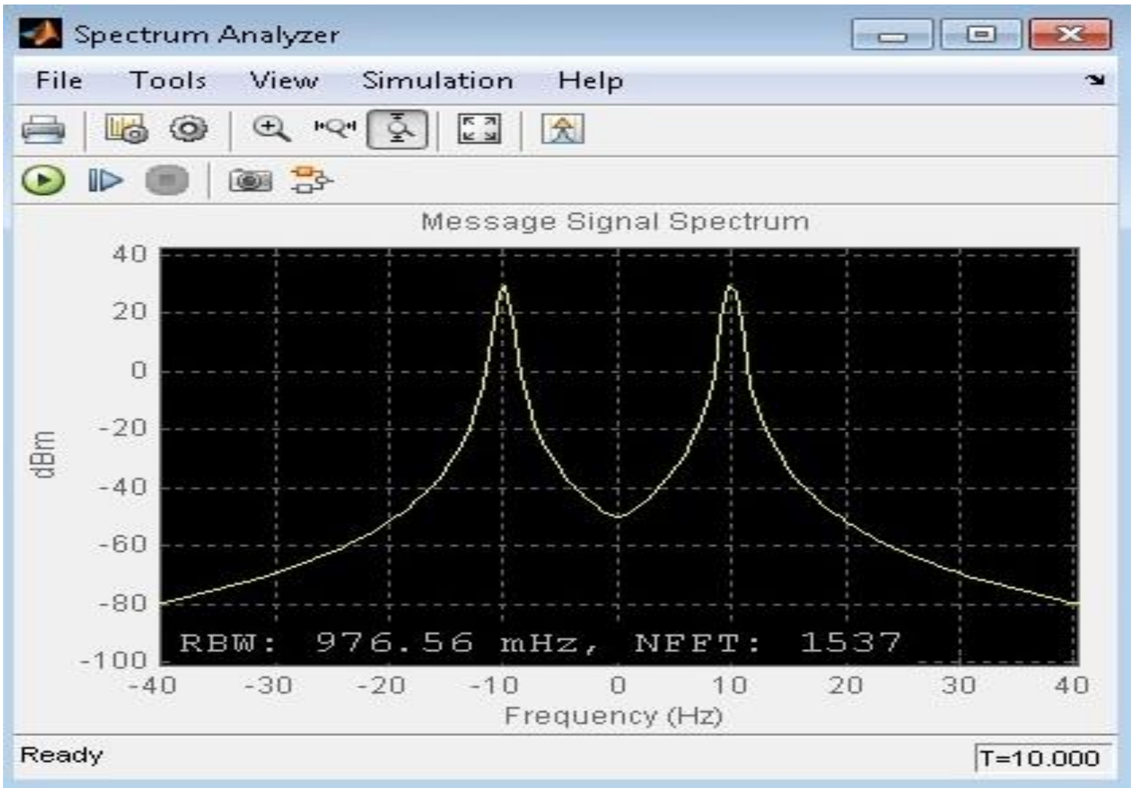




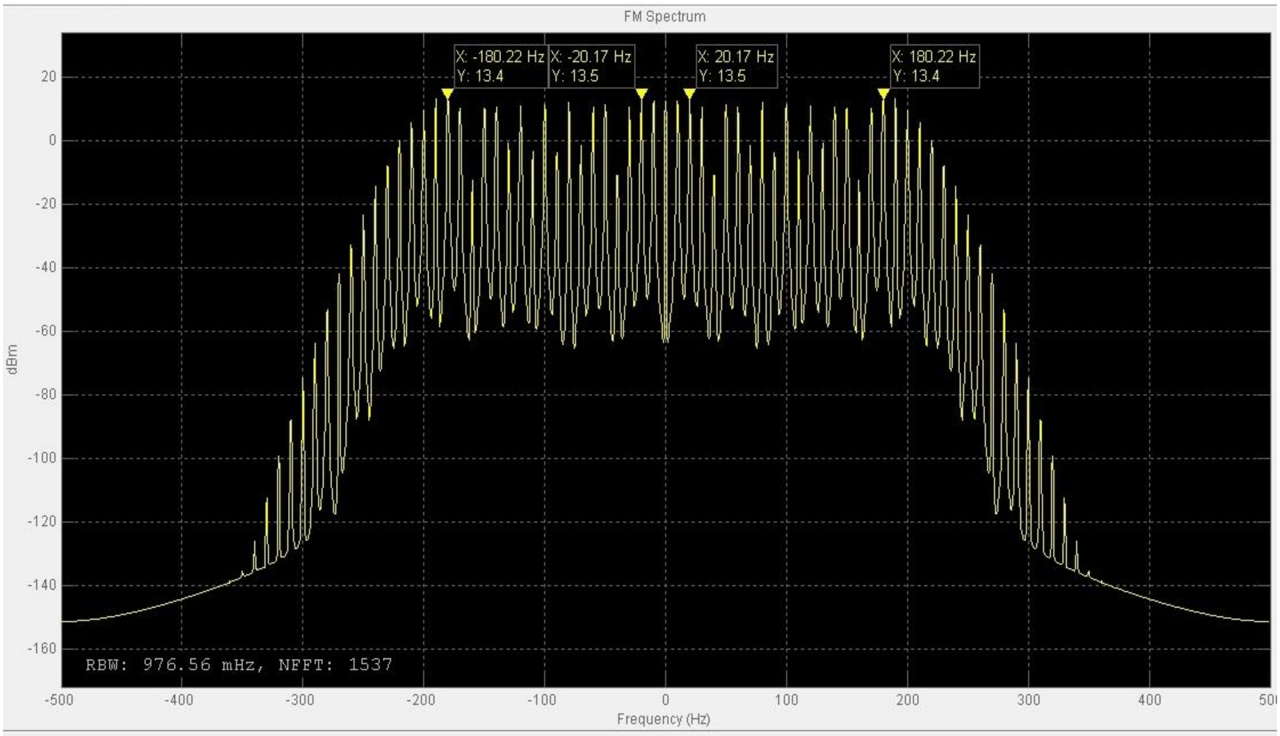


AM Signal Spectrum
X: -299.93 Hz
Y: 23.9
X: -350.03 Hz
Y: 17.9
X: -249.84 Hz
Y: 17.6
X: 249.84 Hz
Y: 17.6
X: 299.93 Hz
Y: 23.9
X: 350.03 Hz
Y: 17.9
RBW: 976.56 mHz, NFFT: 1537
dBm
Frequency (Hz)

For FM



Spectrum Analyzer
File Tools View Simulation Help
Message Signal Spectrum
RBW: 976.56 mHz, NFFT: 1537
dBm
Frequency (Hz)
Ready
T=10.000



Output

Viva Questions

1. What is the Spectrum?
2. Why we consider negative frequencies while dealing with Specturm?
3. What is the bandwidth of AM?
4. What is the bandwidth of FM?
5. What is the theoretical bandwidth of FM signal?
6. Draw the spectrum of the message signal with frequency of 1000 Hz.
7. What is the difference between Spectrums of AM and FM?
8. Draw the spectrum of AM DSB-SC?
9. Draw the spectrum of AM SSB-SC when USB is extracted from the transmitter?
10. Draw the spectrum of AM SSB-SC when LSB is extracted from the transmitter?

Applications

1. Frequency domain analysis of AM & FM signals.

8. Verification of Sampling Theorem

Aim

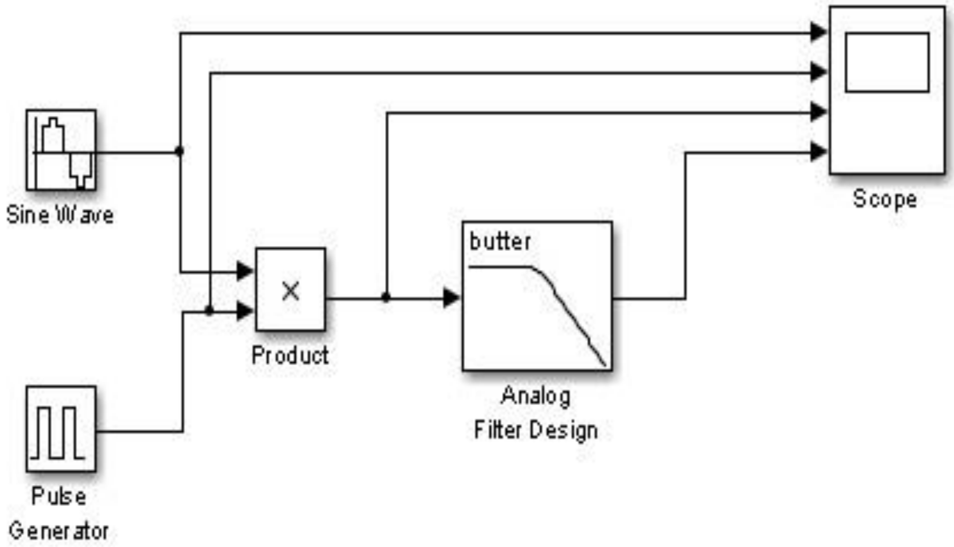
To verify Sampling theorem for different Sampling frequencies using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 or Upgraded version.

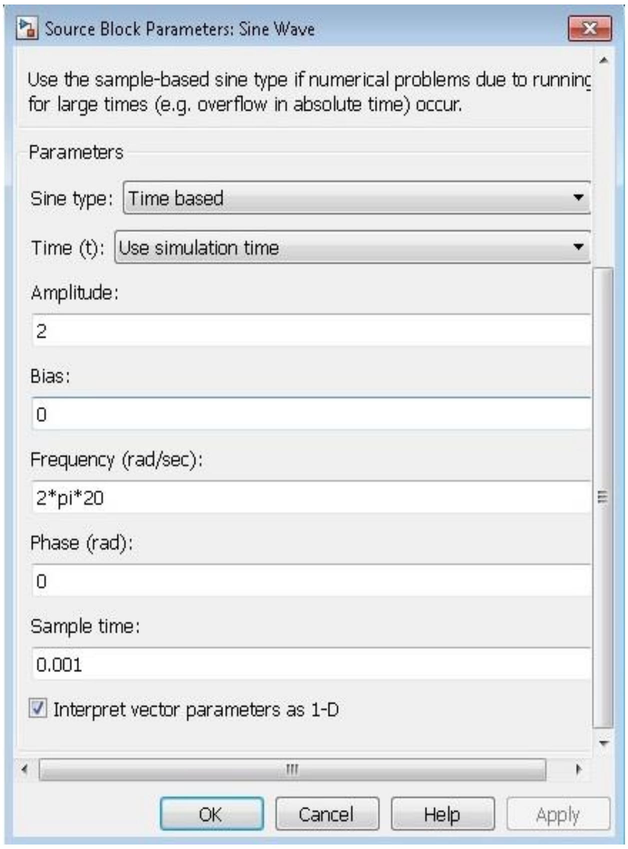
Simulink Model

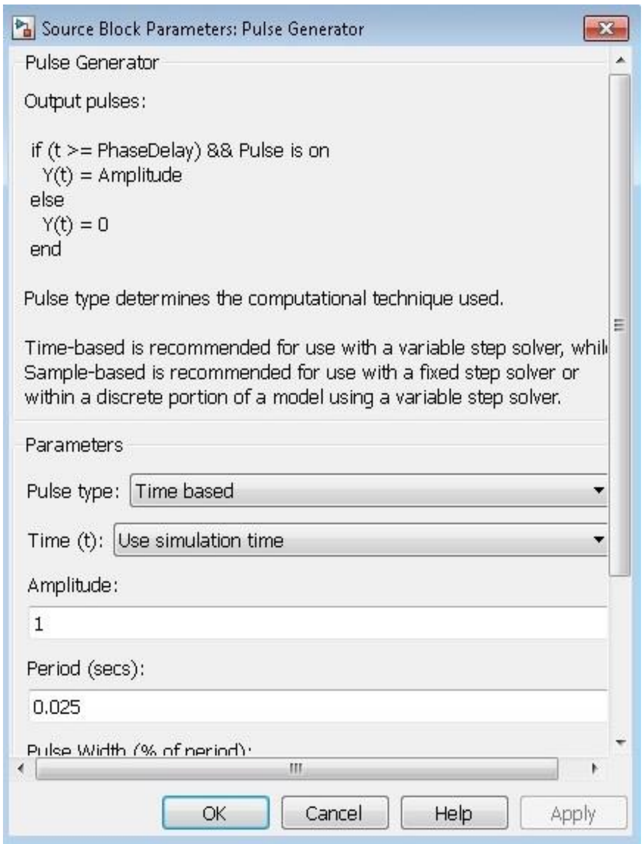


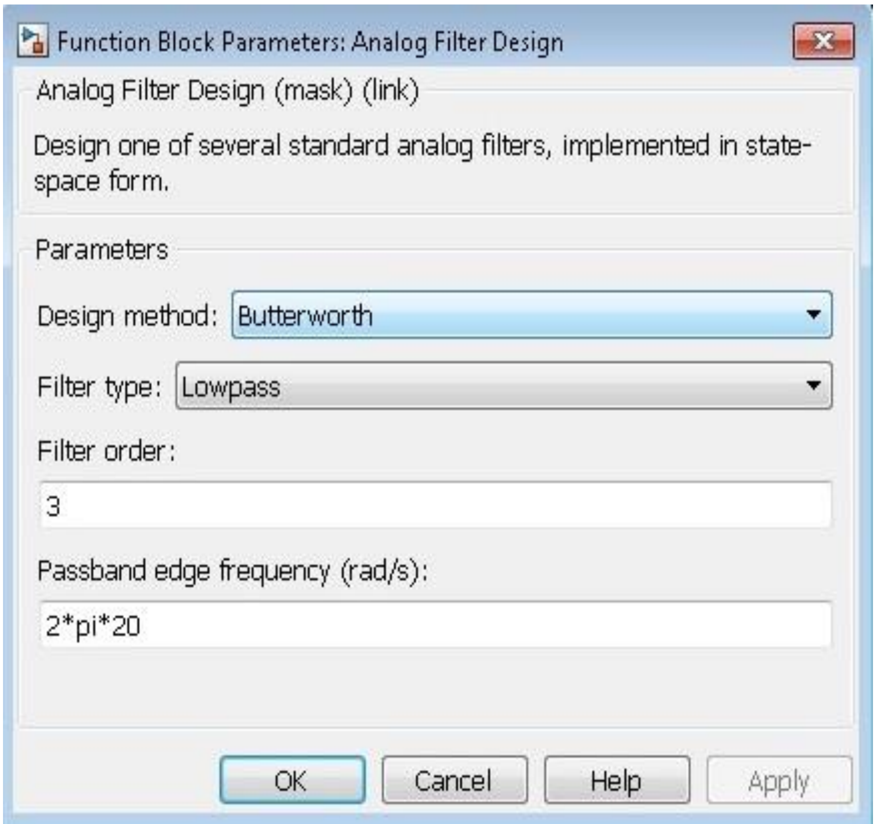
Procedure

1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

Parameters

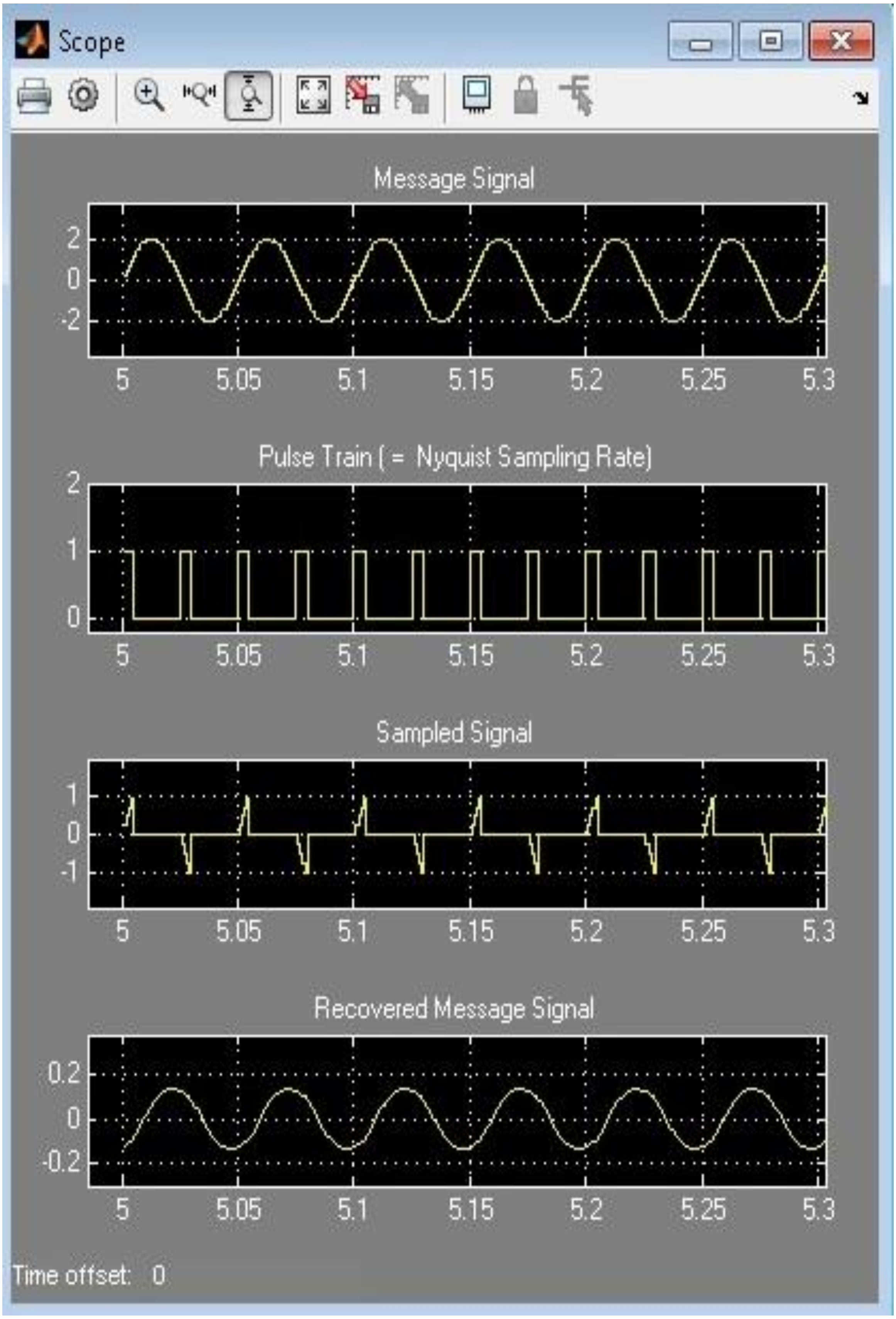

Source Block Parameters: Sine Wave
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
2
Bias:
0
Frequency (rad/sec):
2*pi*20
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply


Source Block Parameters: Pulse Generator
Pulse Generator
Output pulses:
if (t >= PhaseDelay) && Pulse is on
Y(t) = Amplitude
else
Y(t) = 0
end
Pulse type determines the computational technique used.
Time-based is recommended for use with a variable step solver, whil Sample-based is recommended for use with a fixed step solver or within a discrete portion of a model using a variable step solver.
Parameters
Pulse type: Time based
Time (t): Use simulation time
Amplitude:
1
Period (secs):
0.025
OK
Cancel
Help
Apply

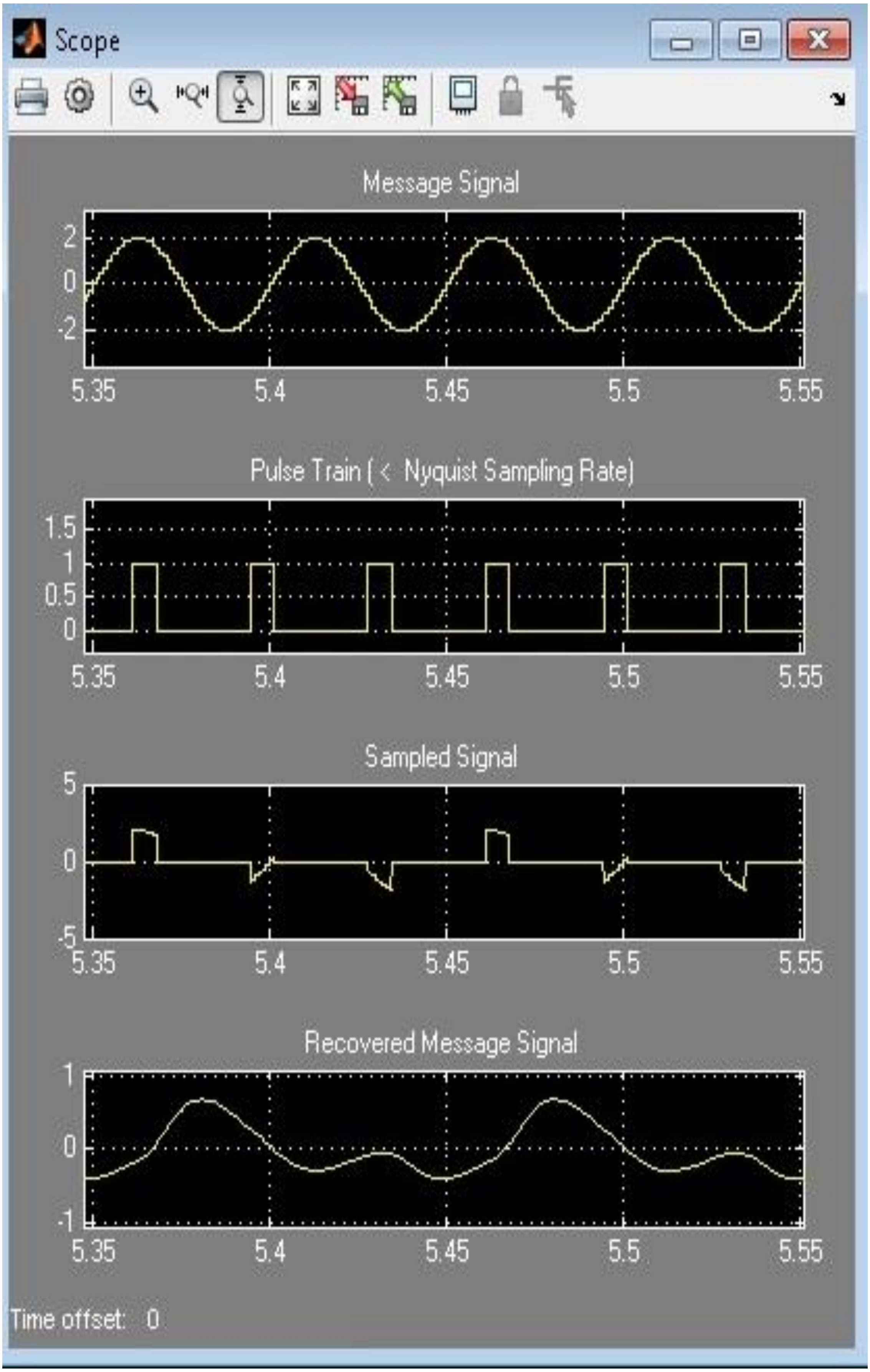

Function Block Parameters: Analog Filter Design
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
3
Passband edge frequency (rad/s):
2*pi*20
OK
Cancel
Help
Apply

Output

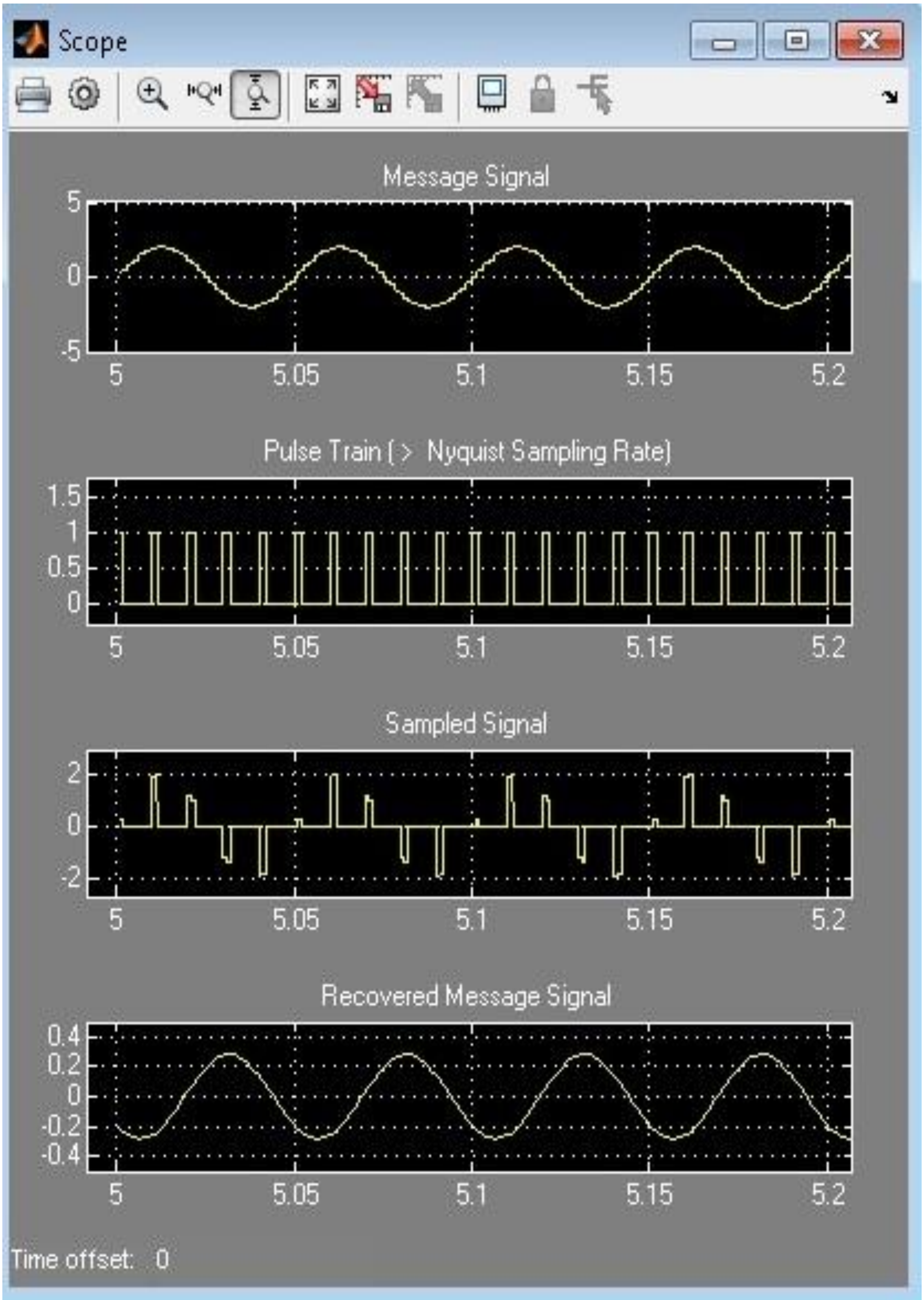
Nyquist Rate



Under Sampling Rate



Over Sampling Rate



Result

Viva Questions

1. What are the types of sampling?
2. State sampling theorem?
3. What happens when $f_s < 2 f_m$?
4. How will be the reconstructed signal when $f_s >= 2f_m$?
5. Explain the operation of sampling circuit?
6. Explain the operation of re-construction circuit?
7. Who formalized the sampling theorem?
8. What are the applications of the Sampling theorem?
9. Is the sampling theorem basis for the modern digital communications?
10. Is the voice signal sampling of 8000 Hz, follows sampling theorem in Land line Telephone Exchange.

9. Pulse Amplitude Modulation & Demodulation

Aim

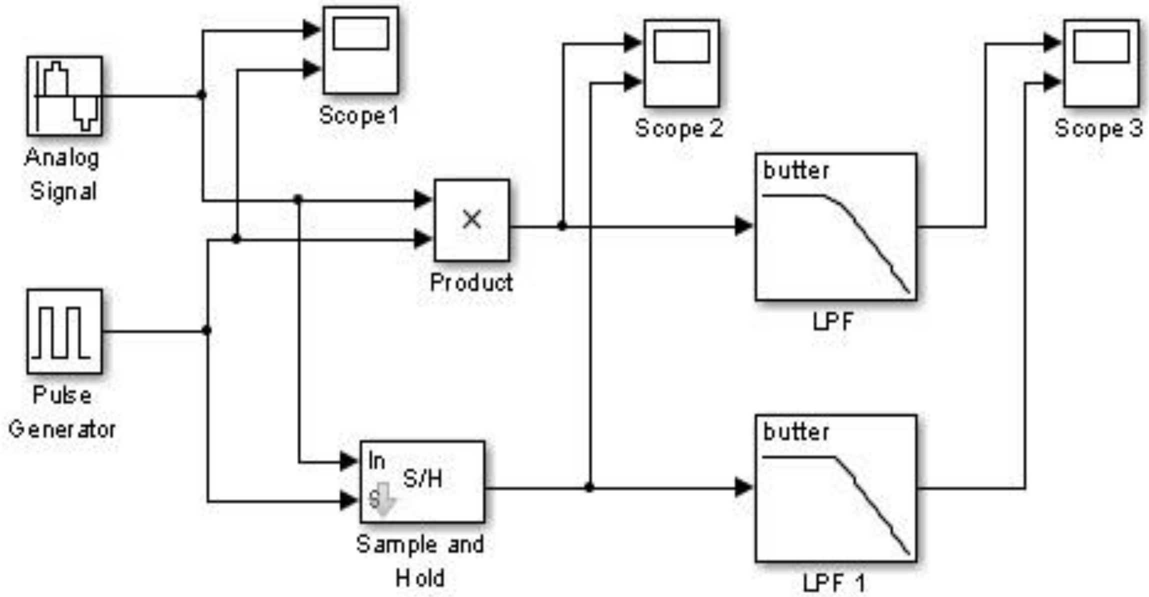
To perform Pulse Amplitude Modulation and Demodulation using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 or Upgraded version.

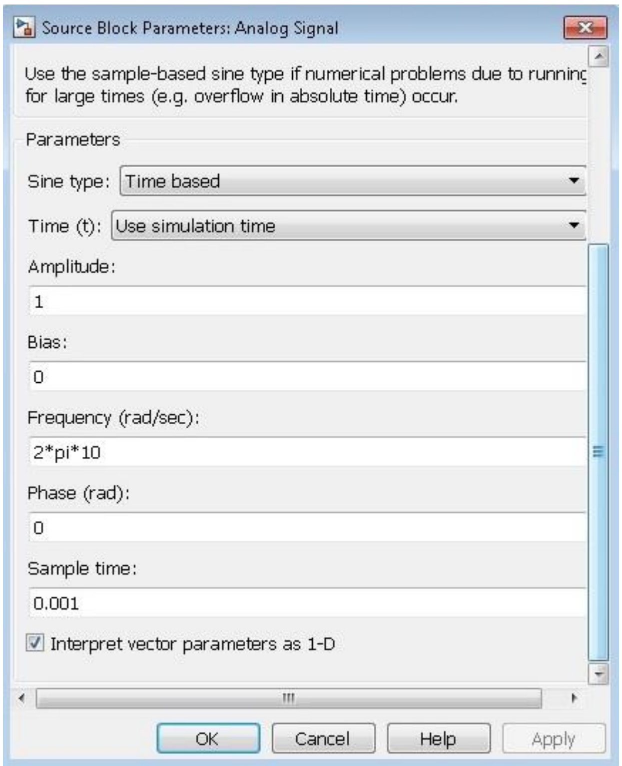
Simulink Model

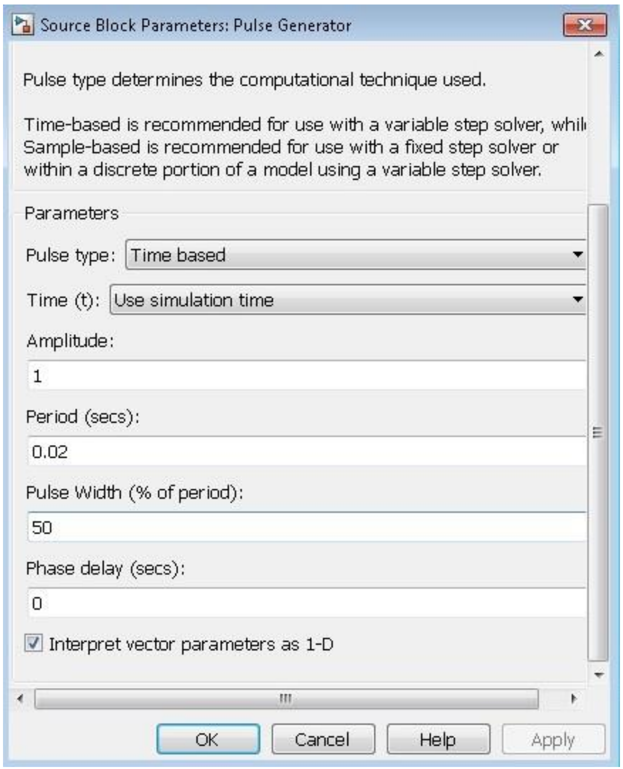


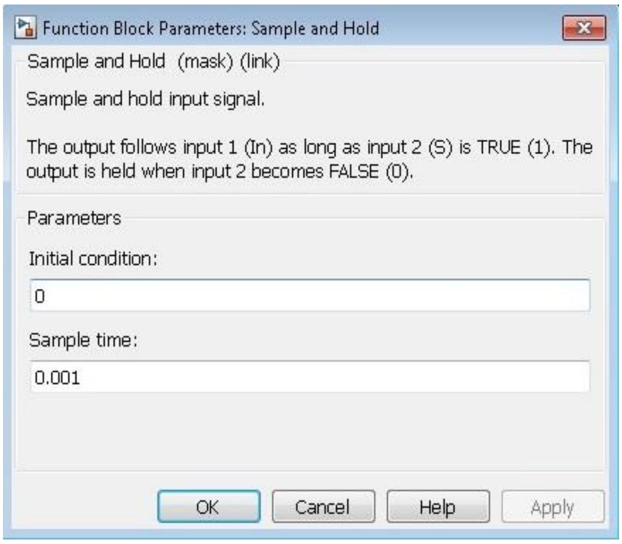
Procedure

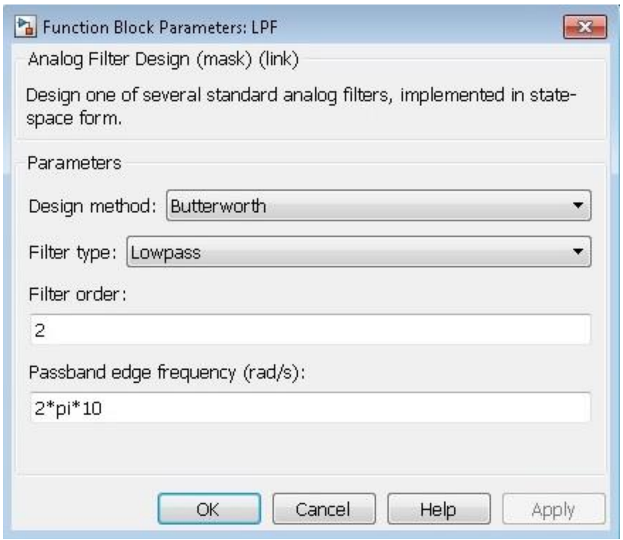
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

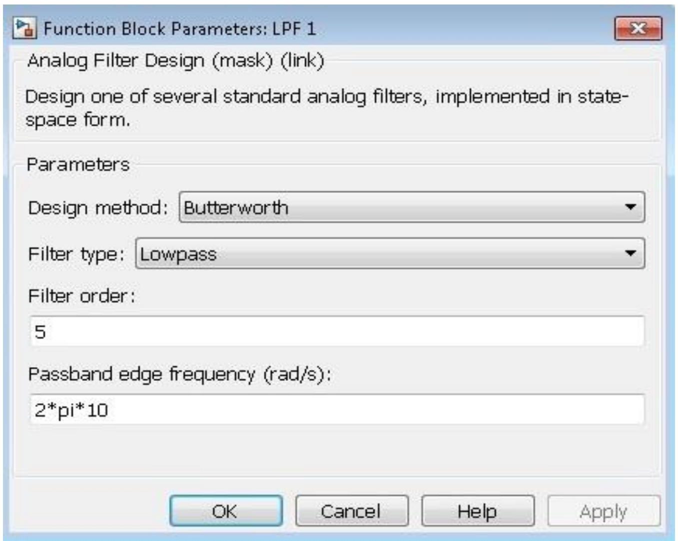
Parameters


Source Block Parameters: Analog Signal
Use the sample-based sine type if numerical problems due to running for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*10
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

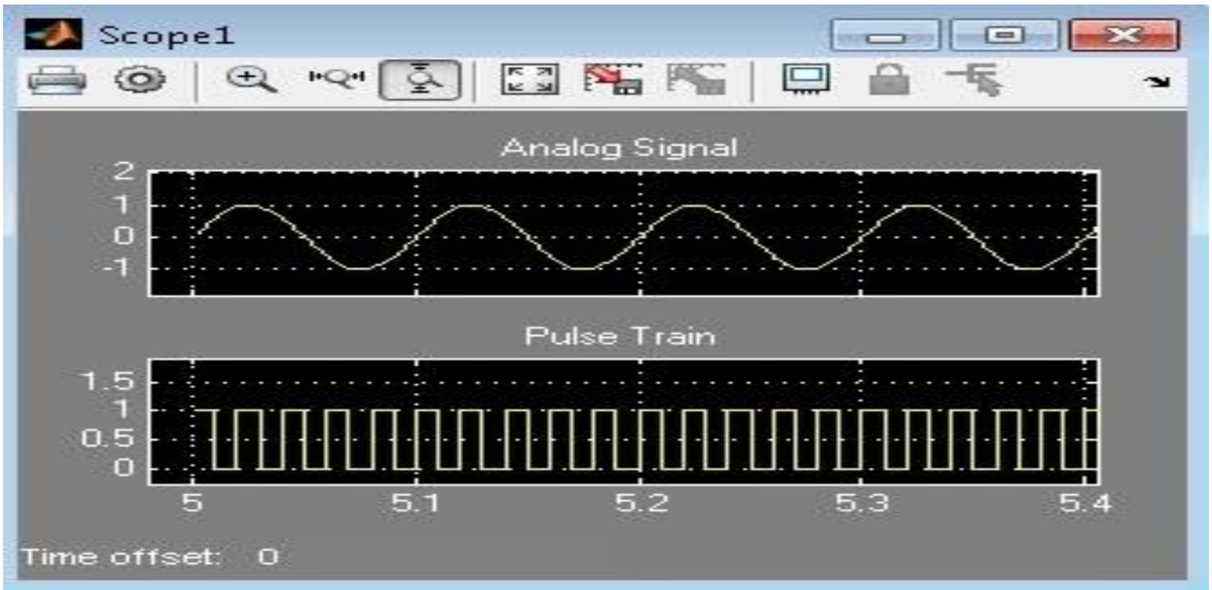

Source Block Parameters: Pulse Generator
Pulse type determines the computational technique used.
Time-based is recommended for use with a variable step solver, while Sample-based is recommended for use with a fixed step solver or within a discrete portion of a model using a variable step solver.
Parameters
Pulse type: Time based
Time (t): Use simulation time
Amplitude:
1
Period (secs):
0.02
Pulse Width (% of period):
50
Phase delay (secs):
0
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply


Function Block Parameters: Sample and Hold
Sample and Hold (mask) (link)
Sample and hold input signal.
The output follows input 1 (In) as long as input 2 (S) is TRUE (1). The output is held when input 2 becomes FALSE (0).
Parameters
Initial condition:
0
Sample time:
0.001
OK
Cancel
Help
Apply

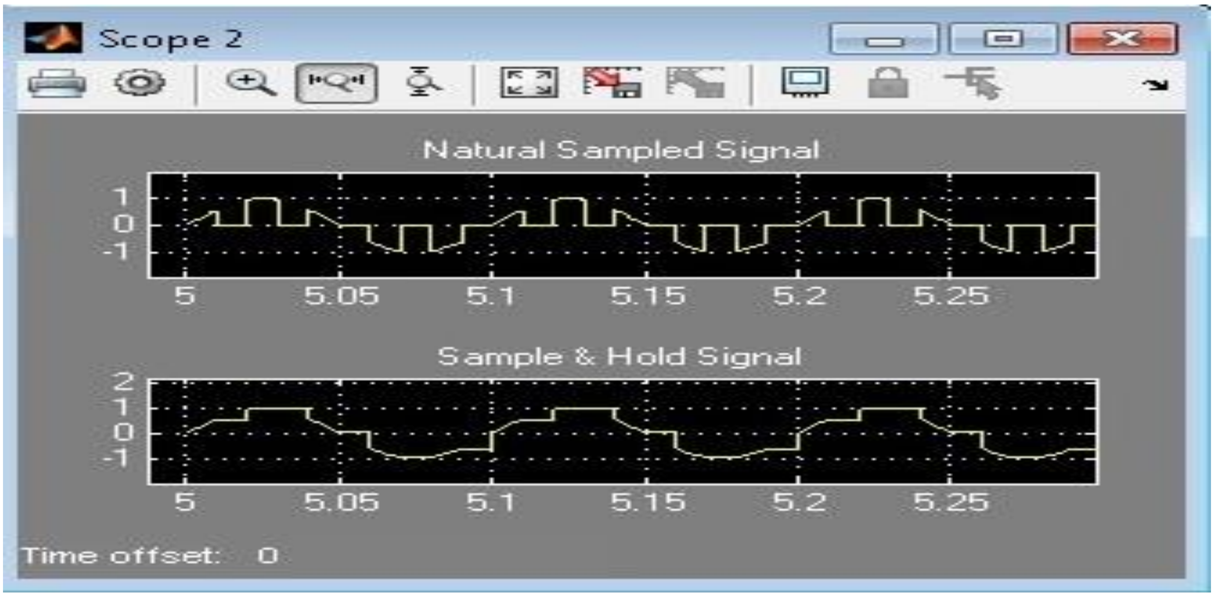

Function Block Parameters: LPF
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
2
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply


Function Block Parameters: LPF 1
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
5
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply

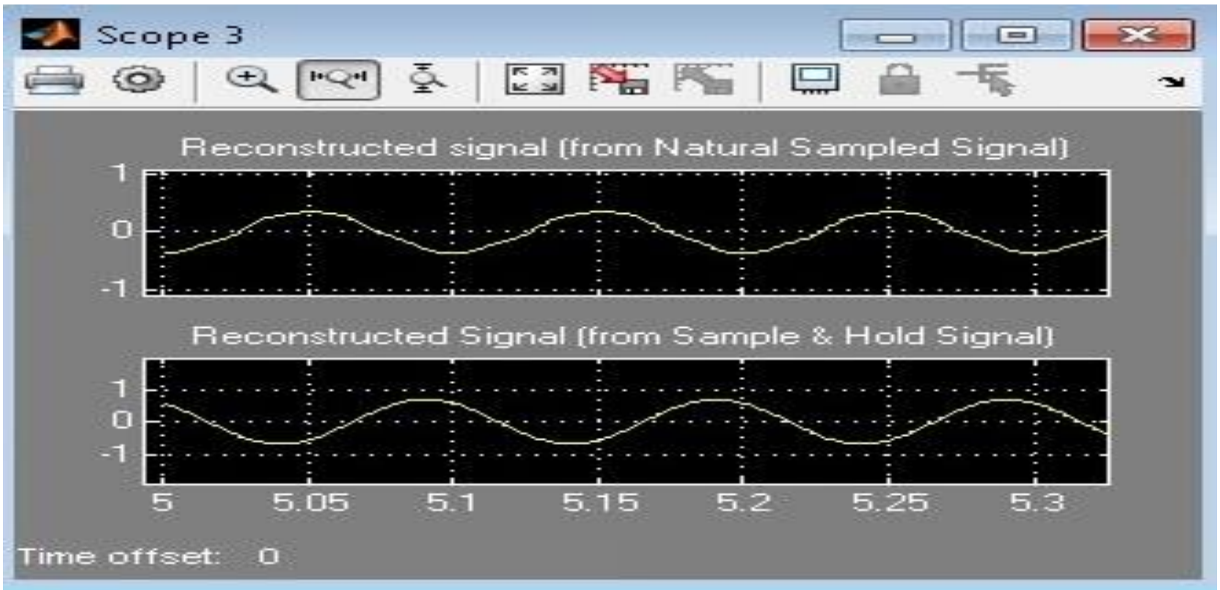
Output



Scope1
Analog Signal
Pulse Train
Time offset: 0



Scope 2
Natural Sampled Signal
Sample & Hold Signal
Time offset: 0



Scope 3
Reconstructed signal (from Natural Sampled Signal)
Reconstructed Signal (from Sample & Hold Signal)
Time offset: 0

Result

Viva Questions

1. TDM is possible for sampled signals. What kind of multiplexing can be used in continuous modulation systems?
2. What is the minimum rate at which a speech signal can be sampled for the purpose of PAM?
3. What is cross talk in the context of time division multiplexing?
4. Which is better, natural sampling or flat topped sampling and why?
5. Why a dc offset has been added to the modulating signal in this board? Was it essential for the working of the modulator? Explain?
6. If the emitter follower in the modulator section saturates for some level of input signal, then what effect it will have on the output?
7. Derive the mathematical expression for frequency spectrum of PAM signal.
8. Explain the modulation circuit operation?
9. Explain the demodulation circuit operation?
10. Is PAM & Demodulation is sensitive to Noise?

Applications

1. It is mainly used in Ethernet which is type of computer network communication, we know that we can use Ethernet for connecting two systems and transfer data between the systems. Pulse amplitude modulation is used for Ethernet communications.
2. It is also used for photo biology which is a study of photosynthesis.
3. Used as electronic driver for LED lighting.
4. Used in many micro controllers for generating the control signals etc.

10. Time Division Multiplexing & DeMultiplexing

Aim

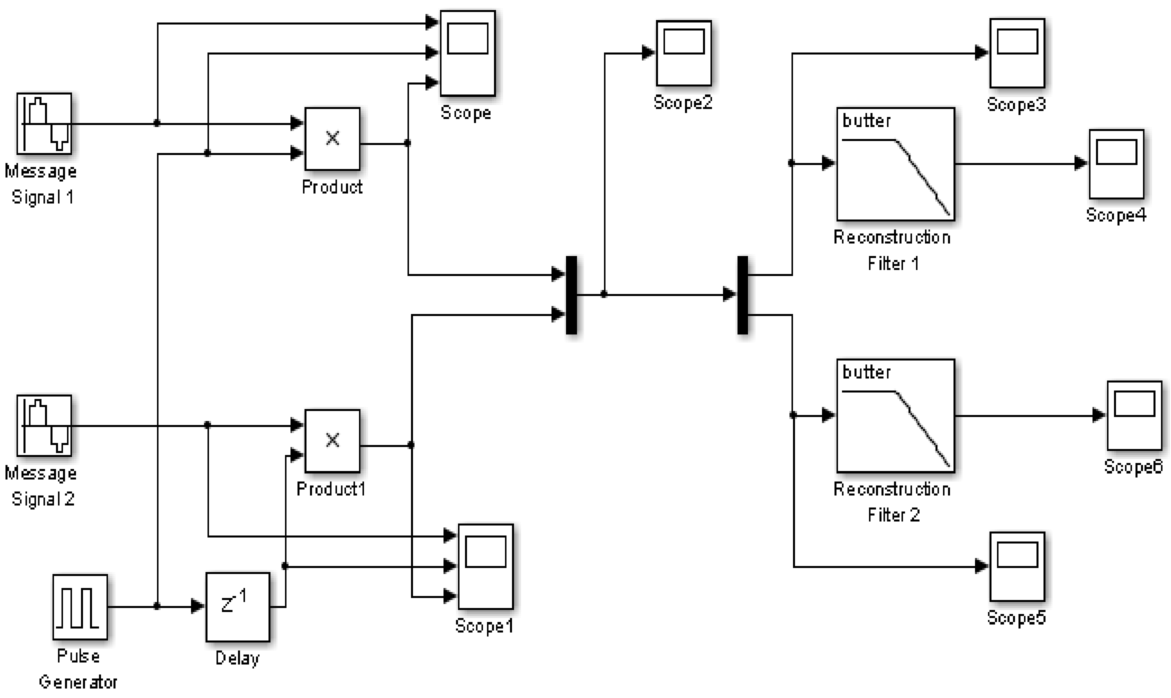
To perform the Time Division Multiplexing using Matlab Simulink.

Apparatus Required

a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 or Upgraded Version

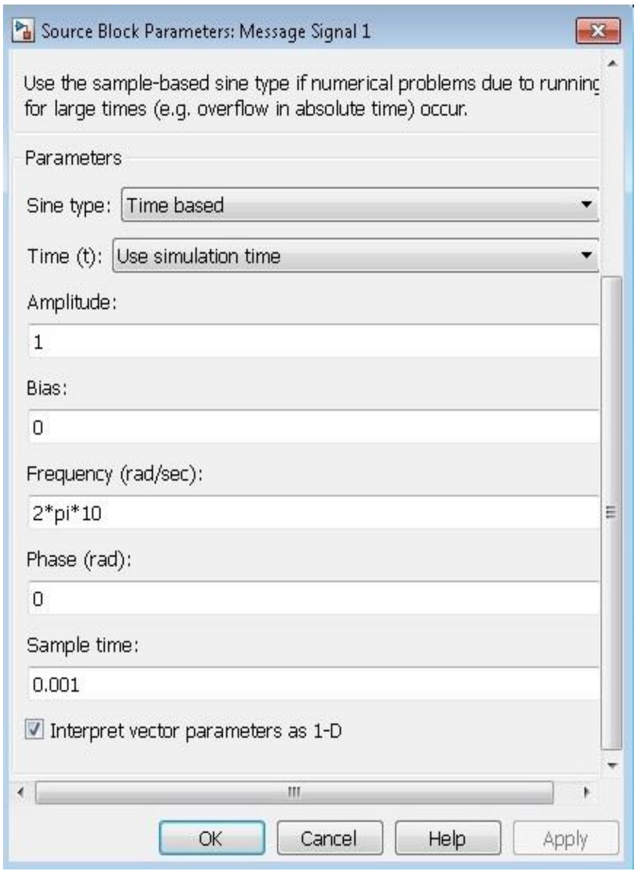
Simulink Model

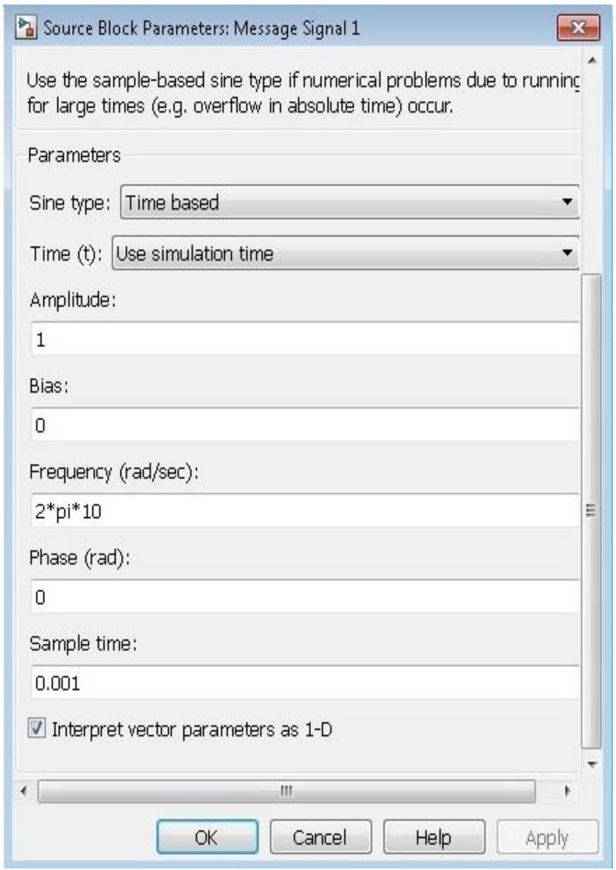


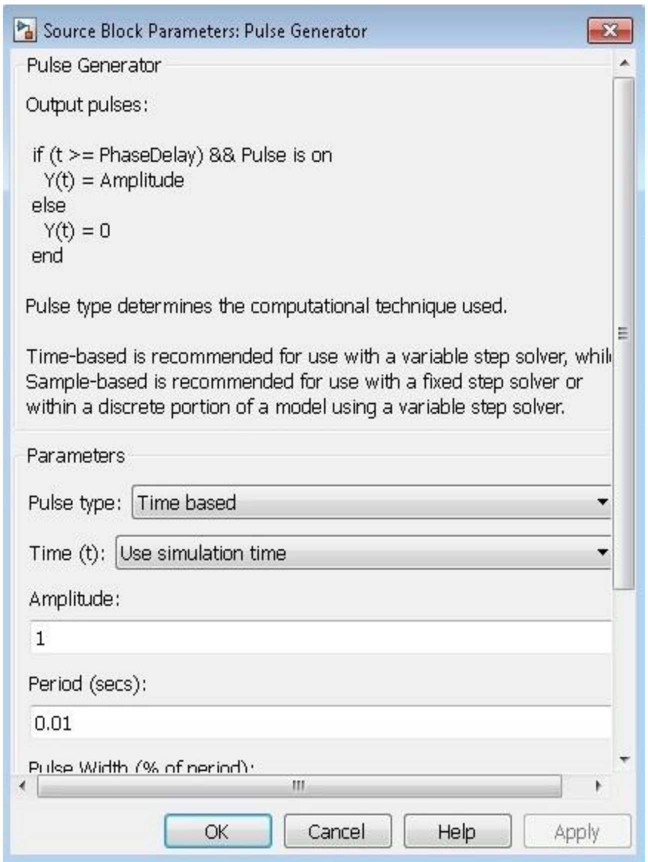
Procedure

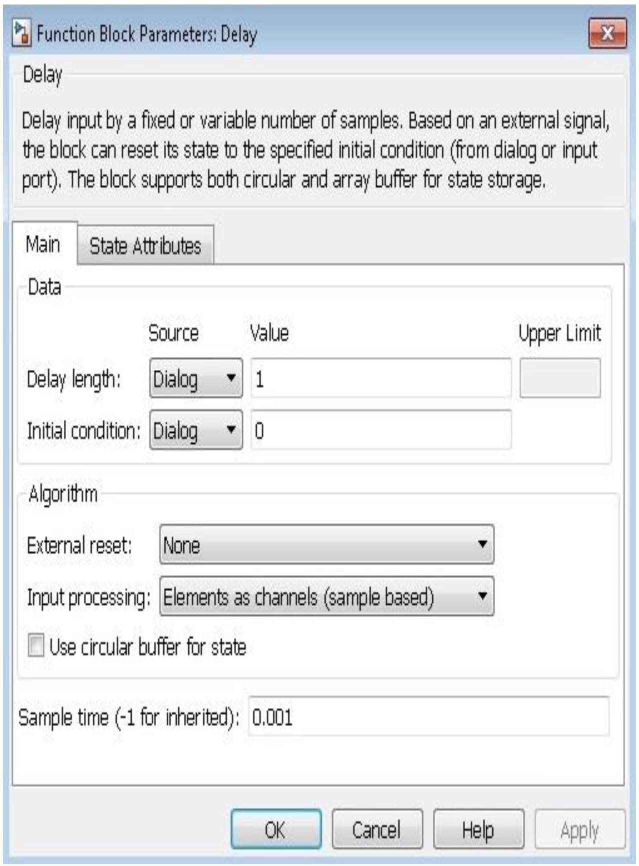
1. Switch on the computer and click on the MATLAB icon.
2. Go to start at the bottom of the command window, then select "Simulink" then go to library browser and drag it into creating file. (or) Once you open the Matlab then click on the Simulink icon . Go to file and select new and then select model. You will get a new window.
3. Arrange the functional blocks as shown in Simulink model.
4. Assign required parameters to each functional block.
5. Observe the outputs on scope.

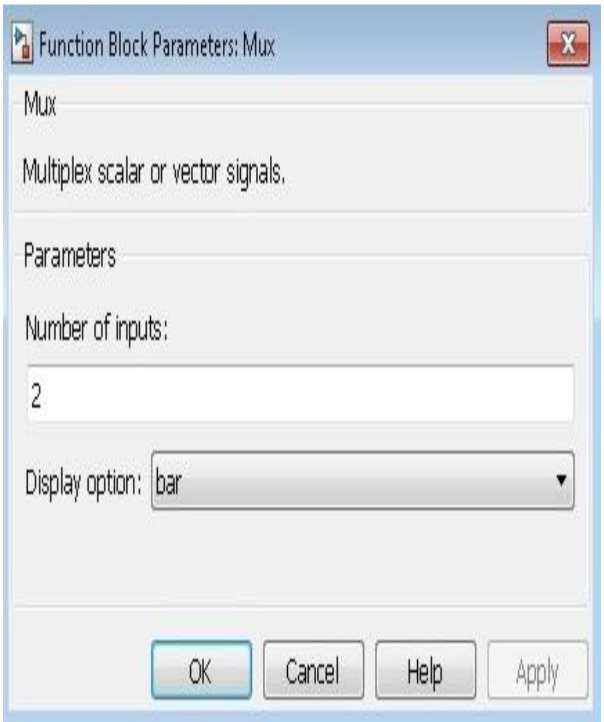
Parameters

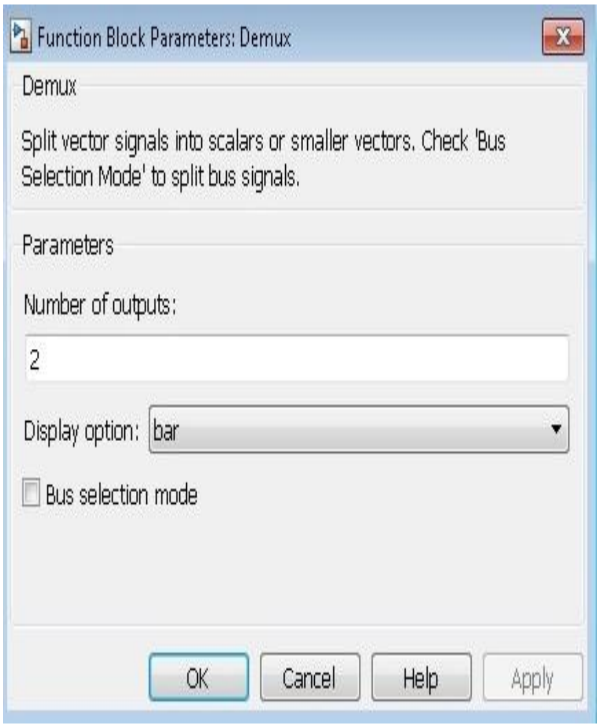

Source Block Parameters: Message Signal 1
Use the sample-based sine type if numerical problems due to runninc
for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*10
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

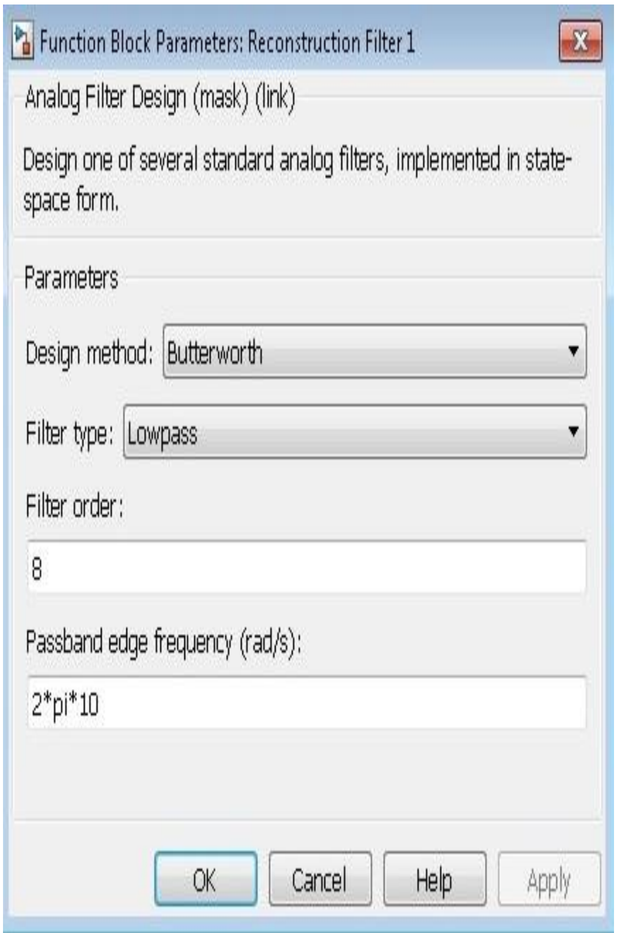

Source Block Parameters: Message Signal 1
Use the sample-based sine type if numerical problems due to runninc
for large times (e.g. overflow in absolute time) occur.
Parameters
Sine type: Time based
Time (t): Use simulation time
Amplitude:
1
Bias:
0
Frequency (rad/sec):
2*pi*10
Phase (rad):
0
Sample time:
0.001
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply

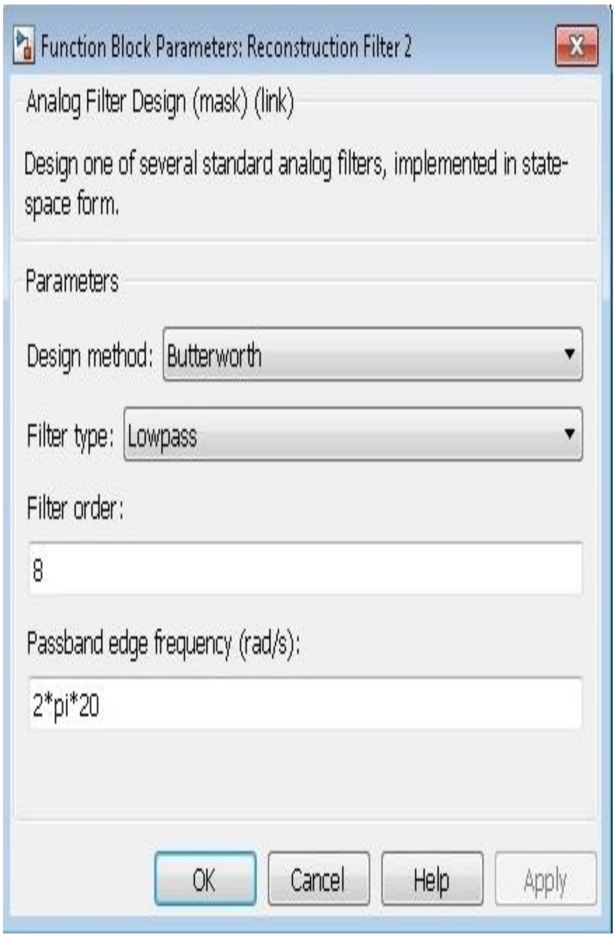

Source Block Parameters: Pulse Generator
Pulse Generator
Output pulses:
if (t >= PhaseDelay) && Pulse is on
Y(t) = Amplitude
else
Y(t) = 0
end
Pulse type determines the computational technique used.
Time-based is recommended for use with a variable step solver, whil
Sample-based is recommended for use with a fixed step solver or
within a discrete portion of a model using a variable step solver.
Parameters
Pulse type: Time based
Time (t): Use simulation time
Amplitude:
1
Period (secs):
0.01
OK
Cancel
Help
Apply


Function Block Parameters: Delay
Delay
Delay input by a fixed or variable number of samples. Based on an external signal, the block can reset its state to the specified initial condition (from dialog or input port). The block supports both circular and array buffer for state storage.
Main
State Attributes
Data
Source
Value
Upper Limit
Delay length: Dialog 1
Initial condition: Dialog 0
Algorithm
External reset: None
Input processing: Elements as channels (sample based)
Use circular buffer for state
Sample time (-1 for inherited): 0.001
OK
Cancel
Help
Apply

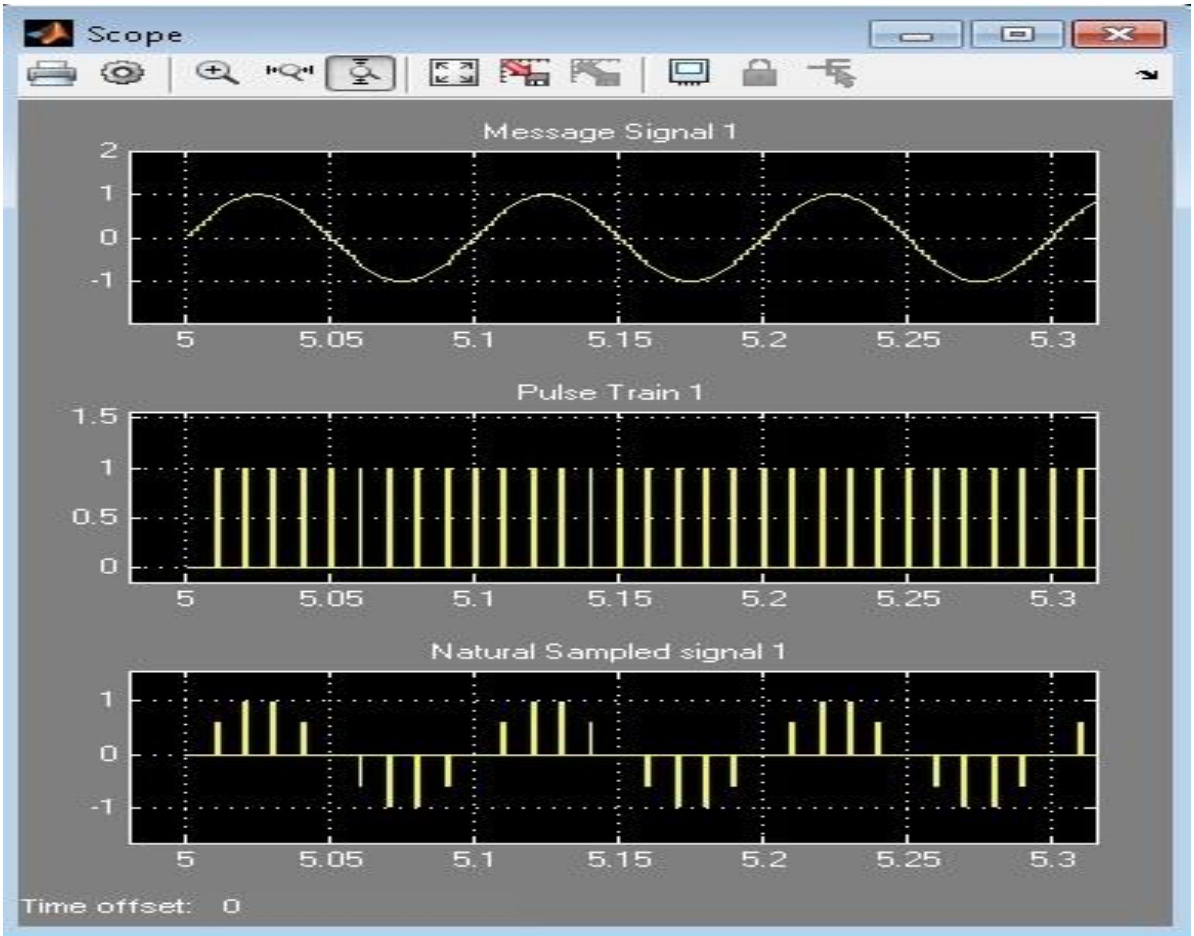

Function Block Parameters: Mux
Mux
Multiplex scalar or vector signals.
Parameters
Number of inputs:
2
Display option: bar
OK
Cancel
Help
Apply


Function Block Parameters: Demux
Demux
Split vector signals into scalars or smaller vectors. Check 'Bus Selection Mode' to split bus signals.
Parameters
Number of outputs:
2
Display option: bar
Bus selection mode
OK
Cancel
Help
Apply

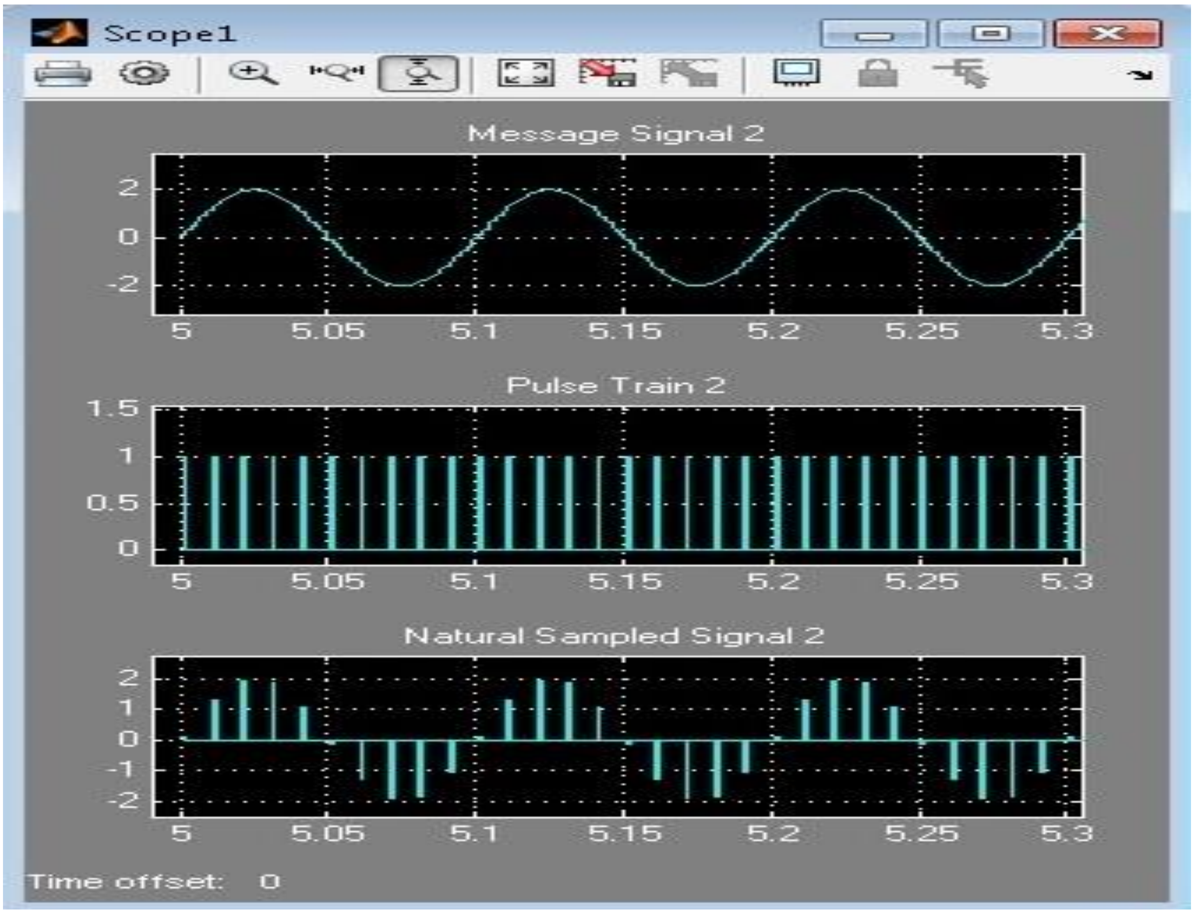

Function Block Parameters: Reconstruction Filter 1
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
8
Passband edge frequency (rad/s):
2*pi*10
OK
Cancel
Help
Apply


Function Block Parameters: Reconstruction Filter 2
Analog Filter Design (mask) (link)
Design one of several standard analog filters, implemented in state-space form.
Parameters
Design method: Butterworth
Filter type: Lowpass
Filter order:
8
Passband edge frequency (rad/s):
2*pi*20
OK
Cancel
Help
Apply

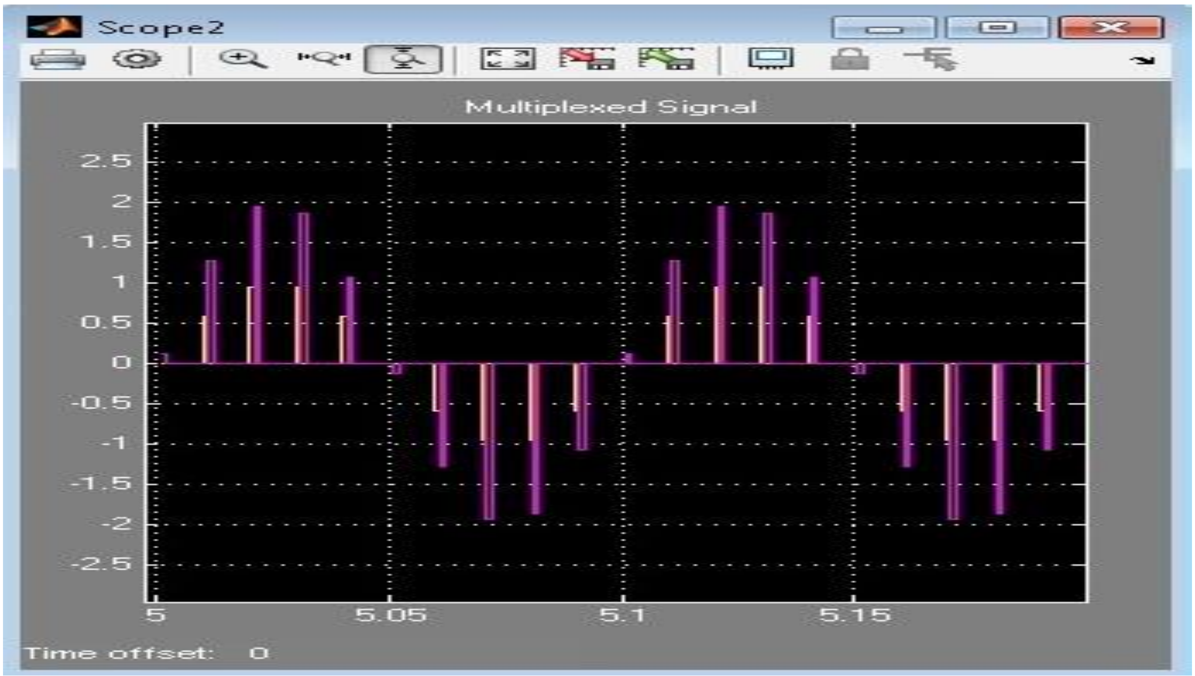
Output



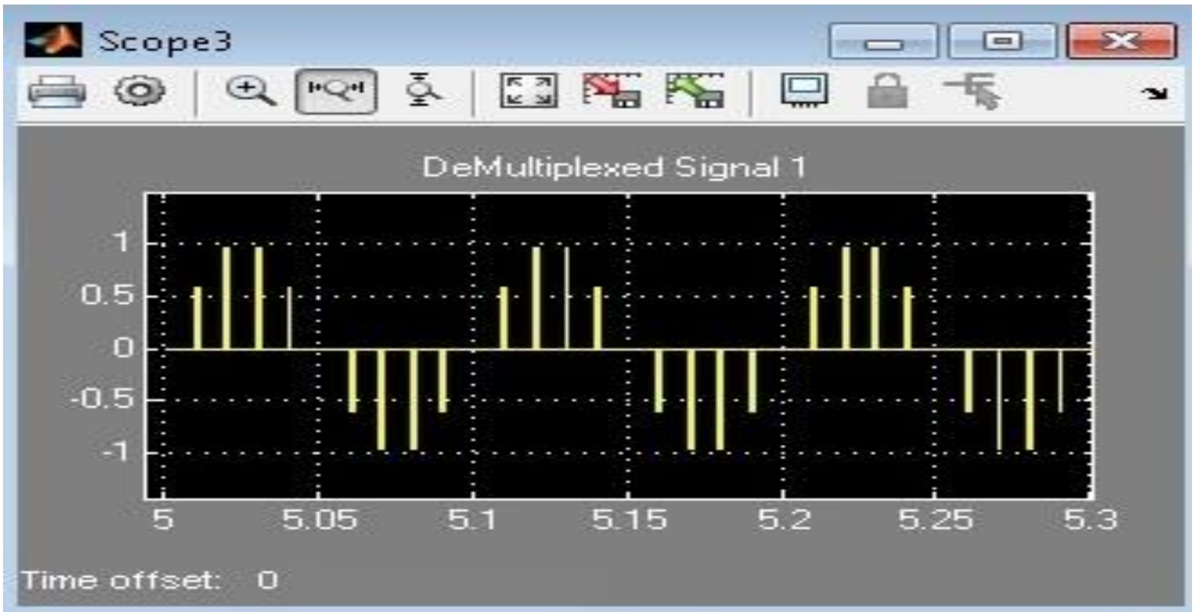
Scope
Message Signal 1
Pulse Train 1
Natural Sampled signal 1
Time offset: 0



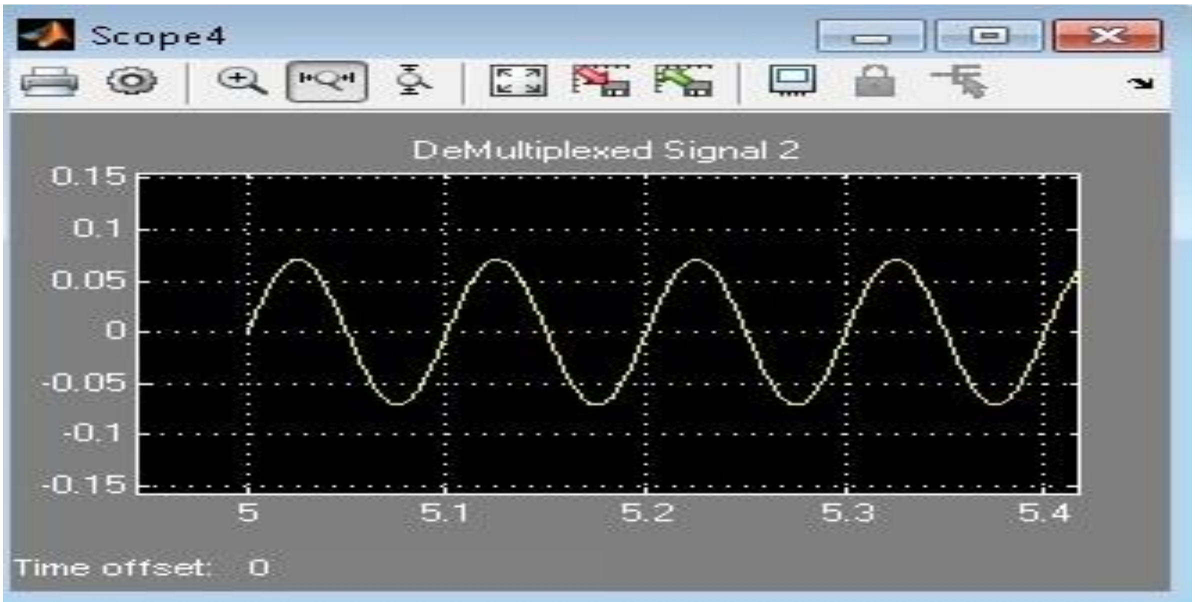
Scope1
Message Signal 2
Pulse Train 2
Natural Sampled Signal 2
Time offset: 0



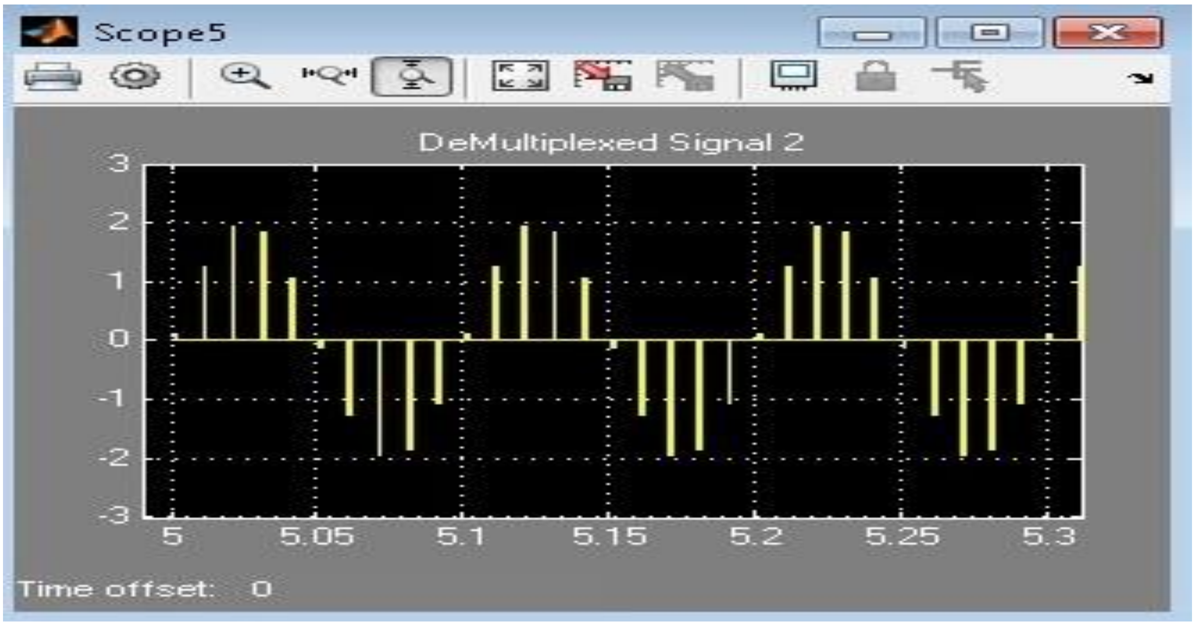
Scope2
Multiplexed Signal
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
5
5.05
5.1
5.15
Time offset: 0

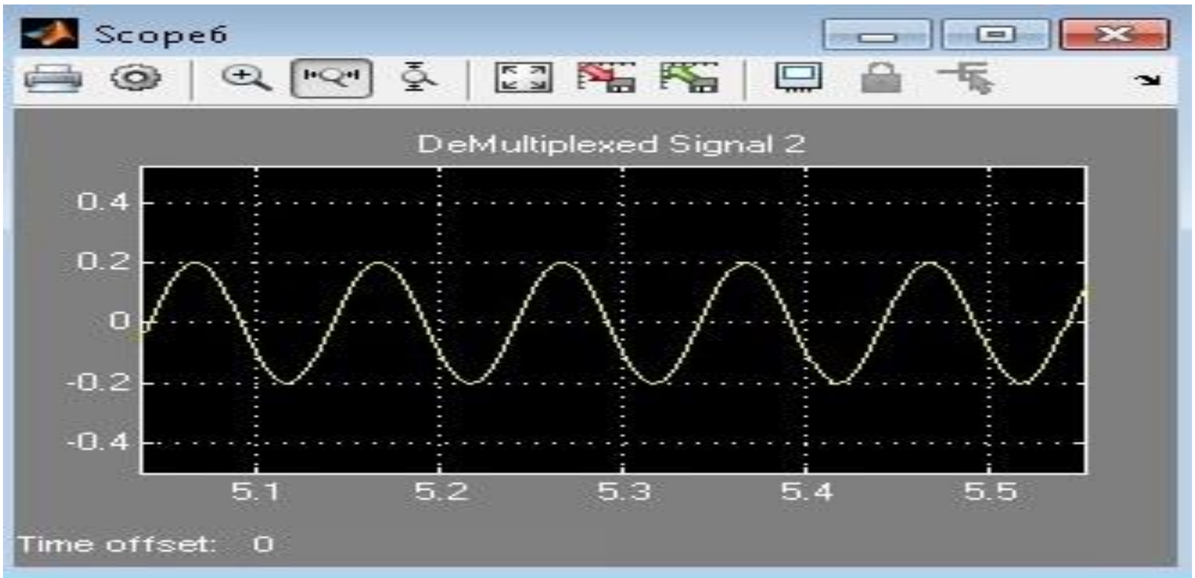


Scope3
DeMultiplexed Signal 1
1
0.5
0
-0.5
-1
5
5.05
5.1
5.15
5.2
5.25
5.3
Time offset: 0



Scope4
DeMultiplexed Signal 2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
5
5.1
5.2
5.3
5.4
Time offset: 0





Result

Viva Questions

1. Draw the TDM signal with 2 signals being multiplexed over the channel?
2. Define guard time & frame time?
3. Explain block schematic of TDM?
4. How TDM differ from FDM?
5. What type of filter is used at receiver end in TDM system?
6. What are the applications of TDM?

7. If 2 signal band limited to 3 kHz, 5 KHz & are to be time division multiplexed. What is the maximum permissible interval between 2 successive samples.?

8. Is the bandwidth requirement for TDM & FDM will be same?

9. Is TDM system is relatively immune to interference with in channels (inter channel cross talk) as compared to FDM?

10. Is the FDM susceptible to harmonic distortion compared to TDM?

11. In what aspects, TDM is superior to FDM?

Applications

1. Telephone based applications uses Pulse coded modulation signals which further uses time division multiplexing for the efficient use of channel bandwidth.
2. Used in wire line telephone systems and some cellular telephone systems.

11.PWM Modulation & Demodulation

Aim

To perform PWM modulation and Demodulation using MATLAB.

Apparatus Required

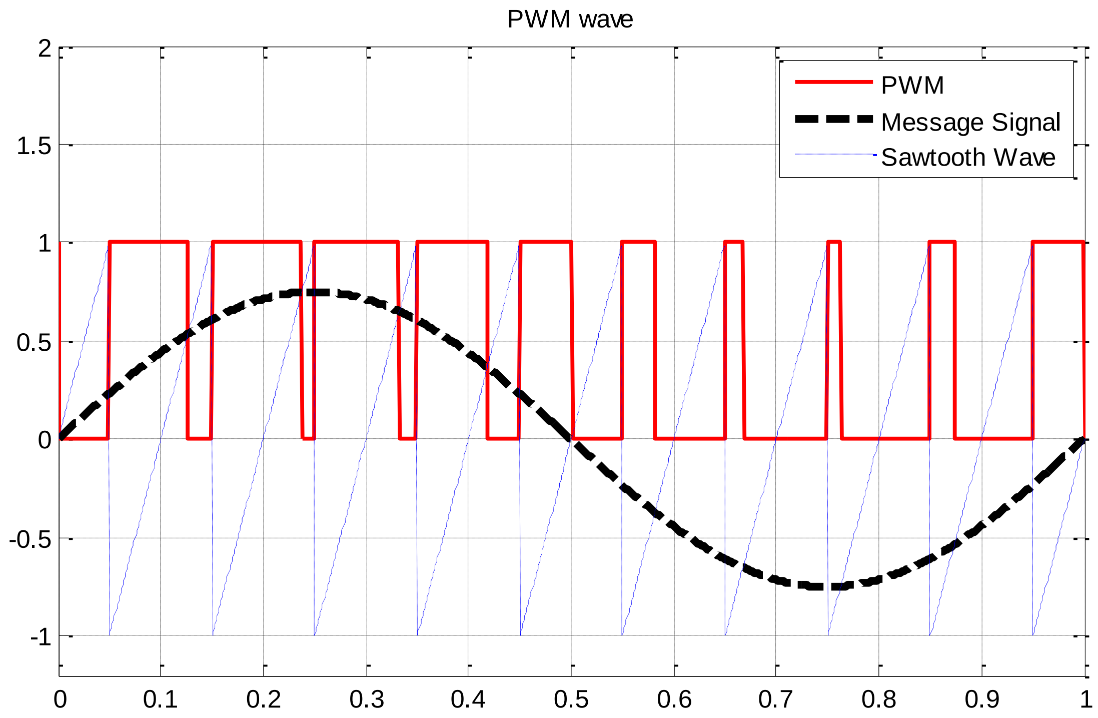
Hardware Tools: Computer system

Software Tool: MATLAB 7.0 or Upgraded Version

Program

```
%PWM wave generation
t=0:0.001:1;
s=sawtooth(2*pi*10*t+pi);
m=0.75*sin(2*pi*1*t);
n=length(s);
for i=1:n
    if (m(i)>=s(i))
        pwm(i)=1;
    elseif (m(i)<=s(i))
        pwm(i)=0;
    end
end
plot(t,pwm,'-r',t,m,'--k',t,s,'--b');grid;
title('PWM wave');axis([0 1 -1.5 1.5]);
```

Output



Result

Viva Questions

1. An audio signal consists of frequencies in the range of 100Hz to 5.5KHz.What is the minimum frequency at which it should be sampled in order to transmit it through pulse modulation?

2. Draw a TDM signal which is handling three different signals using PWM?

3. What do you infer from the frequency spectrum of a PWM signal?

4. Clock frequency in a PWM system is 2.5 kHz and modulating signal frequency is 500Hzhowmany pulses per cycle of signal occur in PWM output? Draw the PWM signal?

5. Why should the curve for pulse width Vs modulating voltage be linear?

6. What is the other name for PWM?

7. What is the disadvantage of PWM?

8. Will PWM work if the synchronization between Tx and Rx fails?

9. Why integrator is required in demodulation of PWM?

10. What kind of conversion is done in PWM generation?

Applications

1. PWM is used in telecommunication systems.
2. PWM can be used to control the amount of power delivered to a load without incurring the losses. So, this can be used in power delivering systems.
3. Audio effects and amplifications purposes also used.
4. PWM signals are used to control the speed of the robot by controlling the motors.
5. PWM is also used in robotics.
6. Embedded applications.
7. Analog and digital applications etc.

12.Pulse Position Modulation & Demodulation

Aim

To simulate PPM modulation and demodulation using MATLAB.

Apparatus Required

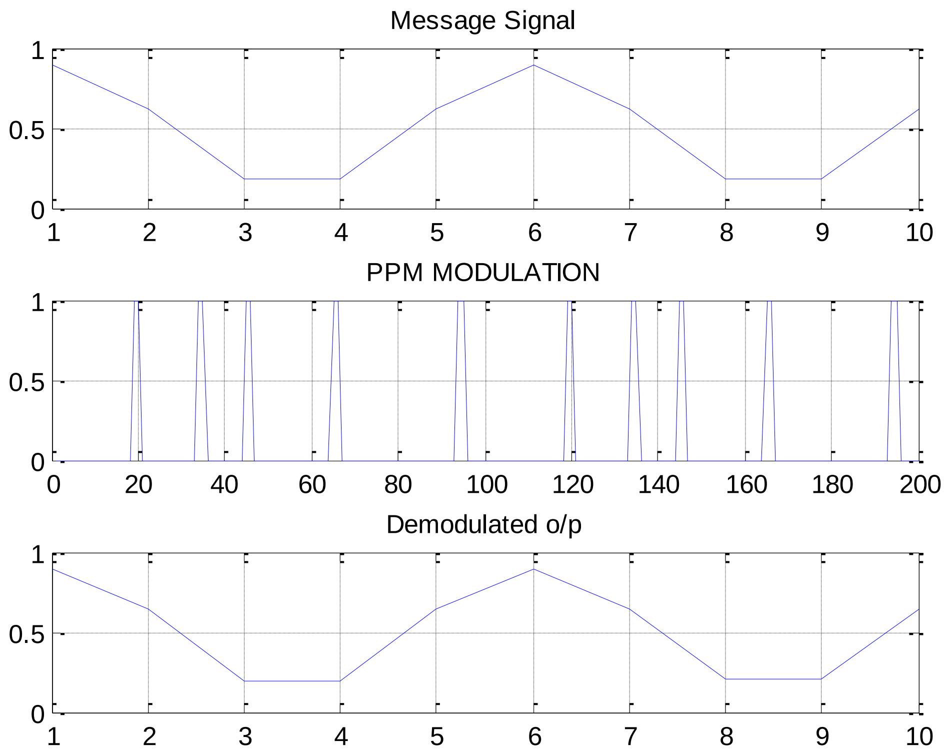
a) Hardware Tools: Computer system

b) Software Tool: MATLAB 7.0 or Upgraded Version

Code:

```
clc
clear all;
close all;
fc=50;
fs=1000;
f1=200;f2=300;
t=0:1/fs:((2/f1)-(1/fs));
x1=0.4*cos(2*pi*f1*t)+0.5;
subplot(311);plot(x1);
title('Message Signal'); grid;
subplot(312);
y=modulate(x1,fc,fs,'ppm');
plot(y);
title('PPM MODULATION');
grid;
z=demod(y,fc,fs,'ppm');
subplot(313);plot(z);
title('Demodulated o/p'); grid;
```

Output



Result

Viva Questions

1. What is the advantage of PPM over PWM?
2. Is the synchronization is must between Tx and Rx
3. Shift in the position of each pulse of PPM depends on what?
4. Can we generate PWM from PPM?
5. Why do we need 555 timers?
6. Does PPM contain derivative of modulating signal compared to PWM?
7. For above scheme, do we have to use LPF and integrator in that order?
8. If we convert PPM to PWM & then detect the message signal, will the o/p has less distortion?
9. Is synchronization critical in PPM?
10. How robust is the PPM to noise?

Applications

1. Used in non coherent detection where a receiver does not need any Phase lock loop for tracking the phase of the carrier.
2. Used in radio frequency (RF) communication.
3. Also used in contactless smart card, high frequency, RFID (radio frequency ID) tags and etc.

Advantages of Pulse Position Modulation (PPM)

- Pulse position modulation has low noise interference when compared to PAM because amplitude and width of the pulses are made constant during modulation.
- Noise removal and separation is very easy in pulse position modulation.
- Power usage is also very low when compared to other modulations due to constant pulse amplitude and width.

Disadvantages of Pulse Position Modulation (PPM)

- The synchronization between transmitter and receiver is required, which is not possible for every time and we need dedicated channel for it.
- Large bandwidth is required for transmission same as pulse amplitude modulation.
- Special equipments are required in this type of modulations.