

Computer Aided Design (CAD)



Lecture 10

Introduction to Simulink (3)

Dr.Eng. Basem ElHalawany

Schedule (Updated 28-10)

Topics	Estimated Duration (# Lectures)
Introduction	1
Introduction to Matlab Environment	1
Matlab Programing (m-files) (1)	5
Modeling using Matlab Simulink Tool	4 (3/4)
Midterm	7 th Week
Communication Systems Simulation (Applications)	3
Introduction to FPGA + Review on Digital Logic/Circuits	2
VHDL Modeling Language	4
VHDL Application	2
Introduction to OPNET Network Simulator	2
Course Closeout / Feedback/ project (s) Delivery	1



The Lecture is based on :

- 1. Modeling of Digital Communication Systems using simulink**
- 2. Online Tutorials, You can find complete links on Instructor “External Links” on University website**
www.bu.edu.eg/staff/basem.mamdoh-external-Links



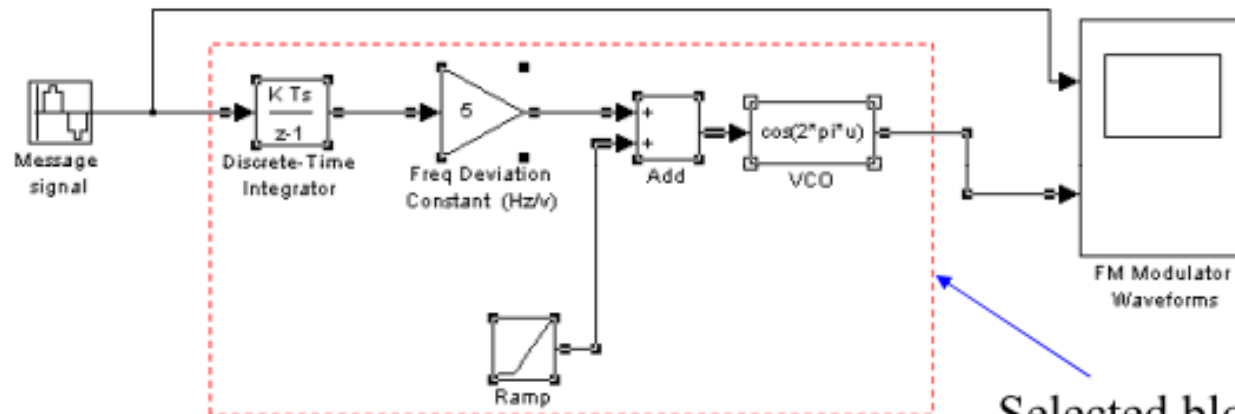
Subsystems

- A subsystem is a set of blocks that have been replaced by a single block called a **Subsystem** block
- As models increases in size and complexity, they can be simplified by grouping blocks into subsystems
- **Advantages of Subsystems**
 - Reduces the number of blocks displayed in the model window
 - Keeps functionally related blocks together
 - Enables a hierarchical block diagram structure, where a subsystem block is on one layer and the blocks that make up the subsystem are on another



Create a Subsystem

- Enclose the blocks and connecting lines that are included in the subsystem within a bounding box.
- Define the starting corner of a bounding box by positioning the pointer at one corner of the box, then pressing and holding down the mouse button.
- Drag the pointer to the opposite corner of the box. A dotted rectangle encloses the selected blocks and lines

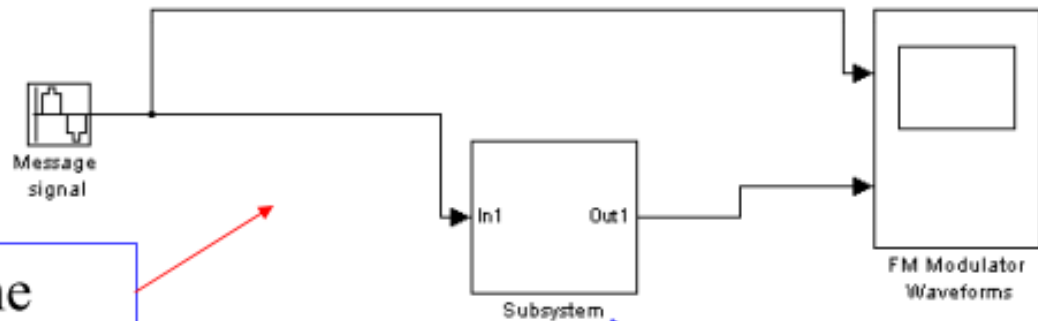


Selected blocks and lines
constituting the subsystem

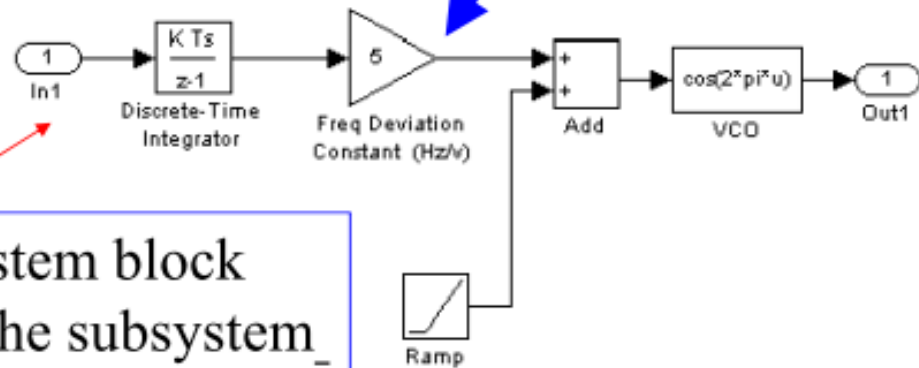


Create a Subsystem (contd)

- Select **Create Subsystem** from the **Edit** menu.
 - A new Subsystem block replaces the selected blocks.



Model after selecting the Create Subsystem command

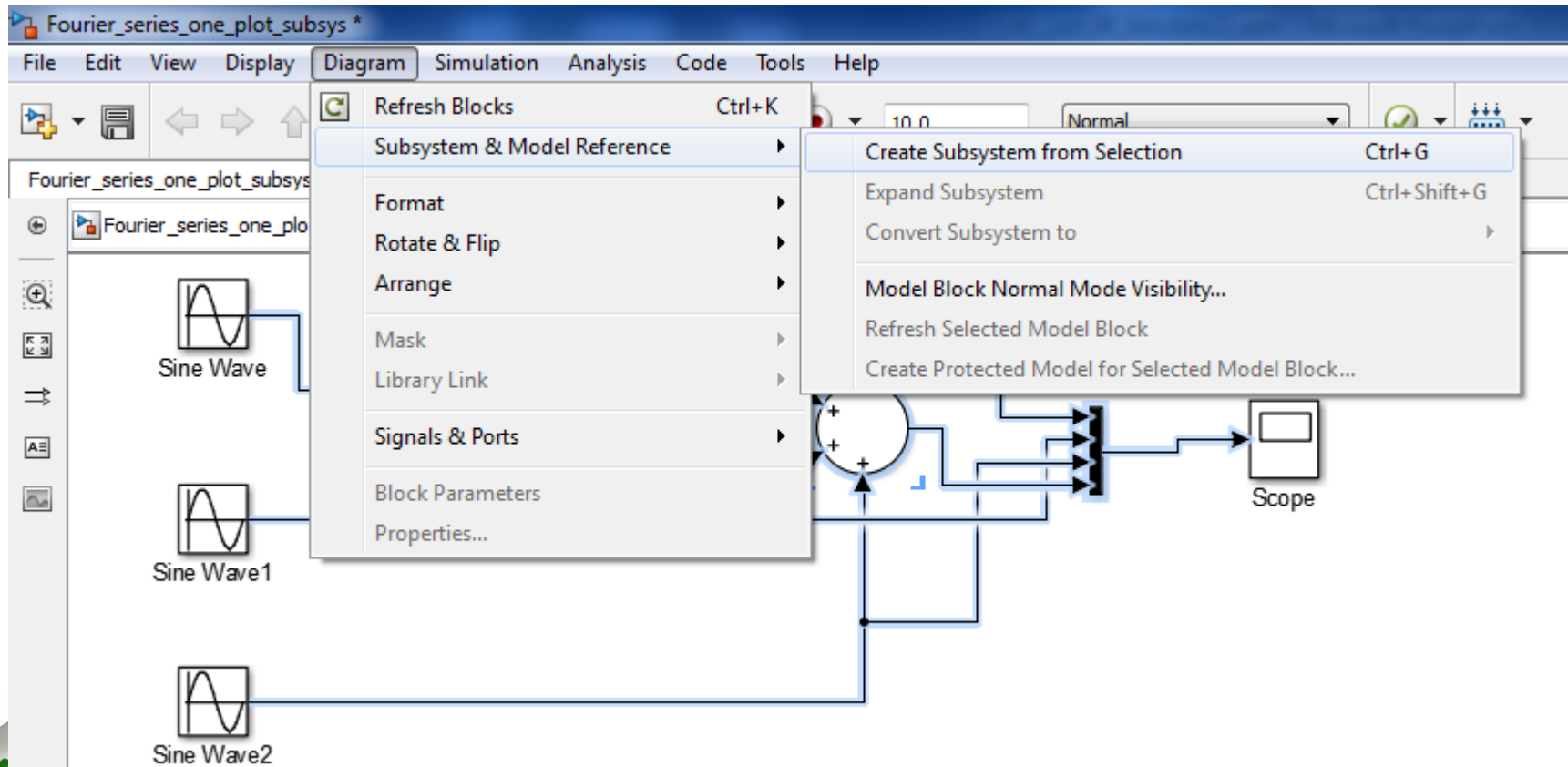


Double-clicking the Subsystem block displaying the contents of the subsystem_



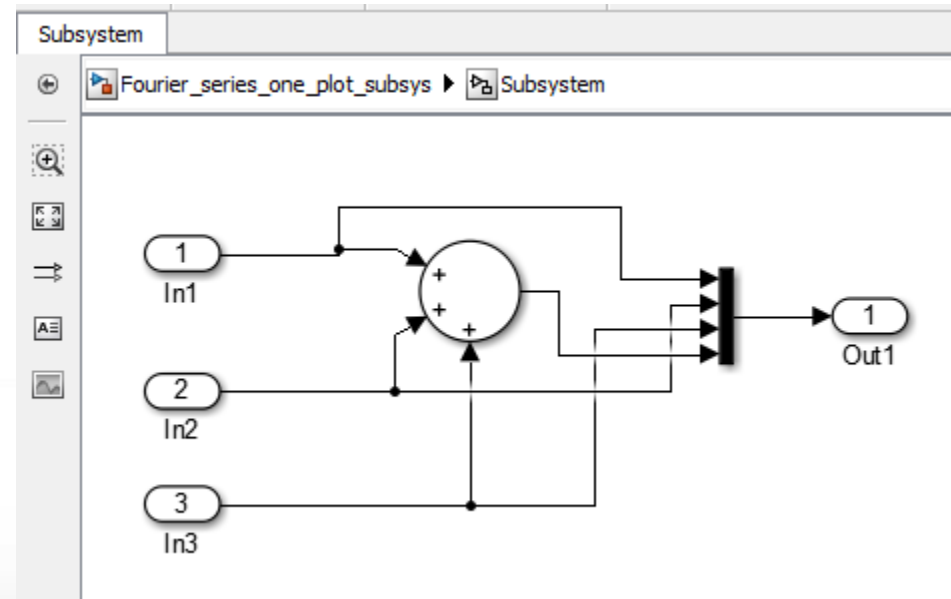
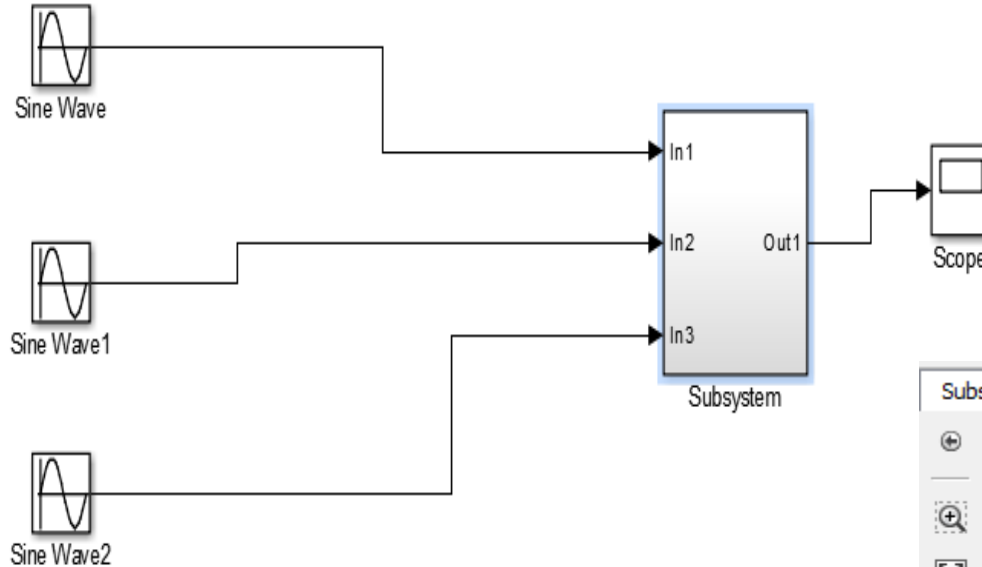
In Matlab 2014

- From Diagram/ Subsystem / Model reference /
- Select Create Subsystem from selection



In Matlab 2014

- The following figure represents the new subsystem
- The internal construction can be accessed by double-clicking on it



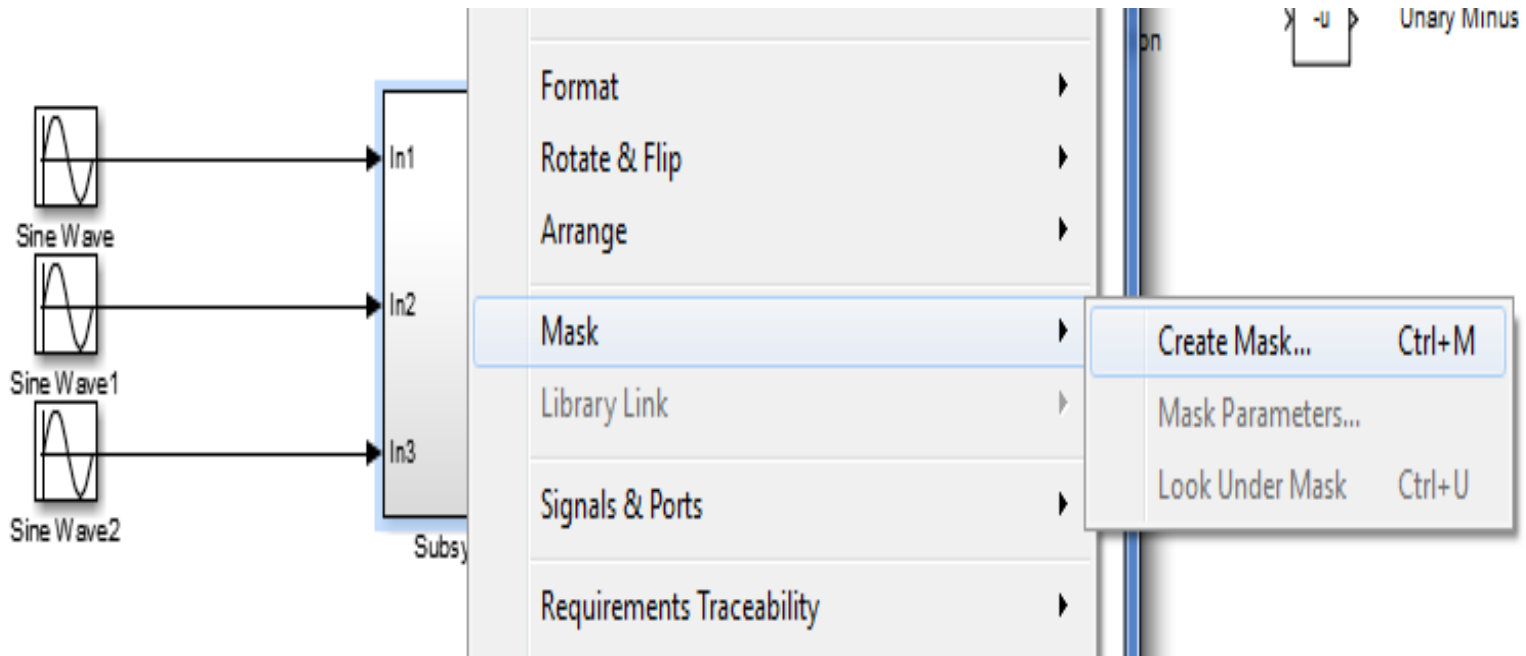
Masking a Subsystem

- A mask is a custom user interface for a subsystem that hides the subsystem's contents, making it appear to the user as a custom block with its own icon and Parameters dialog box
- The Simulink Mask Editor enables us to create a mask for any subsystem. Masking allows us to:
 - Replace the parameter dialogs of a subsystem's contents with a single parameter dialog
 - Replace a subsystem's standard icon with a custom icon that depicts its purpose
 - Prevent unintended modification of subsystems by hiding their contents behind a mask
 - Create a custom block with its own block diagram that defines the block's behavior in a masked subsystem and then placing the masked subsystem in a library.



Masking Subsystem

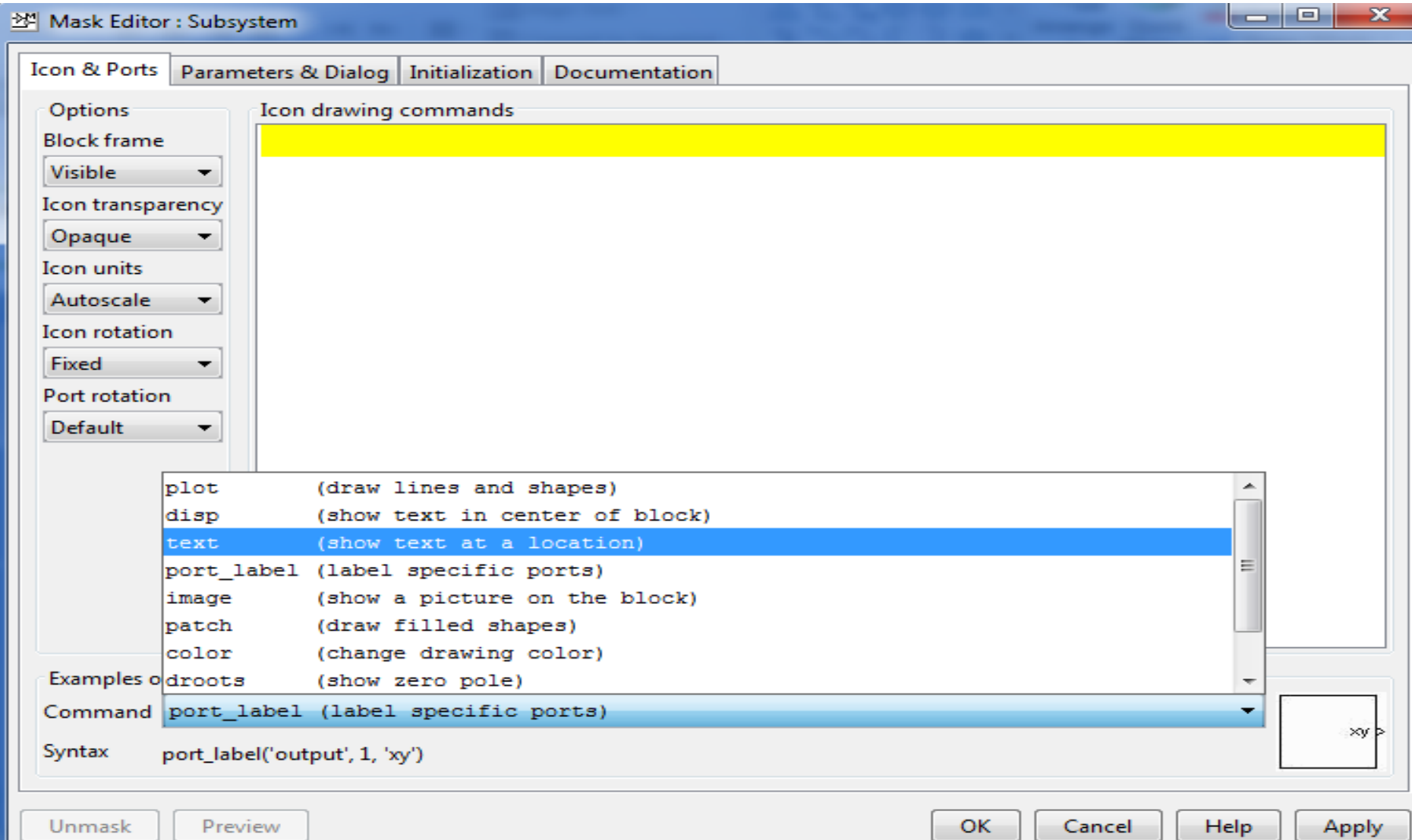
- Right-click on the subsystem, then select “Mask”, then “Create Subsystem”.



Masking Subsystem

11

- You can create the mask here by using the commands in the lower part according to your design



➤ Icons and Ports Tab

Options

Block frame

Visible ▾

Icon transparency

Opaque ▾

Icon units

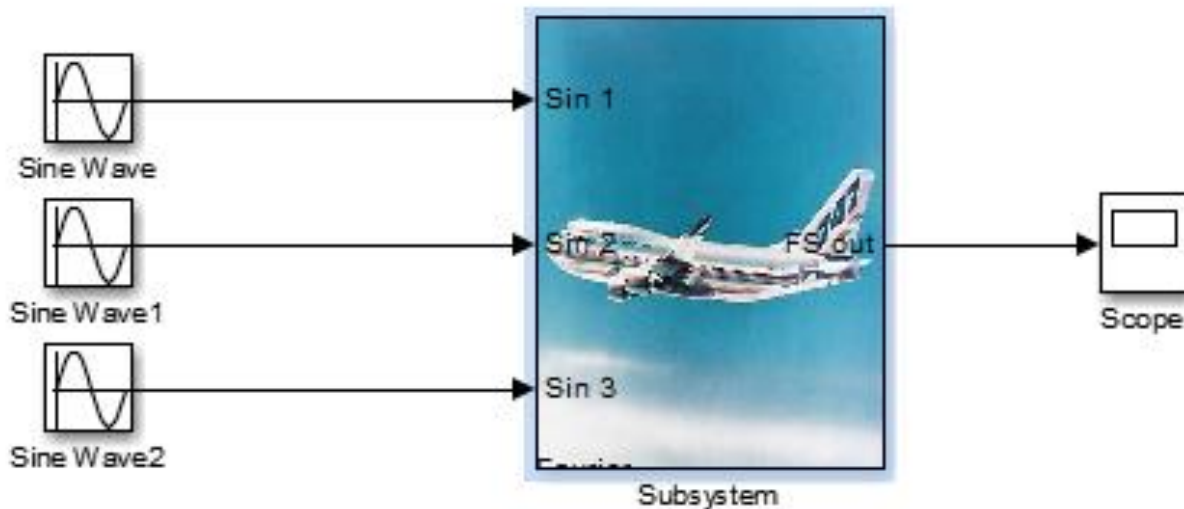
Autoscale ▾

Icon rotation

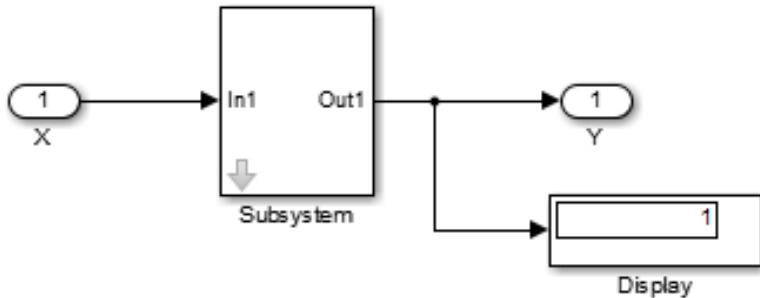
Fixed ▾

Icon drawing commands

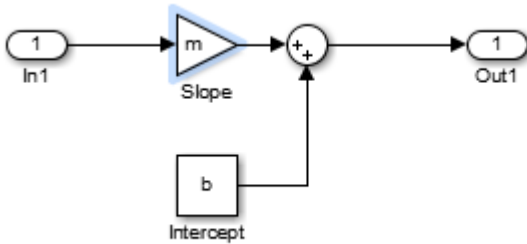
```
image('b747.jpg')  
text(5,10, 'Fourier')  
port_label('output', 1, 'FS out')  
port_label('input', 1, 'Sin 1')  
port_label('input', 2, 'Sin 2')  
port_label('input', 3, 'Sin 3')
```



Parameters and Dialog Tab



System



SubSystem

The screenshot shows the 'Mask Editor: Subsystem' dialog box with the 'Parameters & Dialog' tab selected. The 'Controls' list on the left includes Parameter, Display, and Action categories. The 'Dialog box' table contains the following items:

Type	Prompt	Name
	%<MaskType>	DescGroupVar
A	(Add text here)	DescTextVar
Parameters		ParameterGroupVar

The 'Property editor' on the right shows the following settings:

- Properties: Name (ParameterGroup...), Prompt (Simulink:studio...), Type (groupbox)
- Dialog: Enable (checked), Visible (checked)
- Layout: Item location (New row)

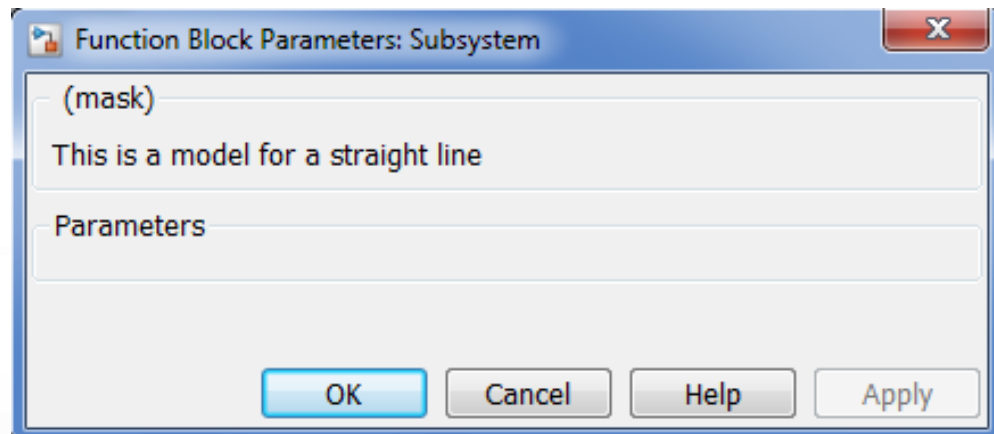
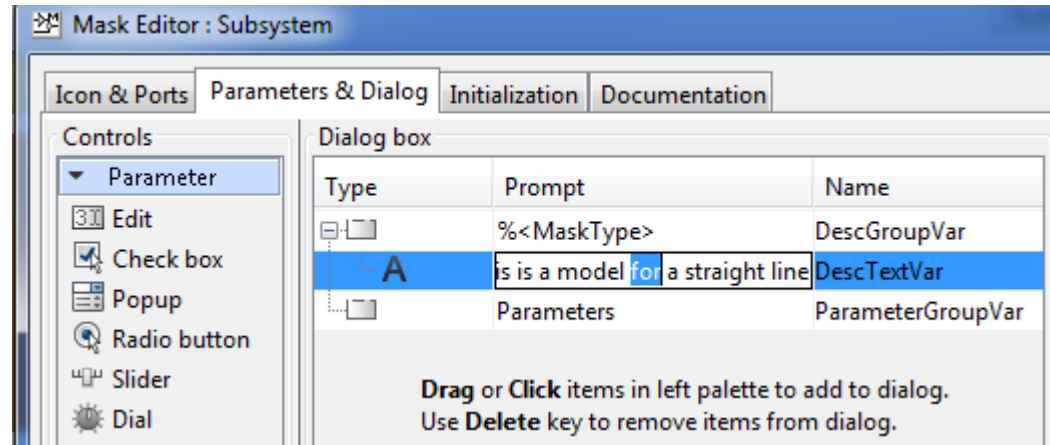
Buttons at the bottom include Unmask, Preview, OK, Cancel, Help, and Apply.



Masking Subsystem

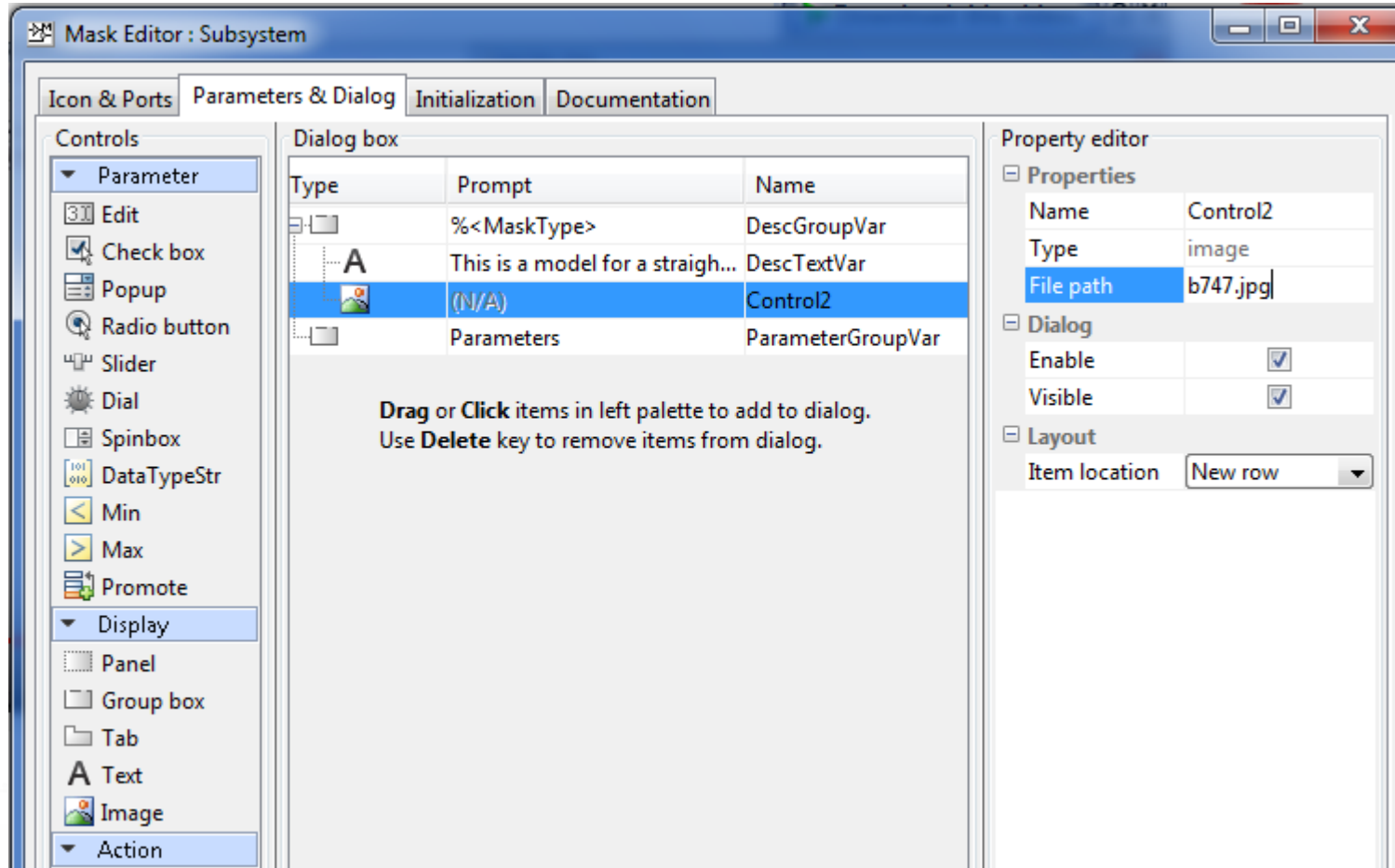
➤ Parameters and Dialog Tab

✓ Adding introductory text or information in "A"




➤ Parameters and Dialog Tab

✓ Adding Image to the information section



The screenshot shows the 'Mask Editor: Subsystem' window with the 'Parameters & Dialog' tab selected. The 'Controls' palette on the left includes 'Image' under the 'Display' category. The 'Dialog box' table lists several controls, with an image control selected. The 'Property editor' on the right shows the 'File path' property set to 'b747.jpg'.

Type	Prompt	Name
	%<MaskType>	DescGroupVar
A	This is a model for a straigh...	DescTextVar
	(N/A)	Control2
	Parameters	ParameterGroupVar

Drag or Click items in left palette to add to dialog.
Use **Delete** key to remove items from dialog.

Property editor

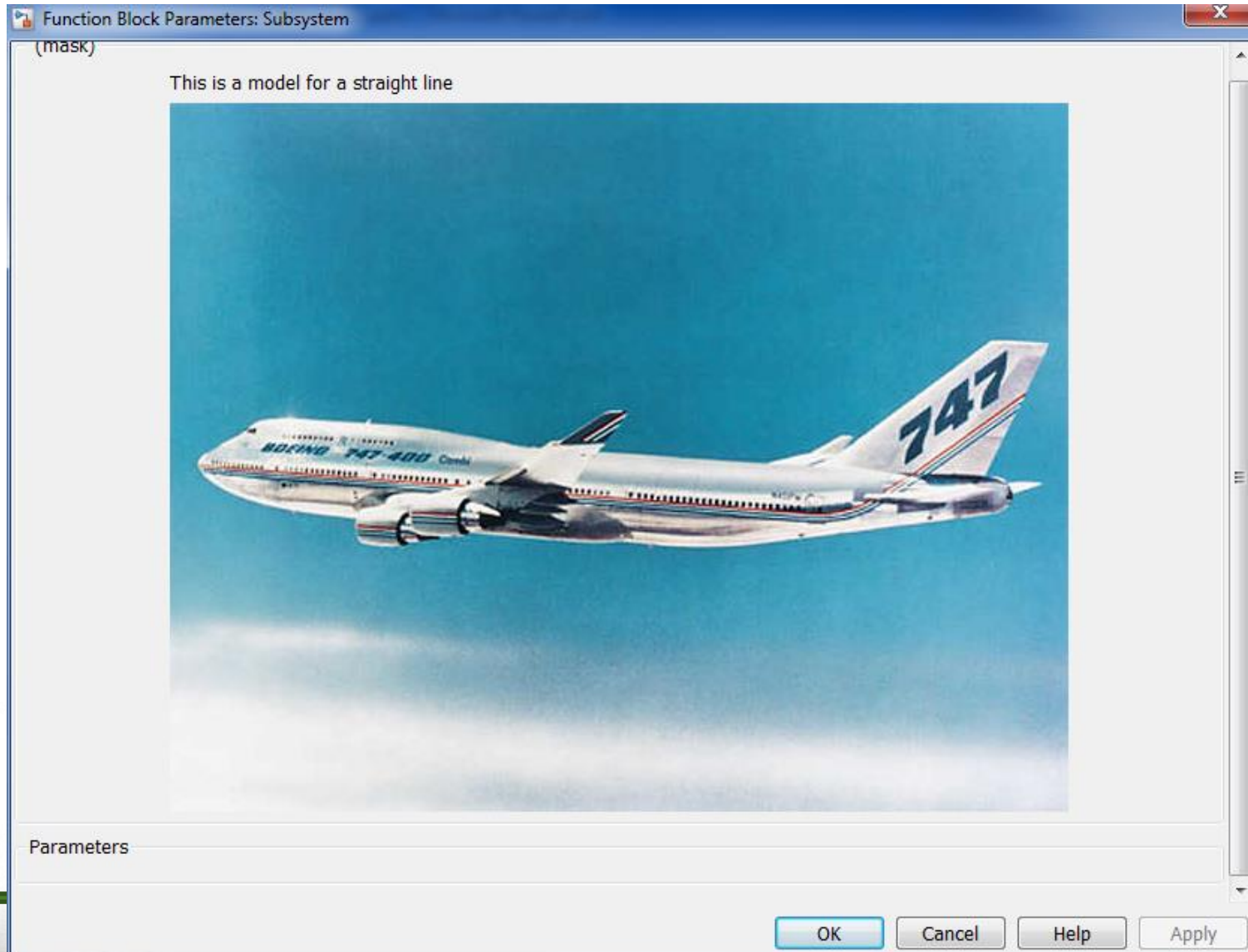
- Properties
 - Name: Control2
 - Type: image
 - File path: b747.jpg
- Dialog
 - Enable:
 - Visible:
- Layout
 - Item location: New row



Masking Subsystem

➤ Parameters and Dialog Tab

✓ Adding Image to the information section



Masking Subsystem

17

➤ Parameters and Dialog Tab

✓ Adding an input prompt from "Edit"

The screenshot shows the 'Mask Editor: Subsystem' window with the 'Parameters & Dialog' tab selected. The 'Controls' list on the left has 'Edit' highlighted. The 'Dialog box' table is as follows:

Type	Prompt	Name
	%<MaskType>	DescGroupVar
A	This is a model for a straigh...	DescTextVar
	Parameters	ParameterGroupVar
#1	Slope	m
#2	Intercept	b

The 'Property editor' on the right shows the following properties:

Name	b
Value	0
Prompt	Intercept
Type	edit

The screenshot shows the 'Function Block Parameters: Subsystem' dialog box. It displays the following content:

(mask)
This is a model for a straight line

Parameters

Slope
1

Intercept
0

Buttons: OK, Cancel, Help, Apply



Masking Subsystem

Initialization

- The Initialization tab allows you to specify initialization commands
- After this, the MATLAB workspace variables are no longer visible

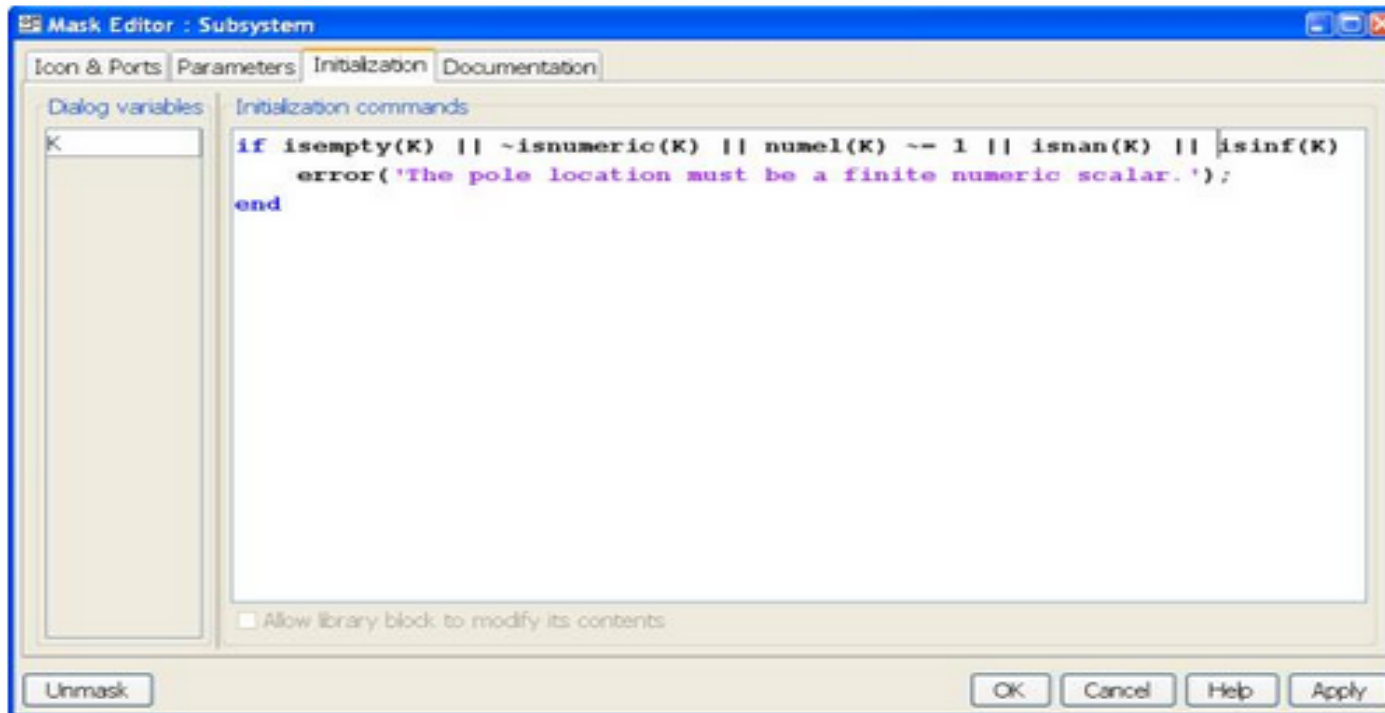


Figure 12: The Initialization Tab.

```
if isempty(K) || ~isnumeric(K) || numel(K) ~= 1 || isnan(K) || isinf(K)
    error('The pole location must be a finite numeric scalar.');
```

```
end
```

Masking Subsystem

➤ Documentation Editor

Mask Editor : Subsystem

Icon & Ports Parameters Initialization Documentation

Mask type

Custom Transfer Function

Mask description

This block models a simple first order continuous-time transfer function of the form:

$$TF = K/(s+K)$$

The user must specify the parameter K, where -K is the pole location.

Mask help

This documentation will be displayed when the block's Help button is pressed.

Detailed text documentation, or a link to another file that contains appropriate documentation would be put here.

Unmask

OK Cancel Help Apply

Function Block Parameters: Subsystem

Custom Transfer Function (mask)

This block models a simple first order continuous-time transfer function of the form:

$$TF = K/(s+K)$$

The user must specify the parameter K, where -K is the pole location.

Parameters

K (>0 => Stable)

OK Cancel Help Apply

Running Simulink simulation from a MATLAB m-file

Two commands are used :

- simset
- sim

```
%% Simulator Settings
```

```
t_stop=100;           % Simulation time  
T_s=t_stop/1000;     % Step Size
```

```
%% Simulation options
```

```
options=simset('solver', 'ode5', 'fixedstep', T_s);
```

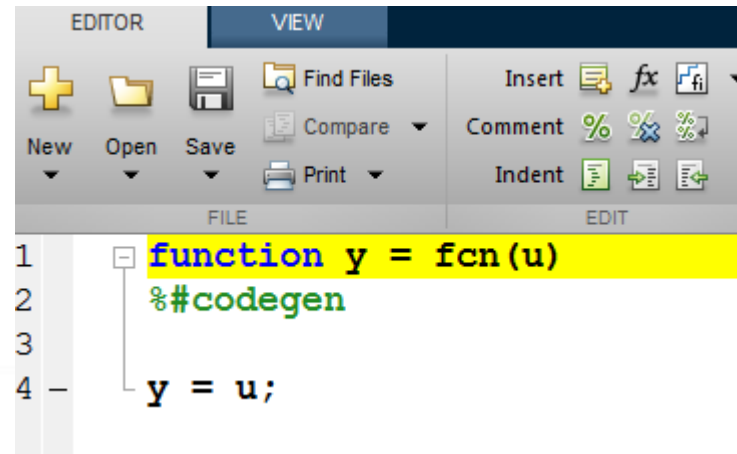
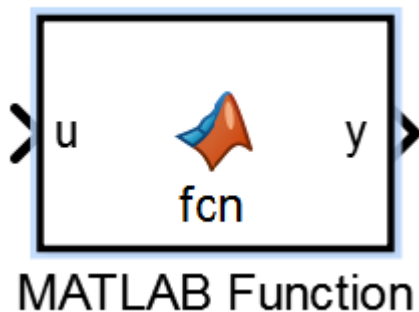
```
%5 Starting simulation
```

```
sim('Simulink_model_name', t_stop, options);
```



Using MATLAB Function Block (old name: Embedded function)

- The MATLAB Function Block is an easy and convenient way to write MATLAB m-code that can be incorporated into a Simulink model.
- The MATLAB Function block is obtained from the *User Defined Functions* Library and is inserted into a model in the same way
- Once in a model the m-code that represents the block's functionality is associated with the block by writing it in the matlab editor and is viewed by double clicking on the block.



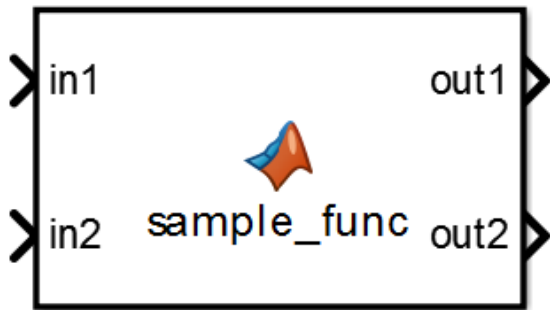
A screenshot of the MATLAB Editor window. The window has a menu bar with 'EDITOR' and 'VIEW' tabs. Below the menu bar, there are icons for 'New', 'Open', 'Save', 'Find Files', 'Compare', 'Print', 'Insert', 'Comment', and 'Indent'. The main area of the editor shows a code editor with the following code:

```
1 function y = fcn(u)
2     %#codegen
3
4     y = u;
```



Using MATLAB Function Block

- The function's number of input arguments automatically corresponds to the number of block input ports and
- The function's number of output arguments automatically corresponds to the number of block output ports.
- Similarly the input arguments automatically take on the size and data-type of input signals, and
- The output signals automatically take on the size and data-type of the output variables created in the function.
- This imposes the restriction that the size and data-type of output variables typically **needs to be defined at the start of the m-code** and **not changed during the simulation**.

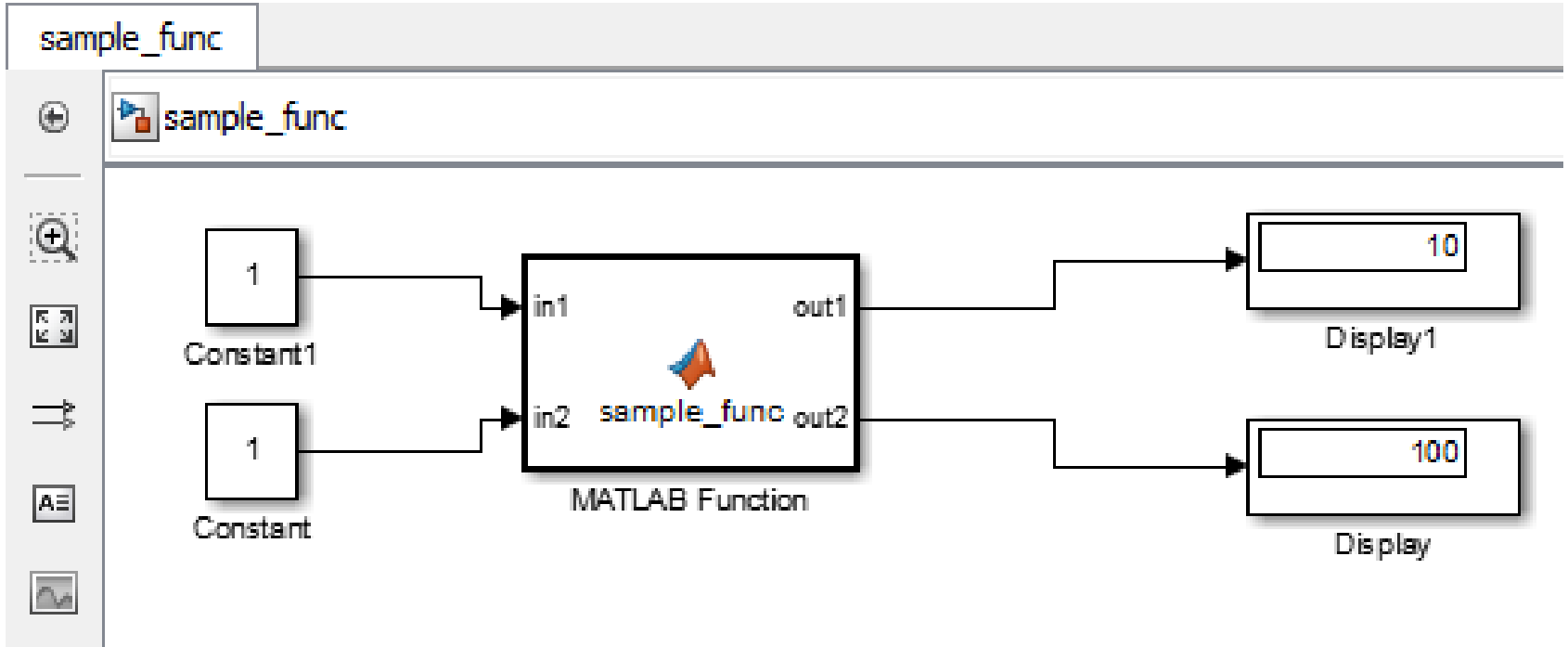


MATLAB Function

```
1 function [out1, out2] = sample_func(in1,in2)
2   %#codegen
3
4   out1 = in1*10;
5   out2 = in2*100;
6 end
```

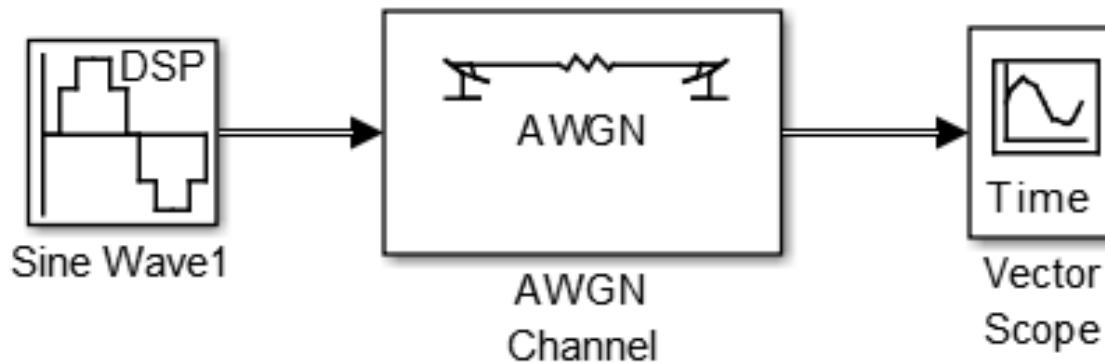

Using MATLAB Function Block

➤ Example:



Example of Channel Effect:

- You can add noise to the model using the AWGN Channel block
- The block adds additive white Gaussian noise (AWGN) to the sine wave.

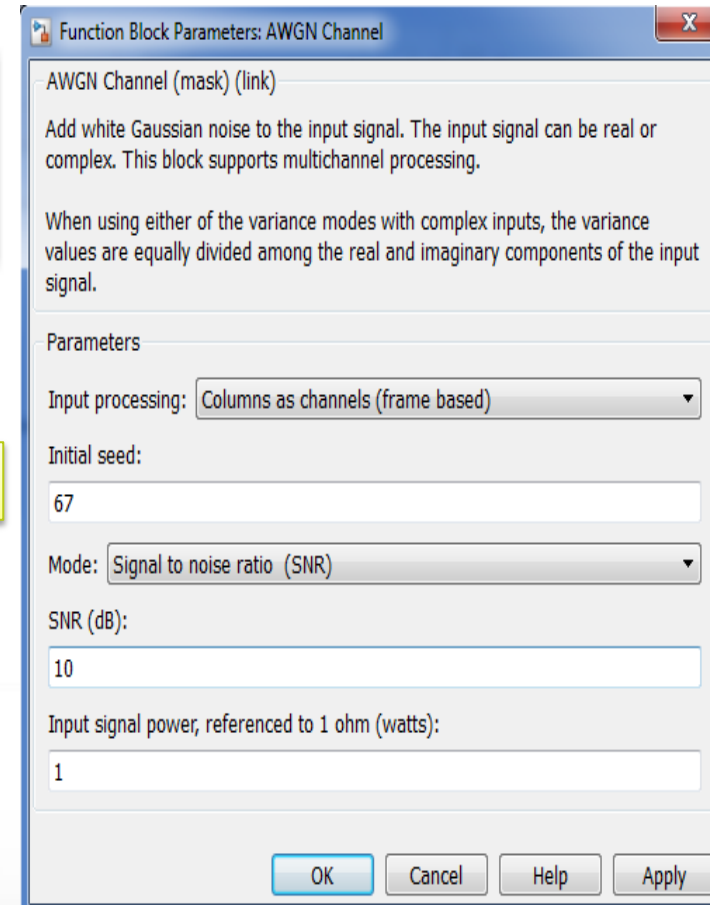


DSP toolbox/ DSP Sources

DSP toolbox/ DSP Sinks

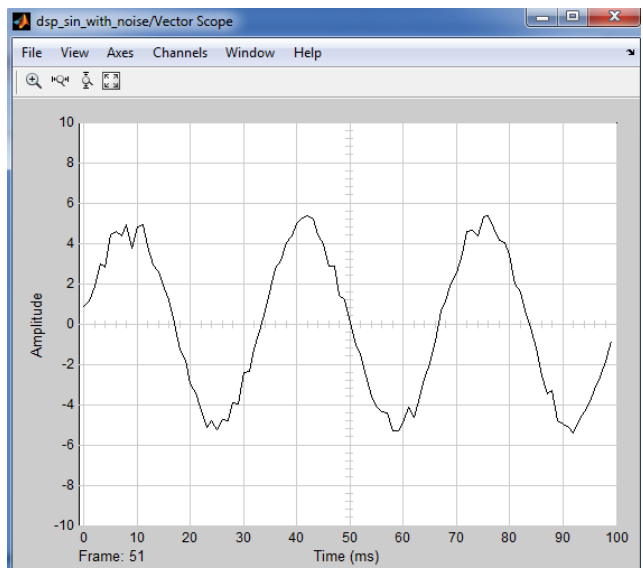
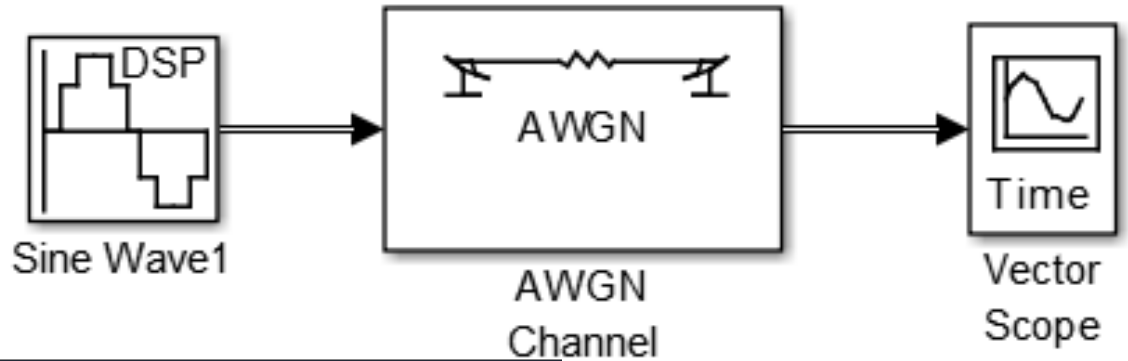
Communications Blockset /
Channels library

- 1 Set **Amplitude** to 5.
- 2 Set **Frequencies** to 30.
- 3 Set **Samples per frame** to 100.

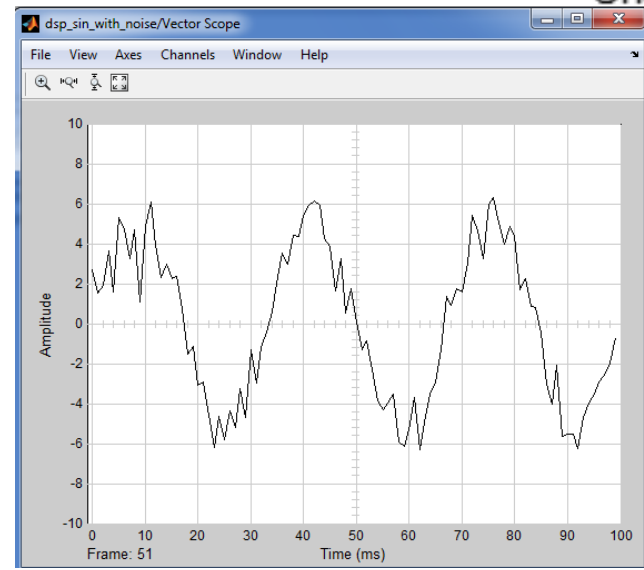


Steps for Building a Simple Communication Model

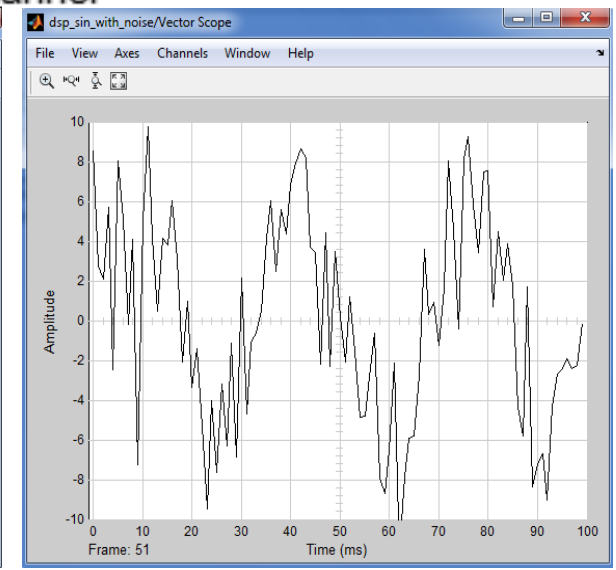
Example of Channel Effect:



SNR = 10 dB



SNR = 0 dB



SNR = -10 dB

