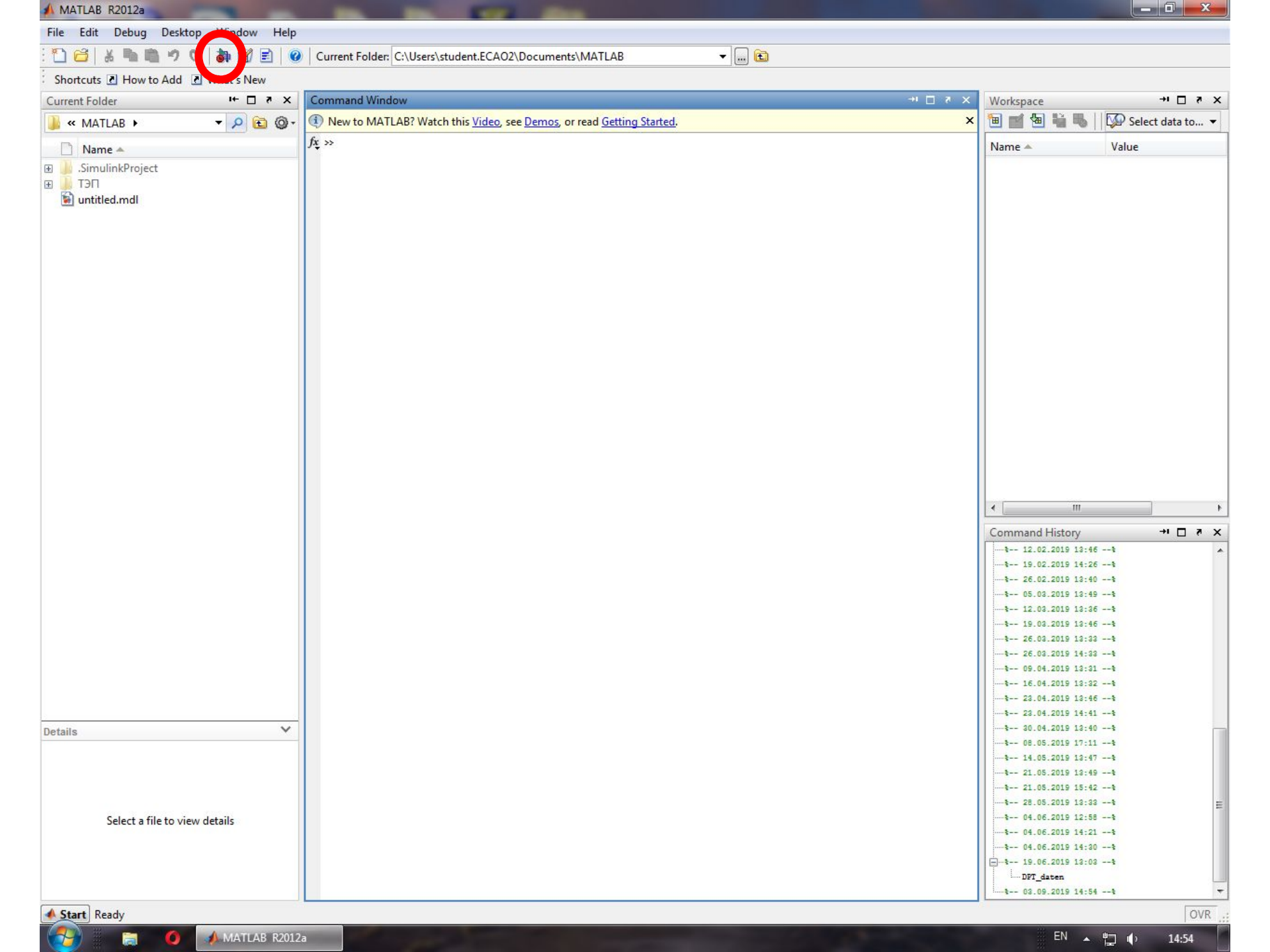
Компьютерные технологии при разработке и проектировании электрооборудования автономных объектов

Вводная лабораторная работа


MATLAB R2012a
File Edit Debug Desktop Window Help
Current Folder: C:\Users\student.ECAO2\Documents\MATLAB
Shortcuts How to Add
Current Folder
MATLAB
Name
.SimulinkProject
ТЭП
untitled.mdl
Details
Select a file to view details
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>>
Workspace
Select data to...
Name
Value
Command History
%-- 12.02.2019 13:46 --%
%-- 19.02.2019 14:26 --%
%-- 26.02.2019 13:40 --%
%-- 05.03.2019 13:49 --%
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%-- 04.06.2019 12:58 --%
%-- 04.06.2019 14:21 --%
%-- 04.06.2019 14:30 --%
%-- 19.06.2019 13:03 --%
DPT_daten
%-- 03.09.2019 14:54 --%
Start Ready
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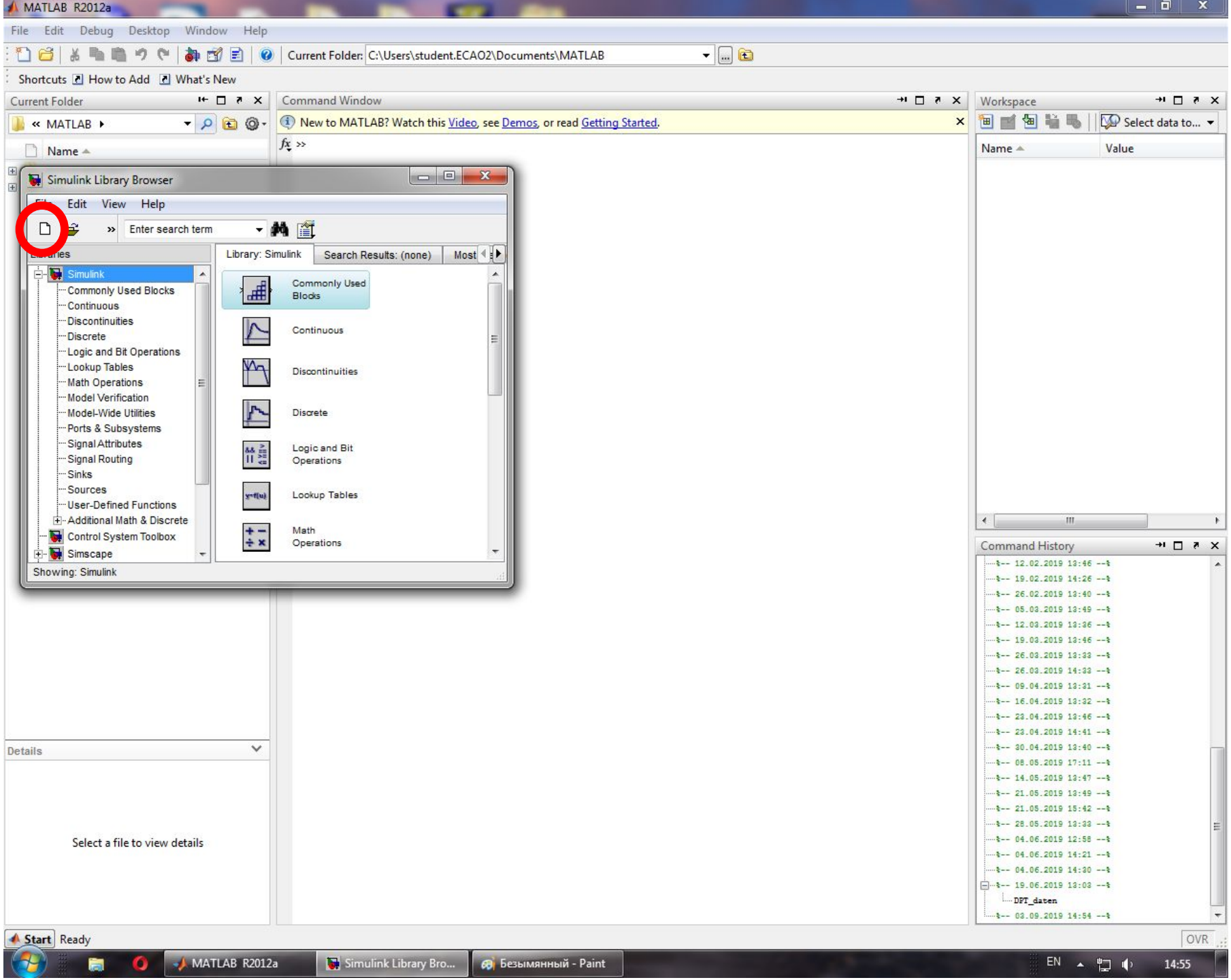
MATLAB R2012a
File Edit Debug Desktop Window Help
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Shortcuts How to Add What's New
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New to MATLAB? Watch this Video, see Demos, or read Getting Started.
Workspace
Select data to...
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Simulink Library Browser
File Edit View Help
Enter search term
Library: Simulink
Search Results: (none)
Most
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete
Control System Toolbox
Simscape
Showing: Simulink
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Lookup Tables
Math Operations
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%-- 08.05.2019 17:11 --%
%-- 14.05.2019 13:47 --%
%-- 21.05.2019 13:49 --%
%-- 21.05.2019 15:42 --%
%-- 28.05.2019 13:33 --%
%-- 04.06.2019 12:58 --%
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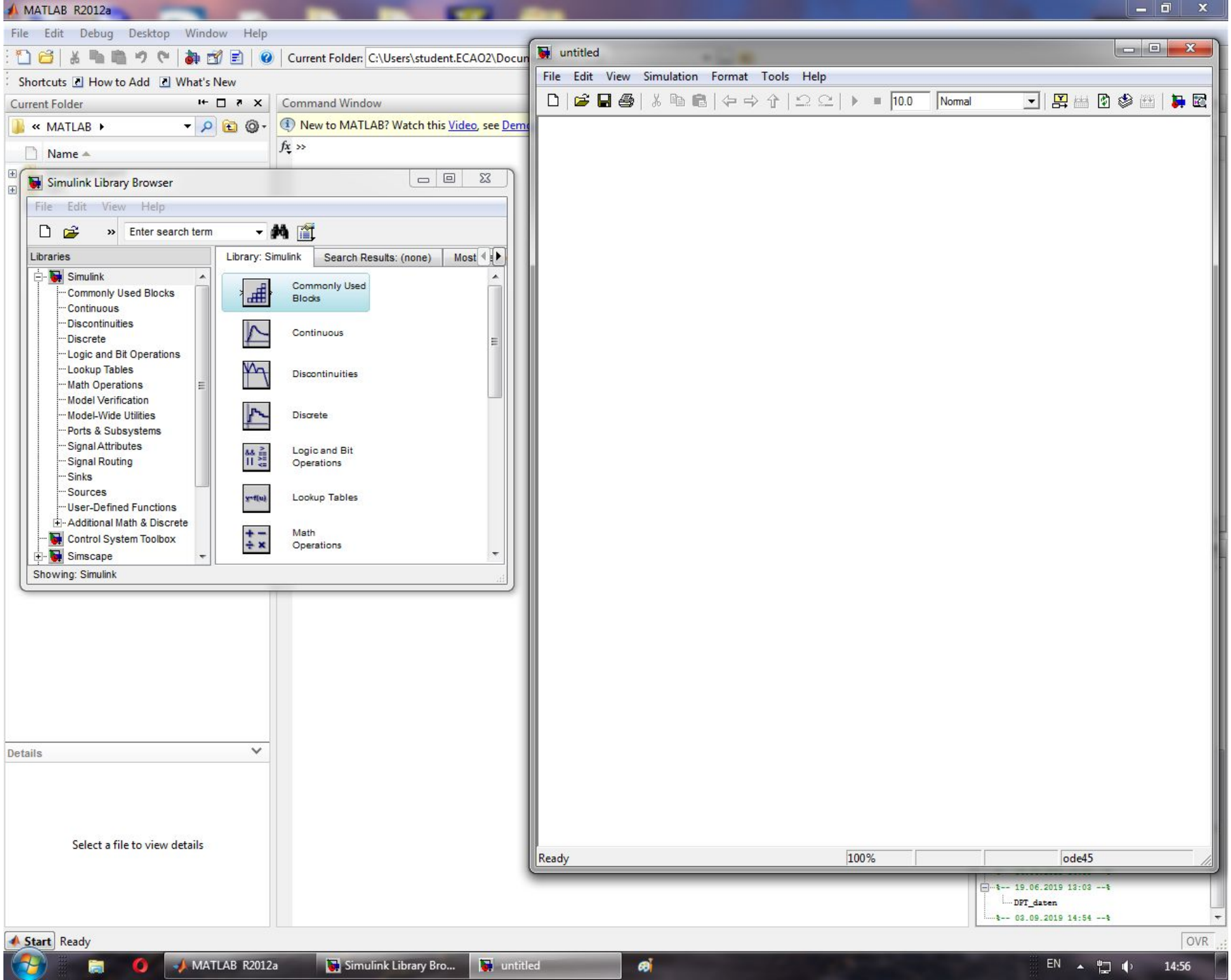
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New to MATLAB? Watch this Video, see Demo
Simulink Library Browser
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Library: Simulink
Search Results: (none)
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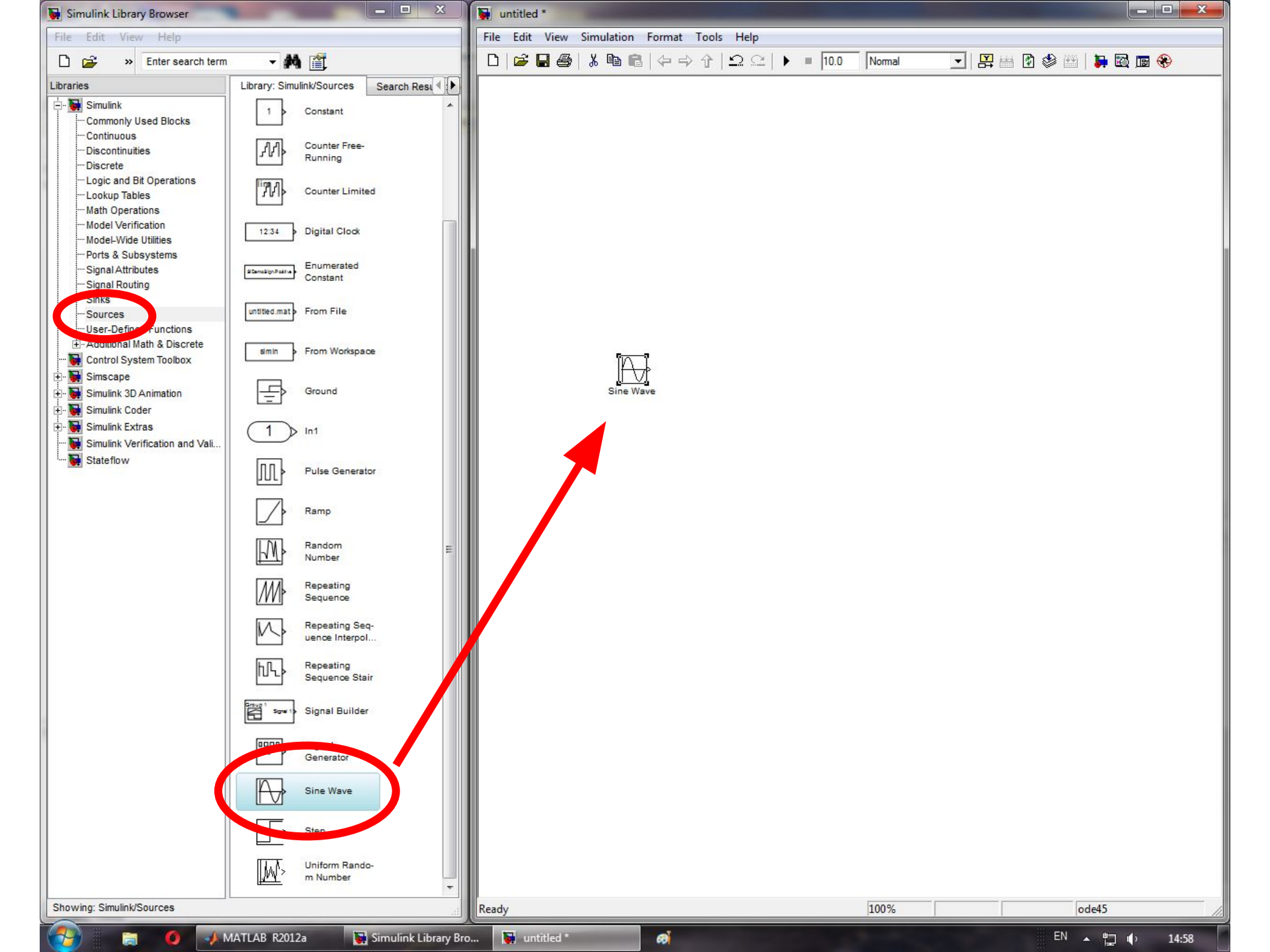
Simulink Library Browser
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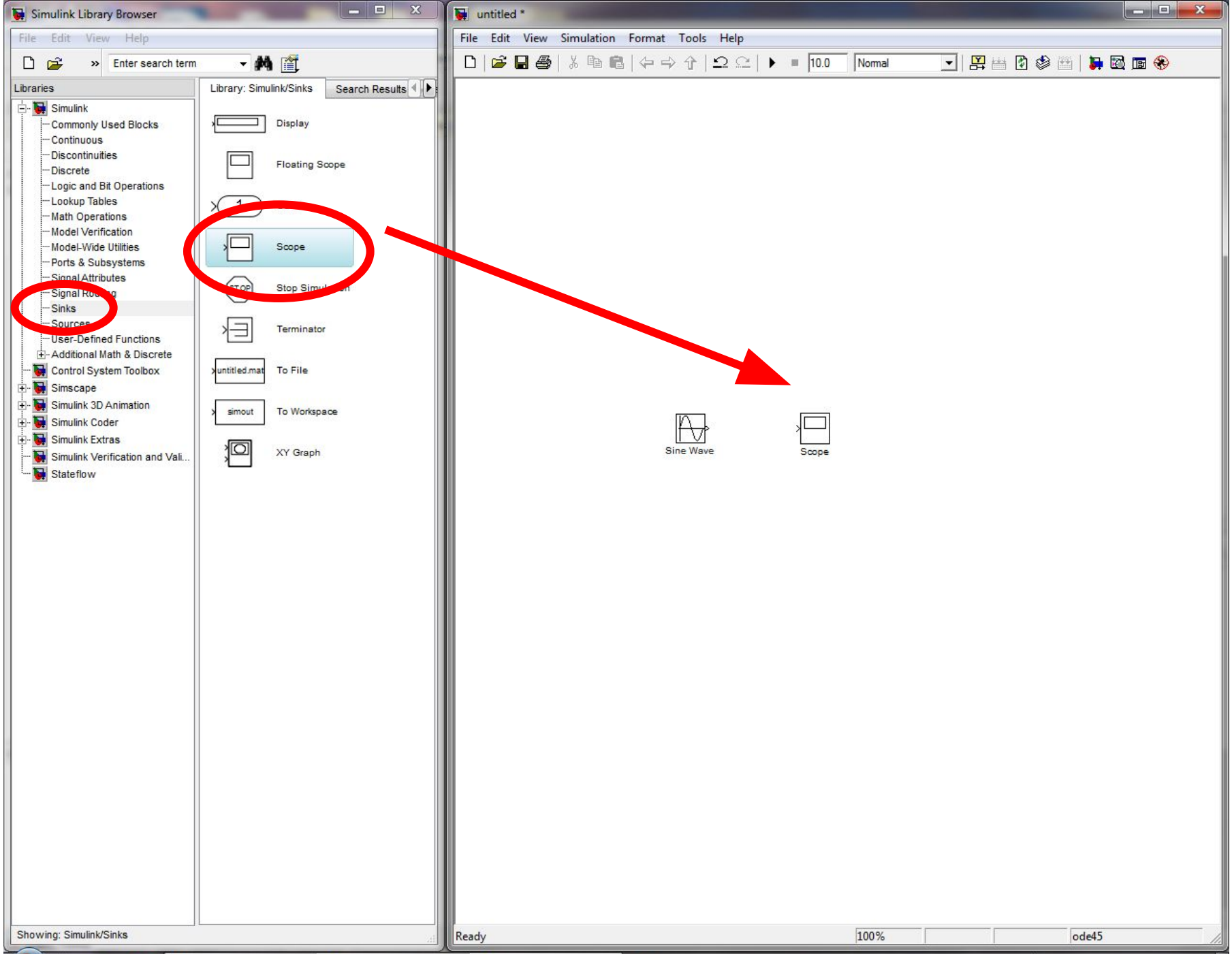
Simulink Library Browser
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Scope
Stop Simulation
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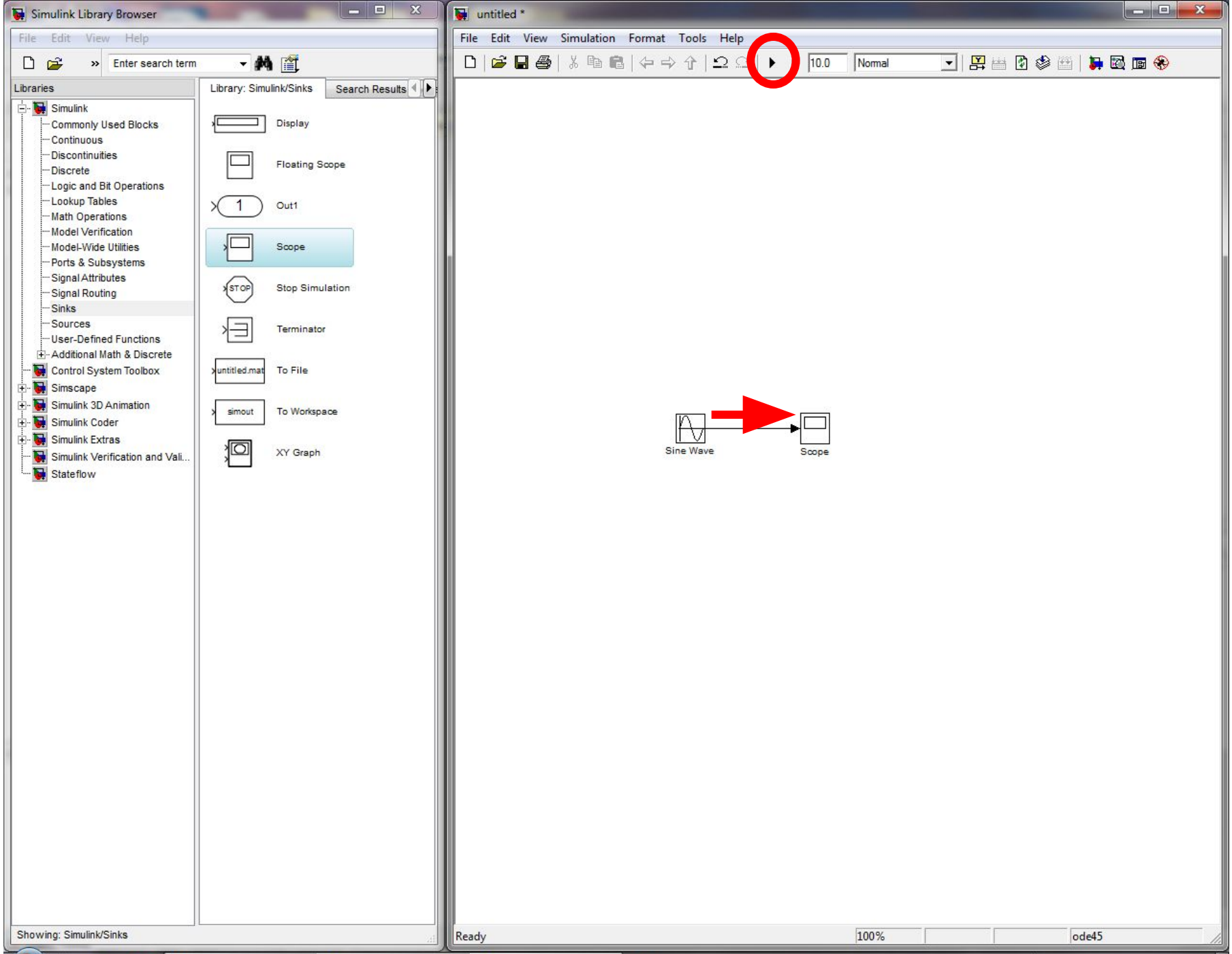
Simulink Library Browser
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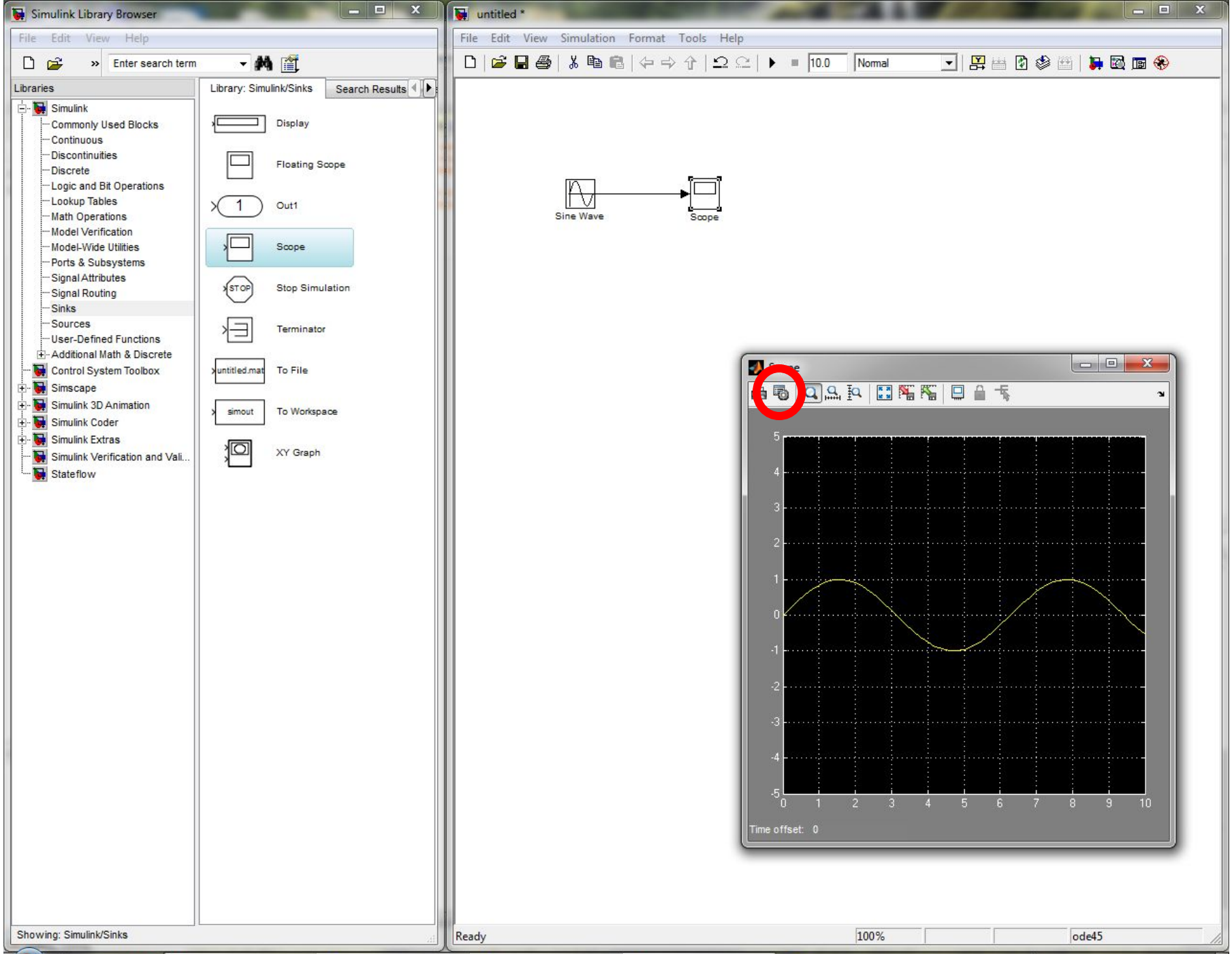
Simulink Library Browser
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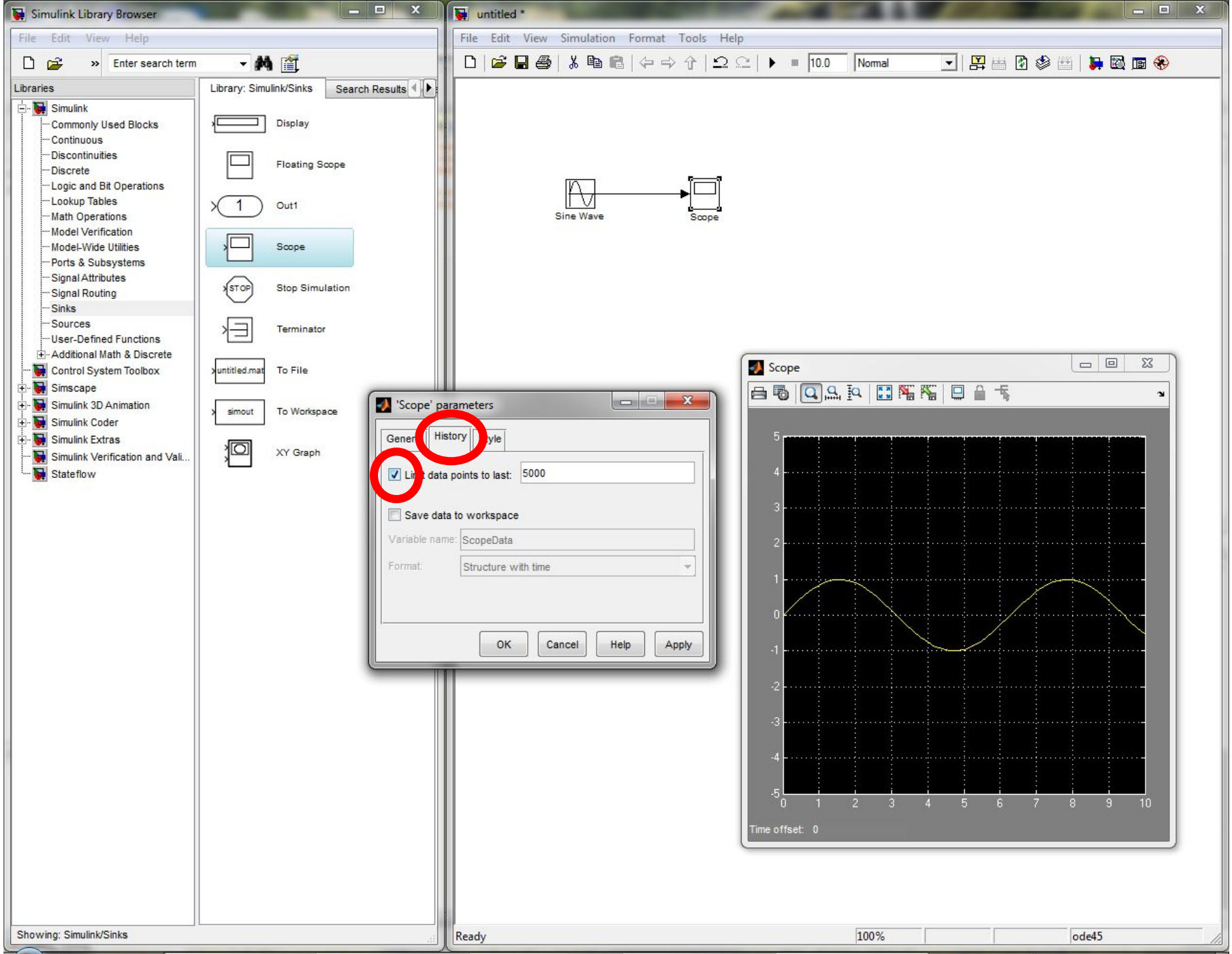
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Limit data points to last:
5000
Save data to workspace
Variable name:
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Format:
Structure with time
OK
Cancel
Help
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Time offset: 0
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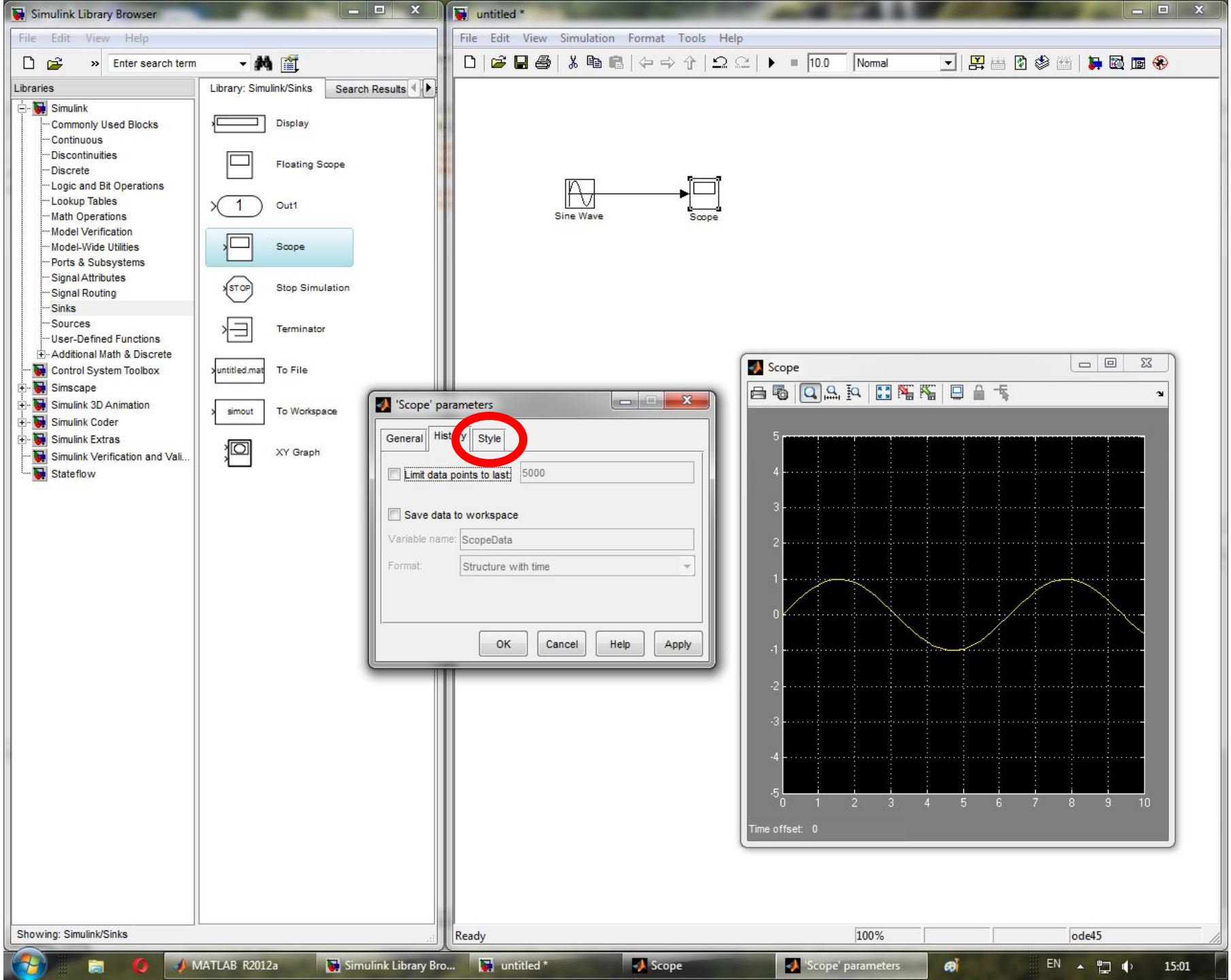
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Structure with time
OK
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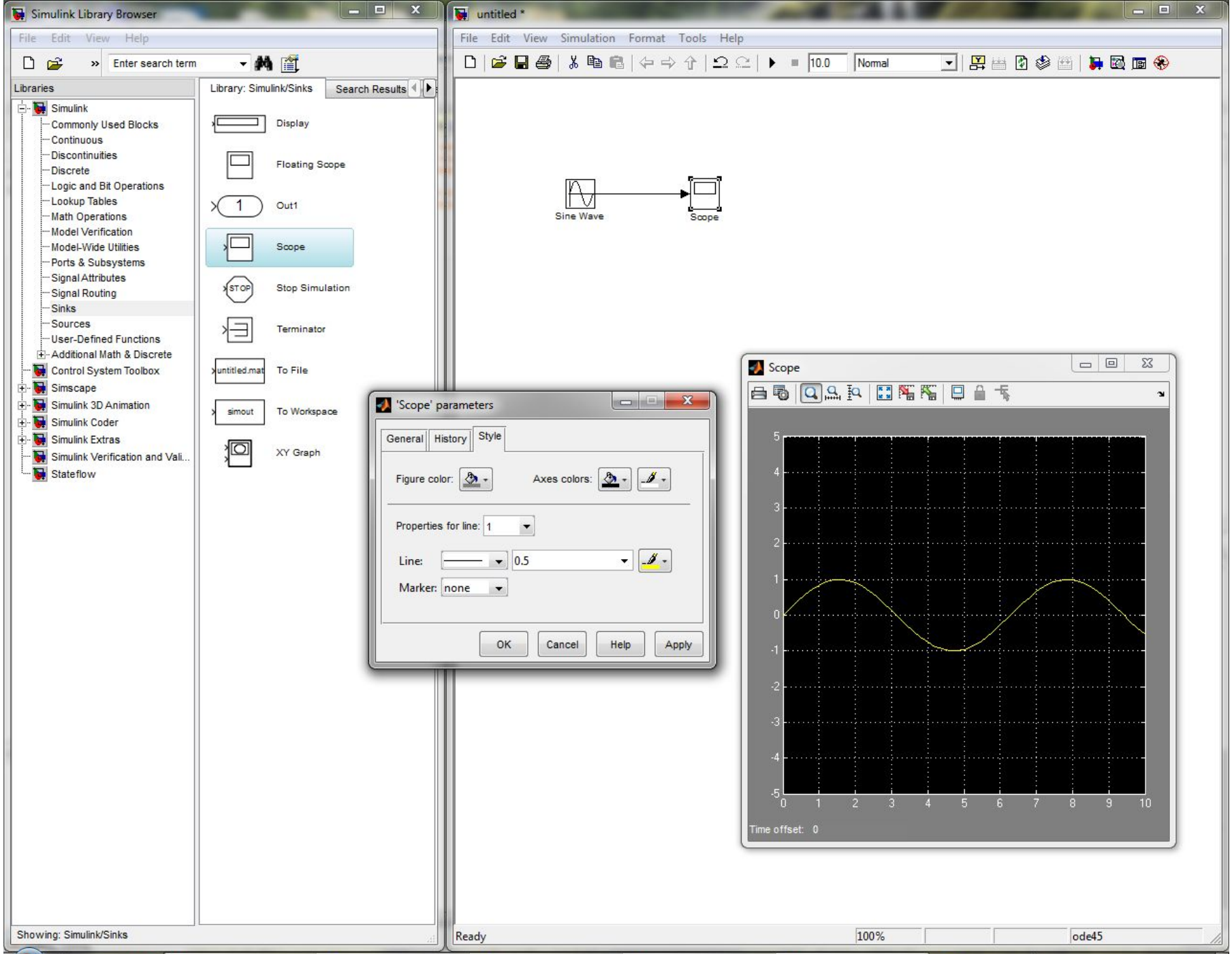
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General
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Figure color:
Axes colors:
Properties for line: 1
Line:
0.5
Marker: none
OK
Cancel
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Time offset: 0
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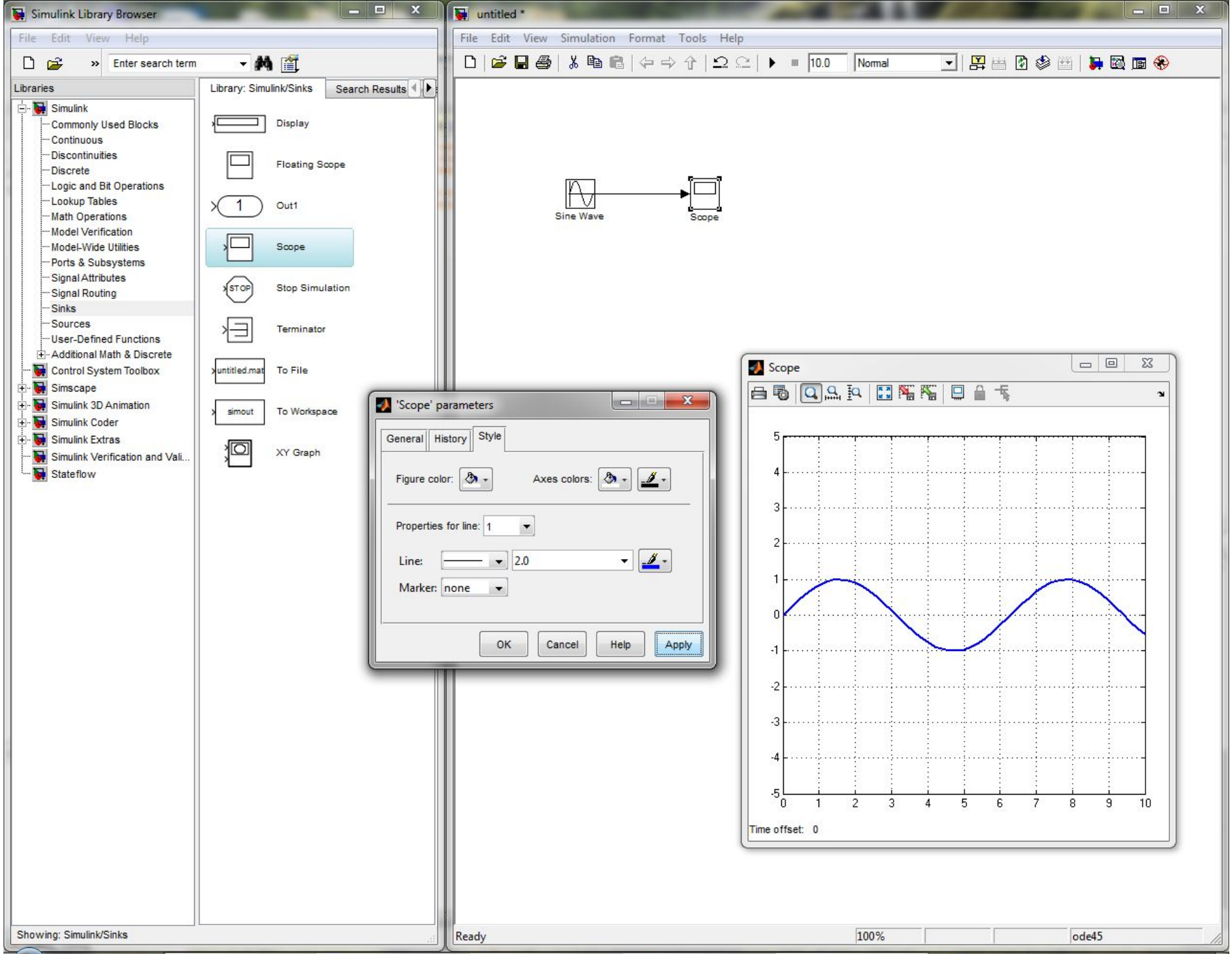
Simulink Library Browser
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Style
Figure color:
Axes colors:
Properties for line: 1
Line:
2.0
Marker: none
OK
Cancel
Help
Apply
Scope
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Time offset: 0
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'Scope' parameters
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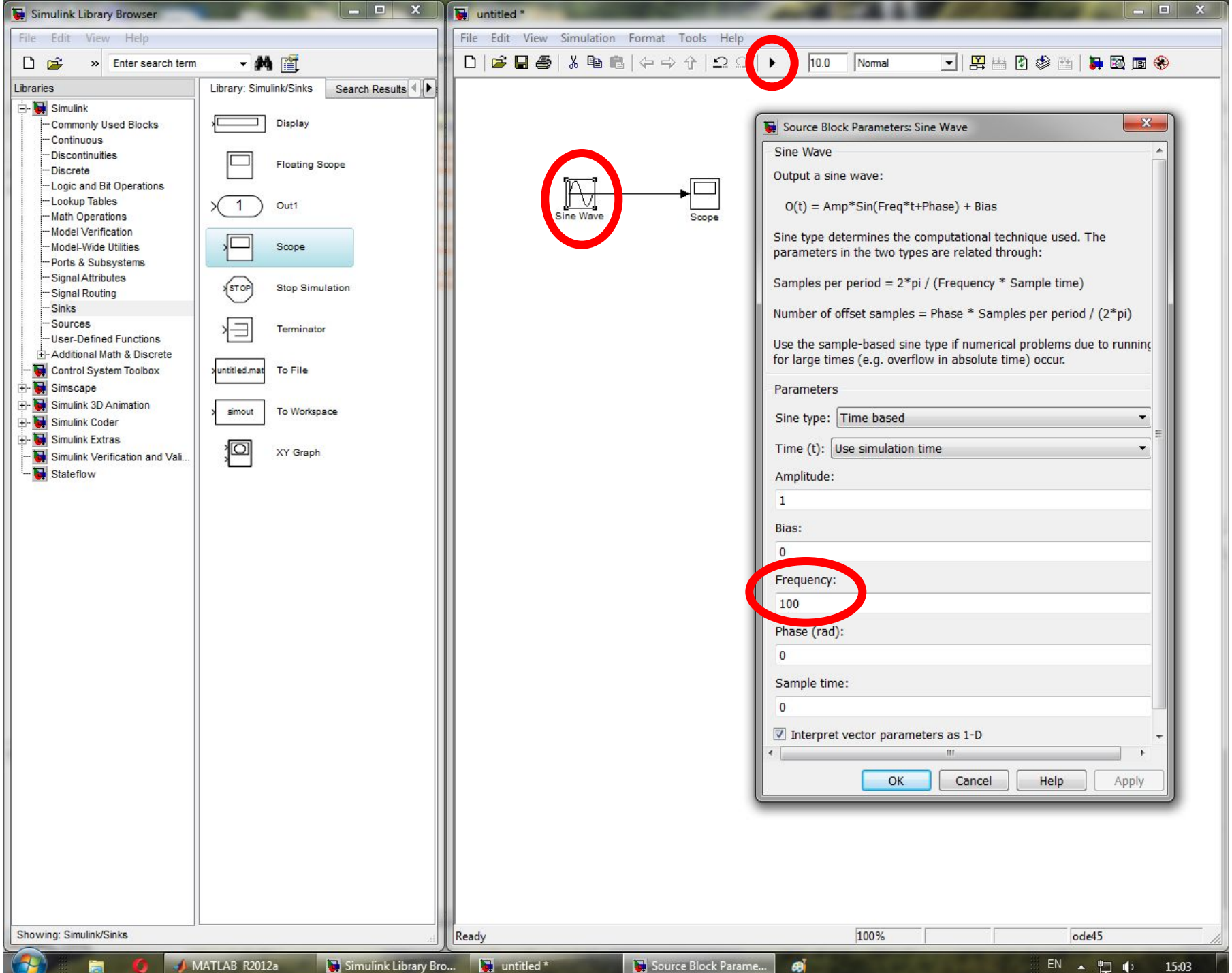
Simulink Library Browser
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Library: Simulink/Sinks
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Stop Simulation
Terminator
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Showing: Simulink/Sinks
untitled *
File Edit View Simulation Format Tools Help
10.0
Normal
Sine Wave
Scope
Source Block Parameters: Sine Wave
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
Frequency:
100
Phase (rad):
0
Sample time:
0
Interpret vector parameters as 1-D
OK
Cancel
Help
Apply
Ready
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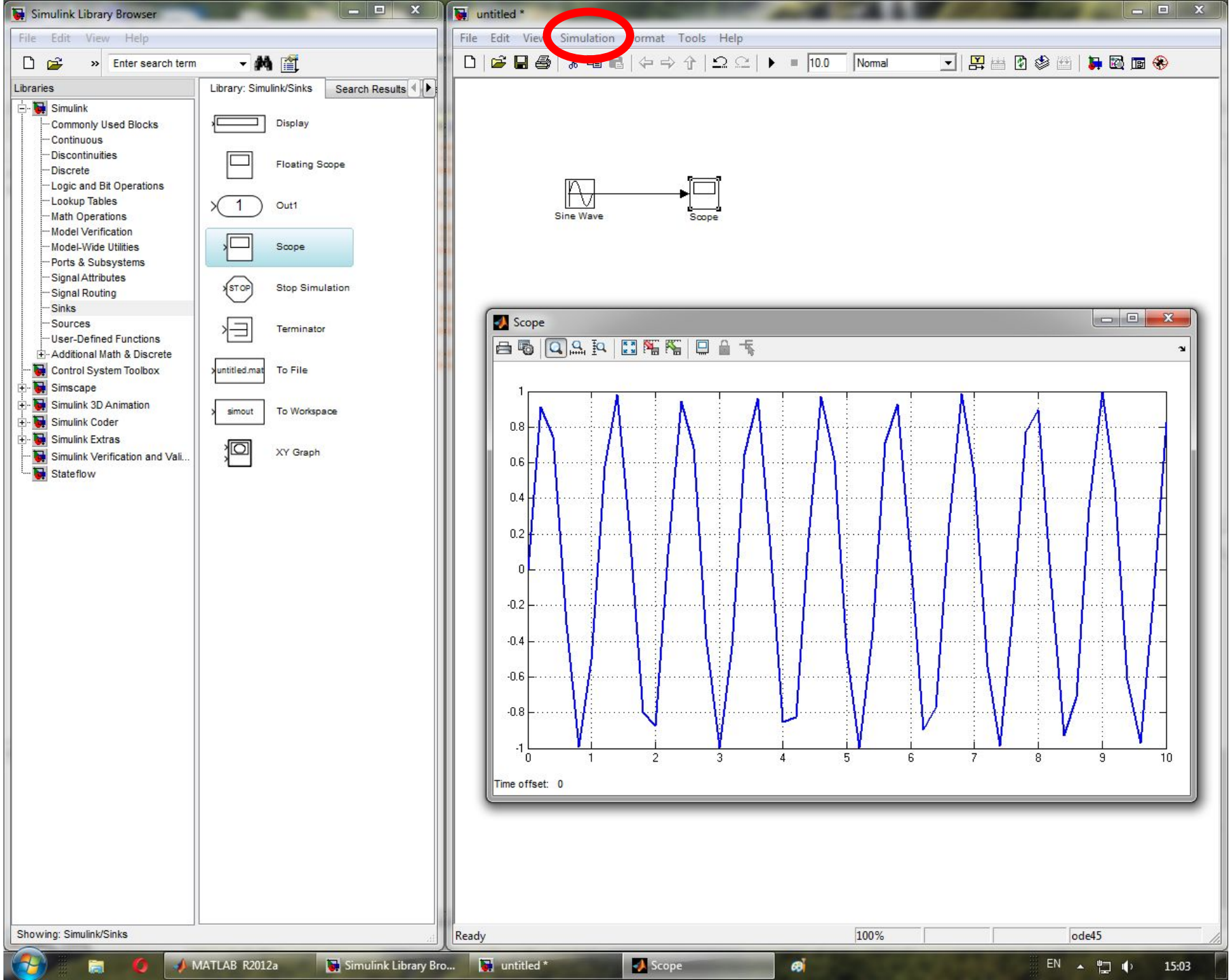
Simulink Library Browser
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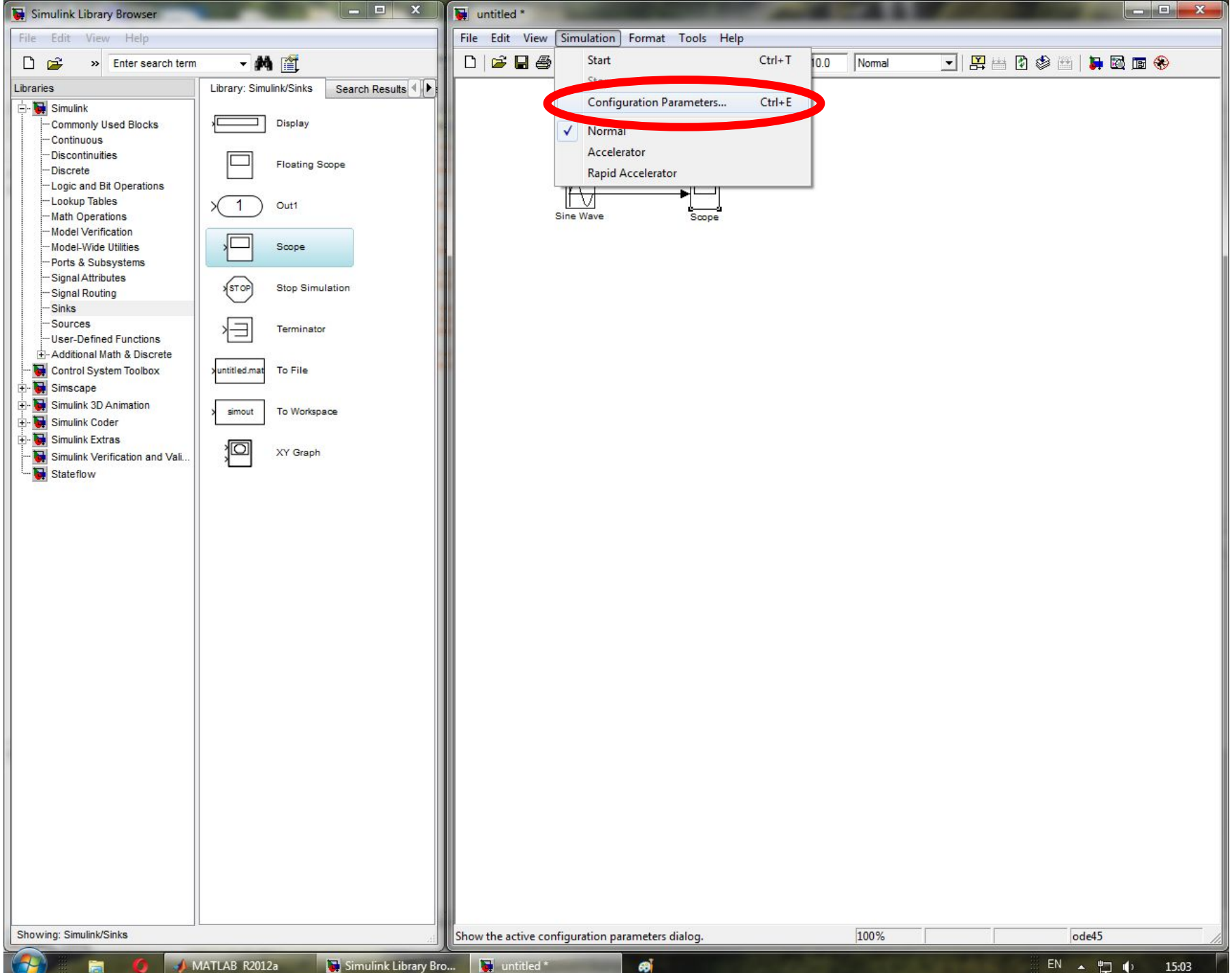
Simulink Library Browser
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Scope
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To File
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File Edit View Simulation Format Tools Help
Start Ctrl+T
Configuration Parameters... Ctrl+E
Normal
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Scope
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100%
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MATLAB R2012a
Simulink Library Bro...
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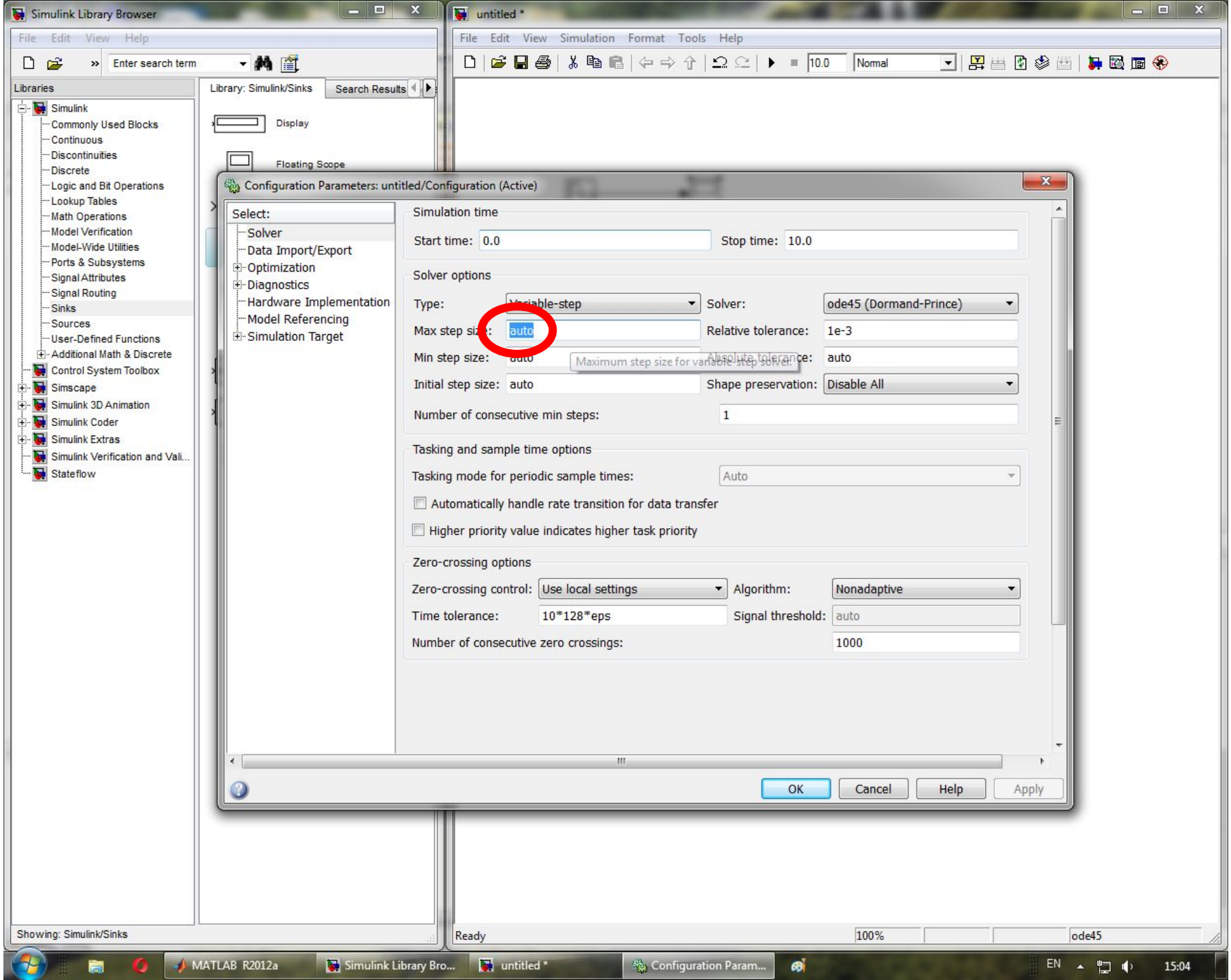
Simulink Library Browser
File Edit View Help
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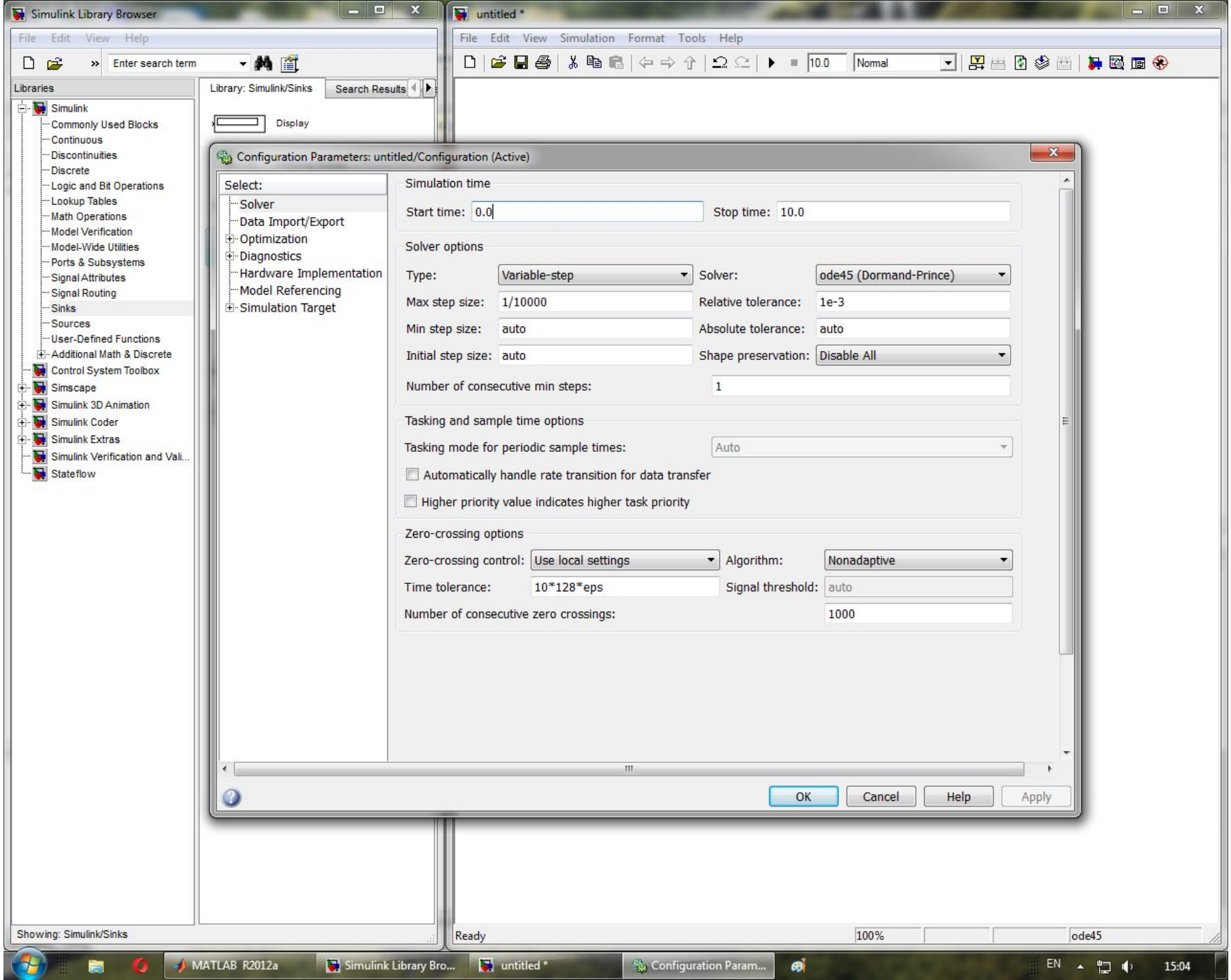
Library: Simulink/Sinks
Search Results
Display
Floating Scope
Showing: Simulink/Sinks
untitled *
File Edit View Simulation Format Tools Help
10.0
Normal
Ready
100%
ode45
Configuration Parameters: untitled/Configuration (Active)
Select:
Solver
Data Import/Export
Optimization
Diagnostics
Hardware Implementation
Model Referencing
Simulation Target
Simulation time
Start time: 0.0
Stop time: 10.0
Solver options
Type: Variable-step
Solver: ode45 (Dormand-Prince)
Max step size: auto
Relative tolerance: 1e-3
Min step size: auto
Absolute tolerance: auto
Maximum step size for variable-step solver.
Initial step size: auto
Shape preservation: Disable All
Number of consecutive min steps: 1
Tasking and sample time options
Tasking mode for periodic sample times: Auto
Automatically handle rate transition for data transfer
Higher priority value indicates higher task priority
Zero-crossing options
Zero-crossing control: Use local settings
Algorithm: Nonadaptive
Time tolerance: 10*128*eps
Signal threshold: auto
Number of consecutive zero crossings: 1000
OK
Cancel
Help
Apply
MATLAB R2012a
Simulink Library Bro...
untitled *
Configuration Param...
EN
15:04


Simulink Library Browser
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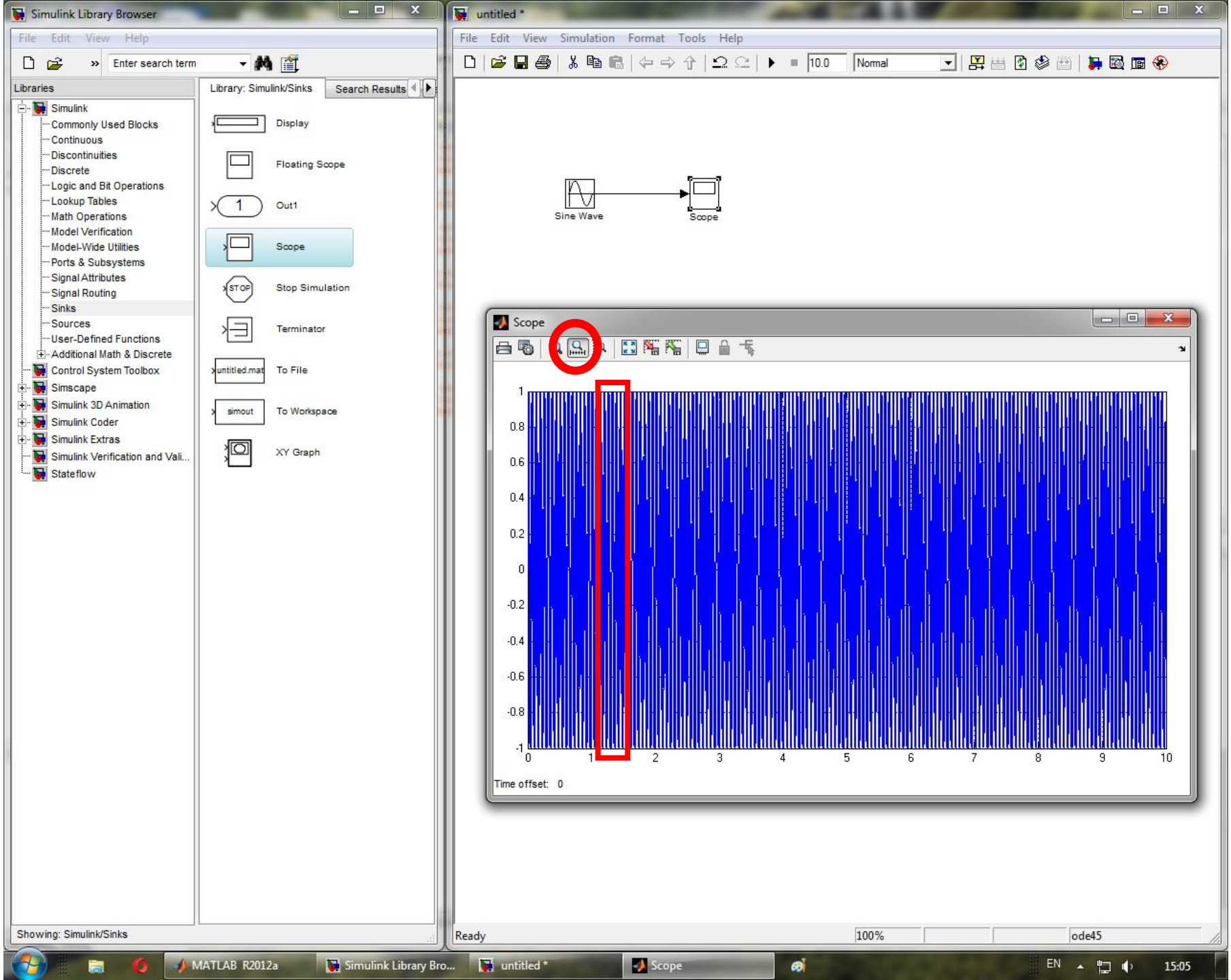
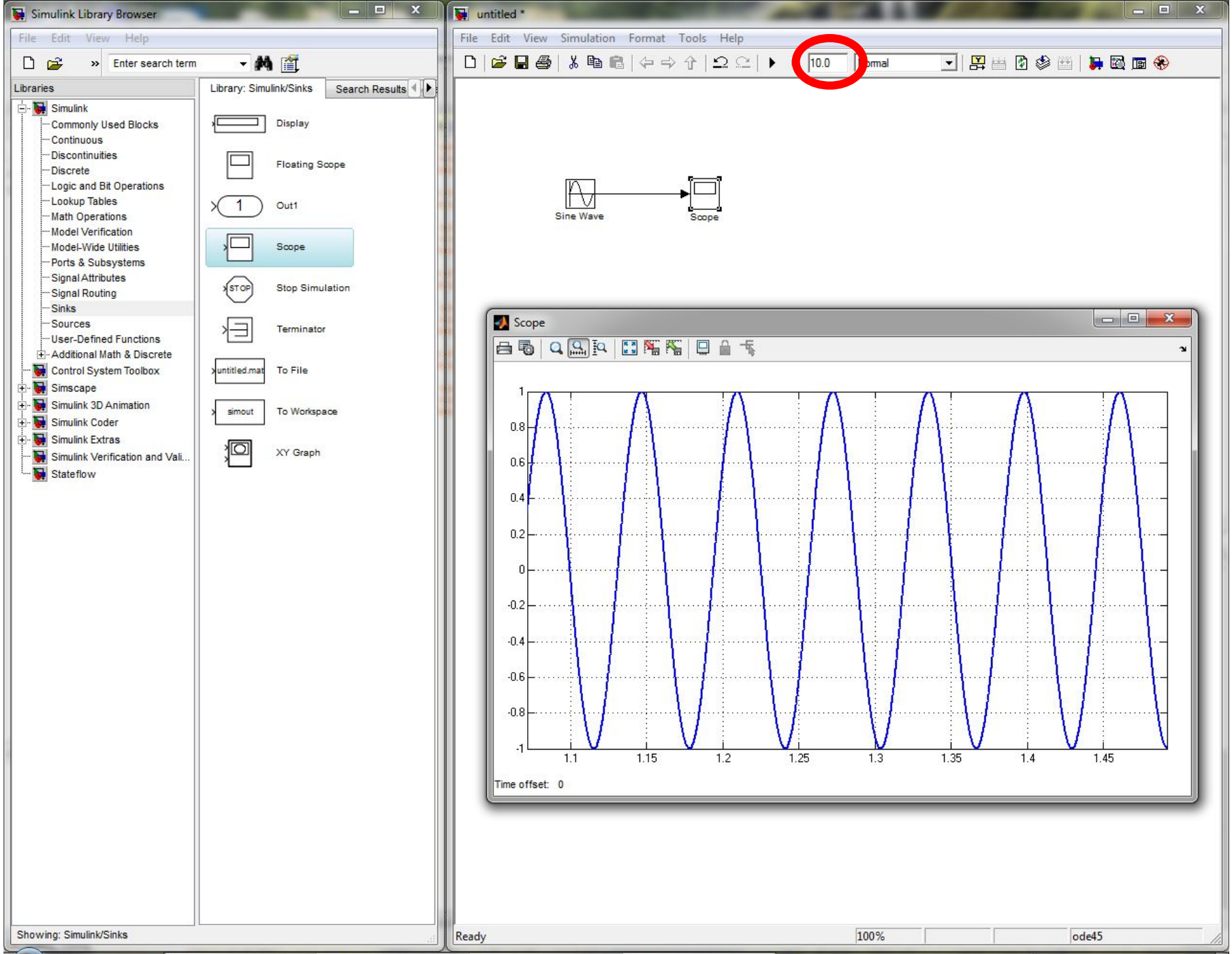
Simulink 3D Animation
Simulink Coder
Simulink Extras
Simulink Verification and Vali...
Stateflow
Library: Simulink/Sinks
Search Results
Display
Showing: Simulink/Sinks
untitled *
File Edit View Simulation Format Tools Help
10.0
Normal
Ready
100%
ode45
Configuration Parameters: untitled/Configuration (Active)
Select:
Solver
Data Import/Export
Optimization
Diagnostics
Hardware Implementation
Model Referencing
Simulation Target
Simulation time
Start time: 0.0
Stop time: 10.0
Solver options
Type: Variable-step
Solver: ode45 (Dormand-Prince)
Max step size: 1/10000
Relative tolerance: 1e-3
Min step size: auto
Absolute tolerance: auto
Initial step size: auto
Shape preservation: Disable All
Number of consecutive min steps: 1
Tasking and sample time options
Tasking mode for periodic sample times: Auto
Automatically handle rate transition for data transfer
Higher priority value indicates higher task priority
Zero-crossing options
Zero-crossing control: Use local settings
Algorithm: Nonadaptive
Time tolerance: 10*128*eps
Signal threshold: auto
Number of consecutive zero crossings: 1000
OK
Cancel
Help
Apply
MATLAB R2012a
Simulink Library Bro...
untitled *
Configuration Param...
EN
15:04


Simulink Library Browser
File Edit View Help
Enter search term
Libraries
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete
Control System Toolbox
Simscape
Simulink 3D Animation
Simulink Coder
Simulink Extras
Simulink Verification and Vali...
Stateflow
Library: Simulink/Sinks
Search Results
Display
Floating Scope
Out1
Scope
Stop Simulation
Terminator
To File
To Workspace
XY Graph
Showing: Simulink/Sinks
untitled *
File Edit View Simulation Format Tools Help
10.0
Normal
Sine Wave
Scope
Scope
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 1 2 3 4 5 6 7 8 9 10
Time offset: 0
Ready
100%
ode45
MATLAB R2012a
Simulink Library Bro...
untitled *
Scope
EN
15:05


Simulink Library Browser
File Edit View Help
Enter search term
Libraries
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
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User-Defined Functions
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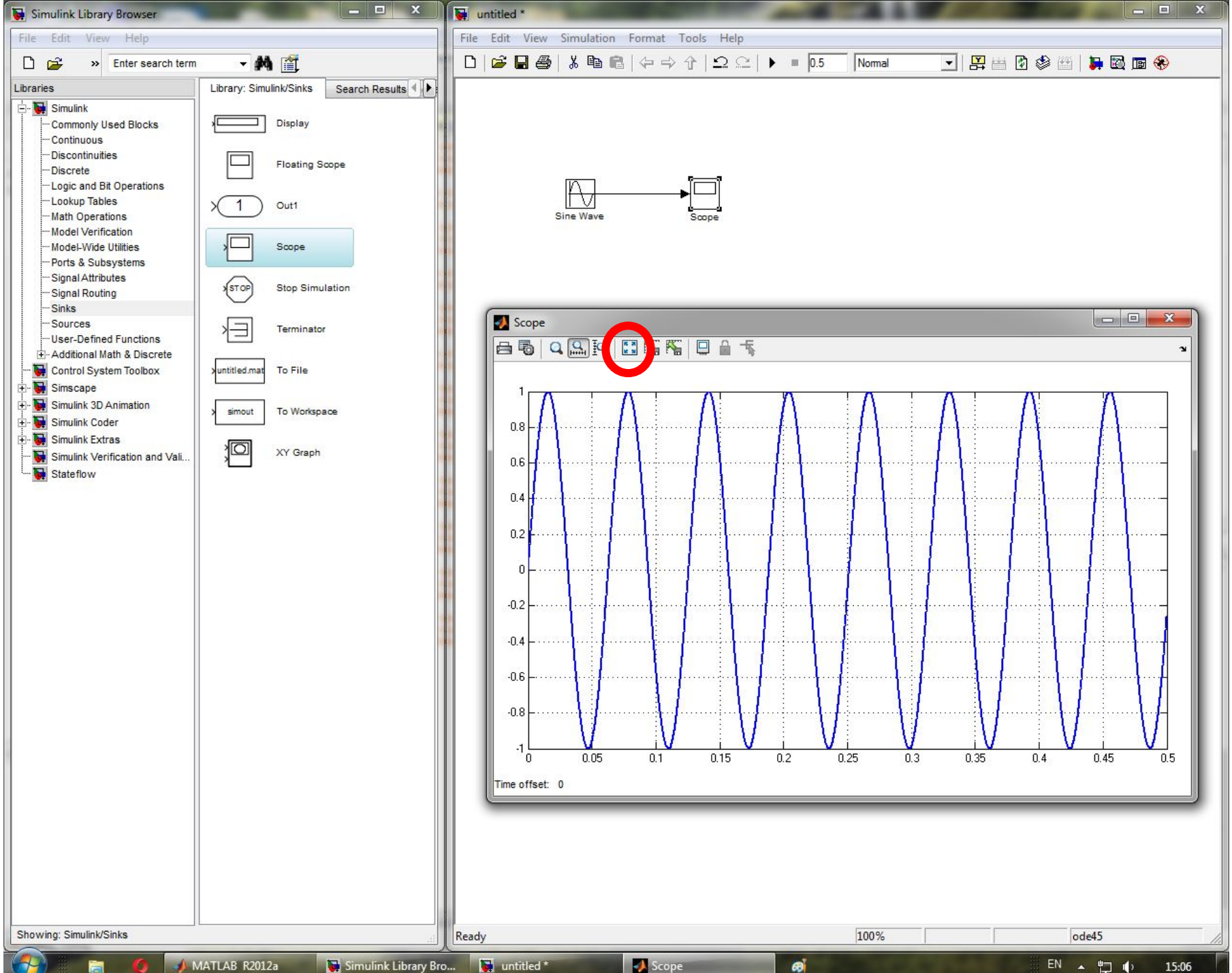
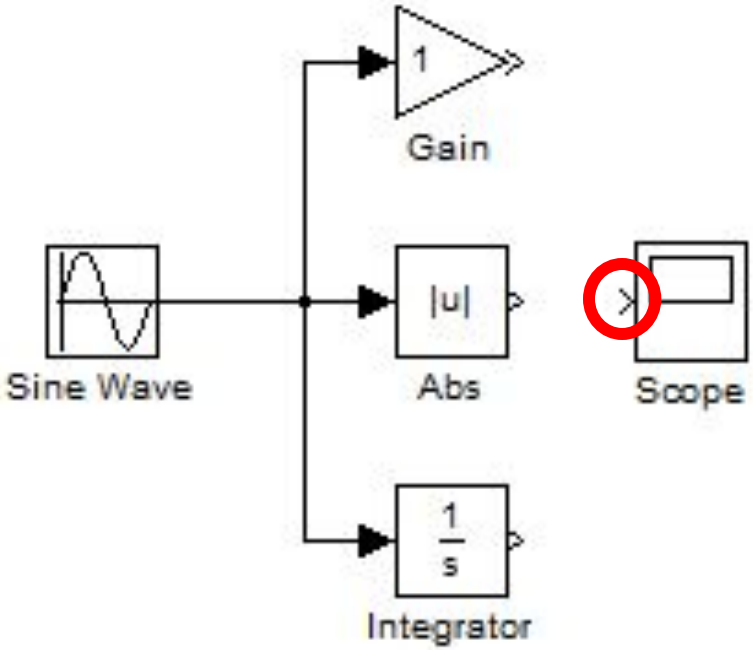
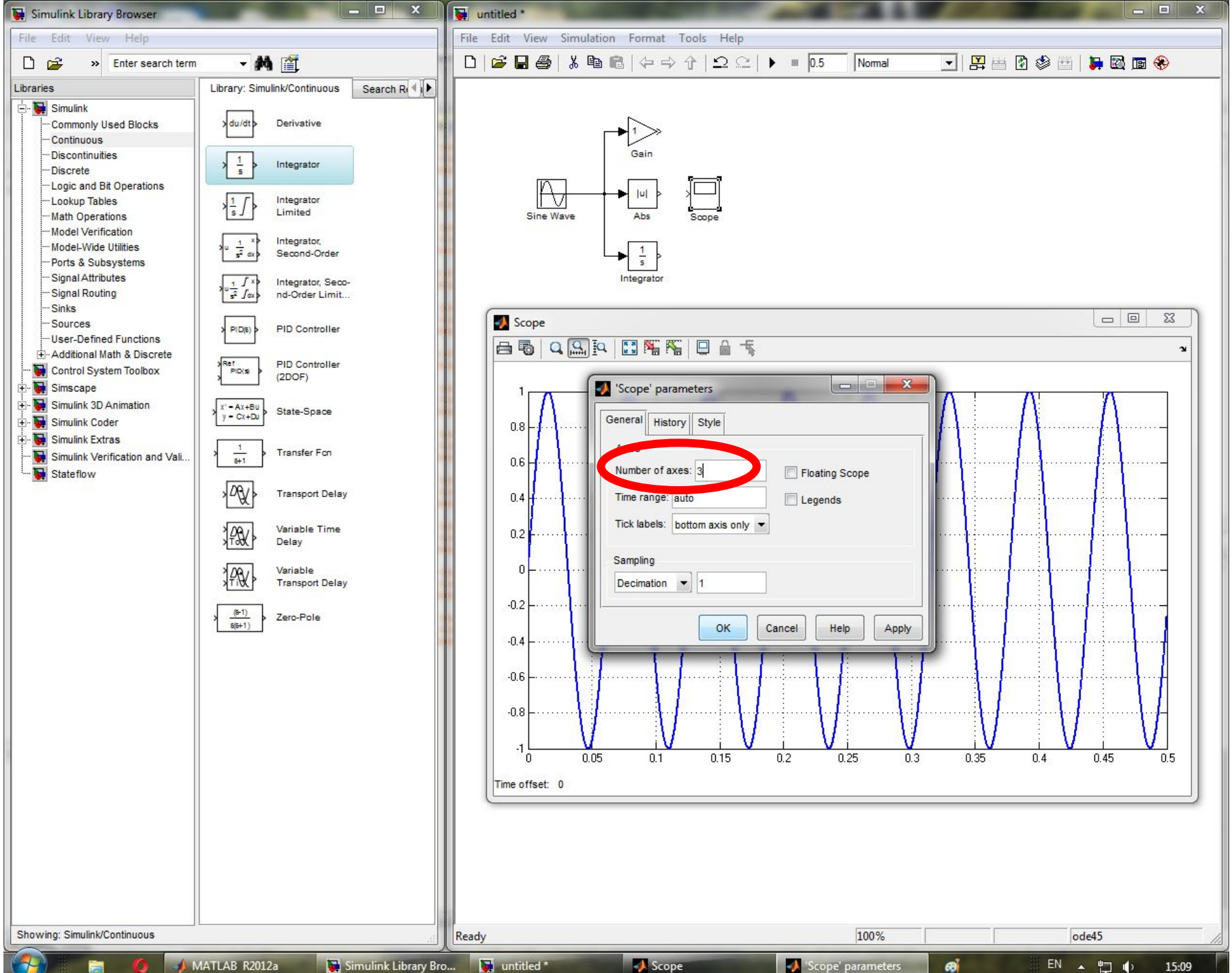
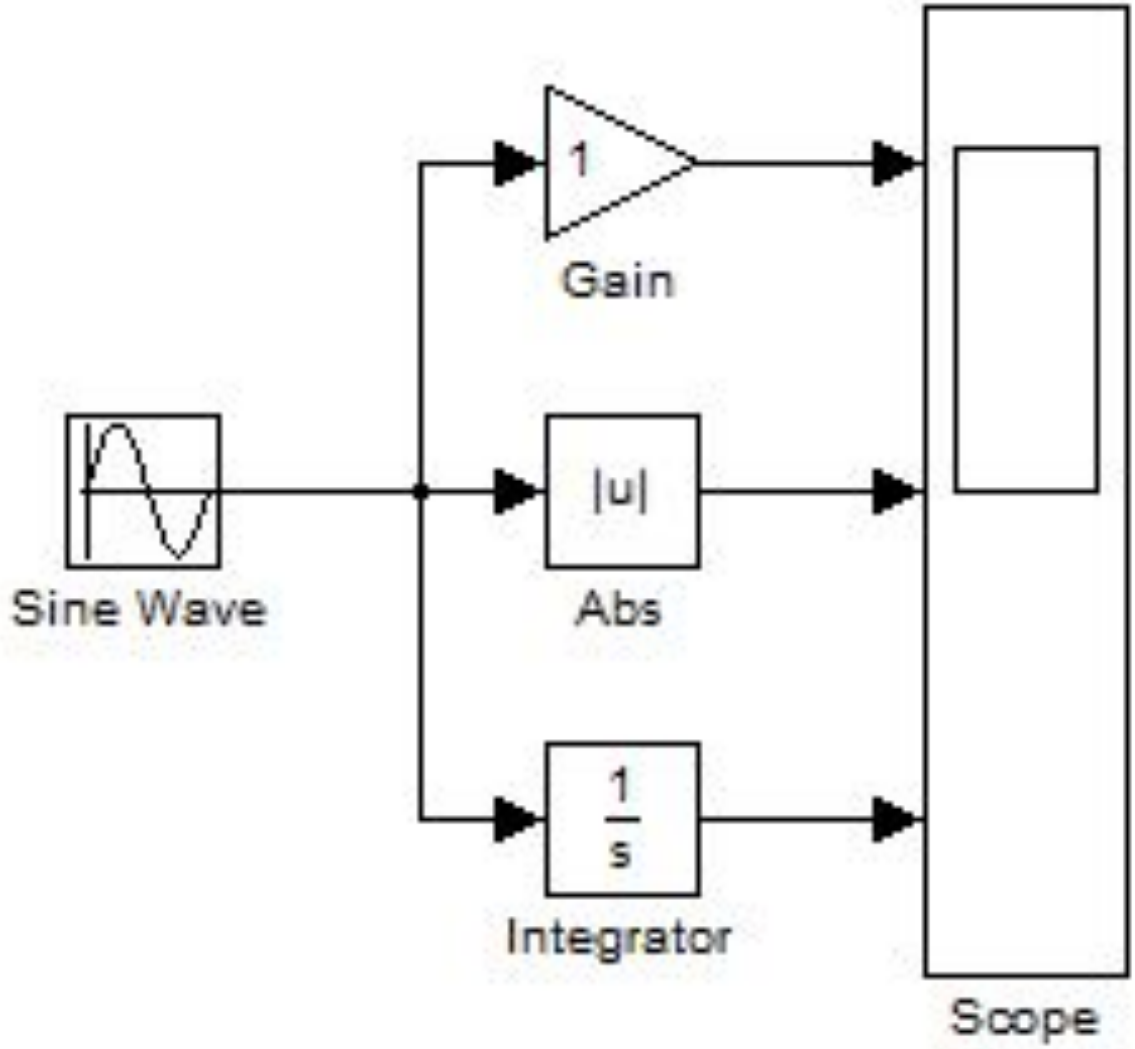
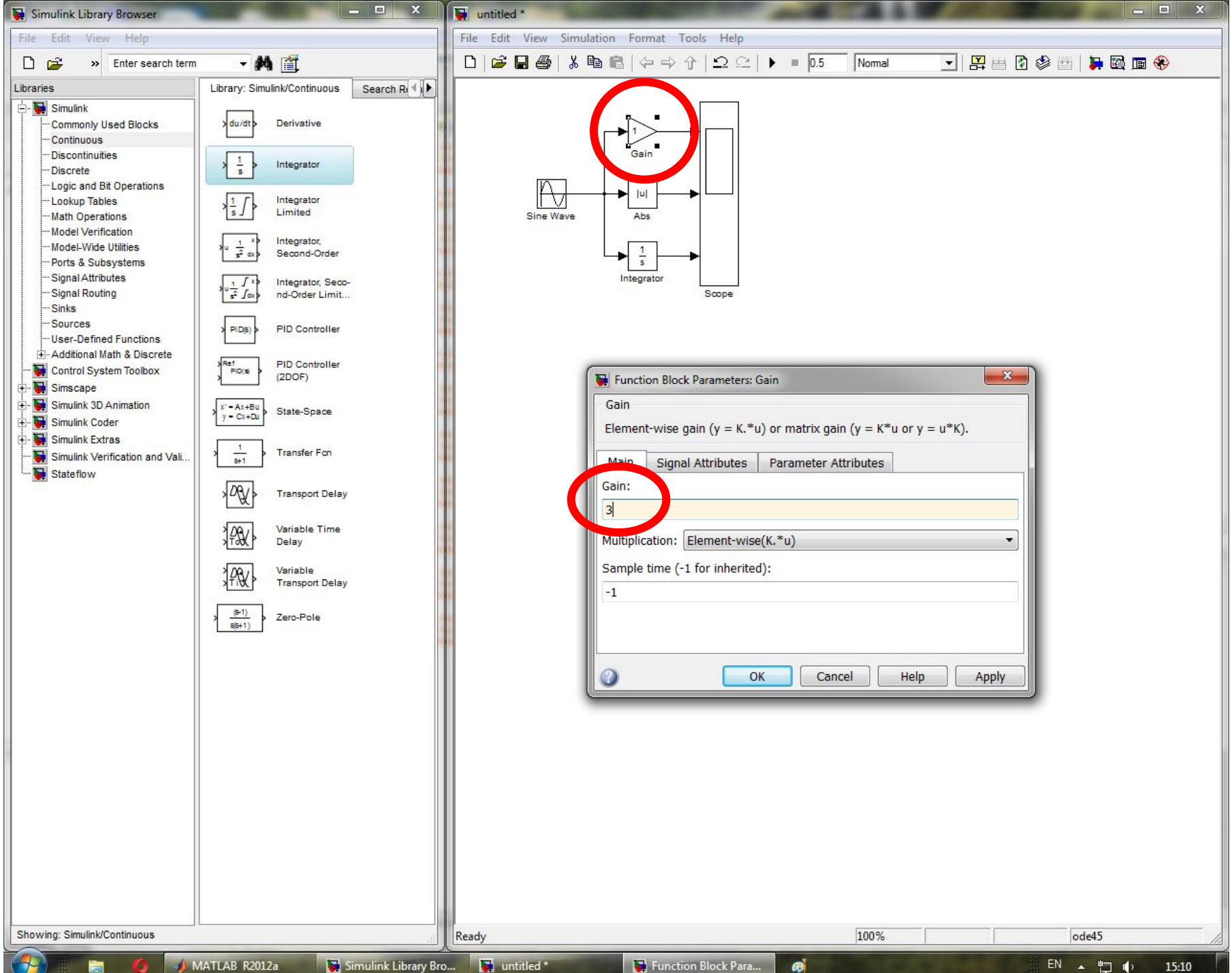
Simscape
Simulink 3D Animation
Simulink Coder
Simulink Extras
Simulink Verification and Vali...
Stateflow
Library: Simulink/Sinks
Search Results
Display
Floating Scope
Out1
Scope
Stop Simulation
Terminator
To File
To Workspace
XY Graph
Showing: Simulink/Sinks
untitled *
File Edit View Simulation Format Tools Help
10.0
Sine Wave
Scope
Scope
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
Time offset: 0
Ready
100%
ode45
MATLAB R2012a
Simulink Library Bro...
untitled *
Scope
EN
15:05


Simulink Library Browser
File Edit View Help
Enter search term
Libraries
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete
Control System Toolbox
Simscape
Simulink 3D Animation
Simulink Coder
Simulink Extras
Simulink Verification and Vali...
Stateflow
Library: Simulink/Sinks
Search Results
Display
Floating Scope
Out1
Scope
Stop Simulation
Terminator
To File
To Workspace
XY Graph
Showing: Simulink/Sinks
untitled *
File Edit View Simulation Format Tools Help
0.5
Normal
Sine Wave
Scope
Scope
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5
Time offset: 0
Ready
100%
ode45
MATLAB R2012a
Simulink Library Bro...
untitled *
Scope
EN
15:06


1
Gain
Sine Wave
|u|
Abs
Scope
1
s
Integrator


Simulink Library Browser
File Edit View Help
Enter search term
Libraries
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete
Control System Toolbox
Simscape
Simulink 3D Animation
Simulink Coder
Simulink Extras
Simulink Verification and Vali...
Stateflow
Library: Simulink/Continuous
Search R
Derivative
Integrator
Integrator Limited
Integrator, Second-Order
Integrator, Seco-nd-Order Limit...
PID Controller
PID Controller (2DOF)
State-Space
Transfer Fcn
Transport Delay
Variable Time Delay
Variable Transport Delay
Zero-Pole
Showing: Simulink/Continuous
untitled *
File Edit View Simulation Format Tools Help
0.5
Normal
Gain
Sine Wave
Abs
Scope
Integrator
Scope
'Scope' parameters
General
History
Style
Number of axes: 3
Floating Scope
Time range: auto
Legends
Tick labels: bottom axis only
Sampling
Decimation 1
OK
Cancel
Help
Apply
Time offset: 0
Ready
100%
ode45
MATLAB R2012a
Simulink Library Bro...
untitled *
Scope
'Scope' parameters
EN
15:09


1
Gain
|u|
Abs
1
s
Integrator
Sine Wave
Scope


Simulink Library Browser
File Edit View Help
Enter search term
Libraries
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
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Additional Math & Discrete
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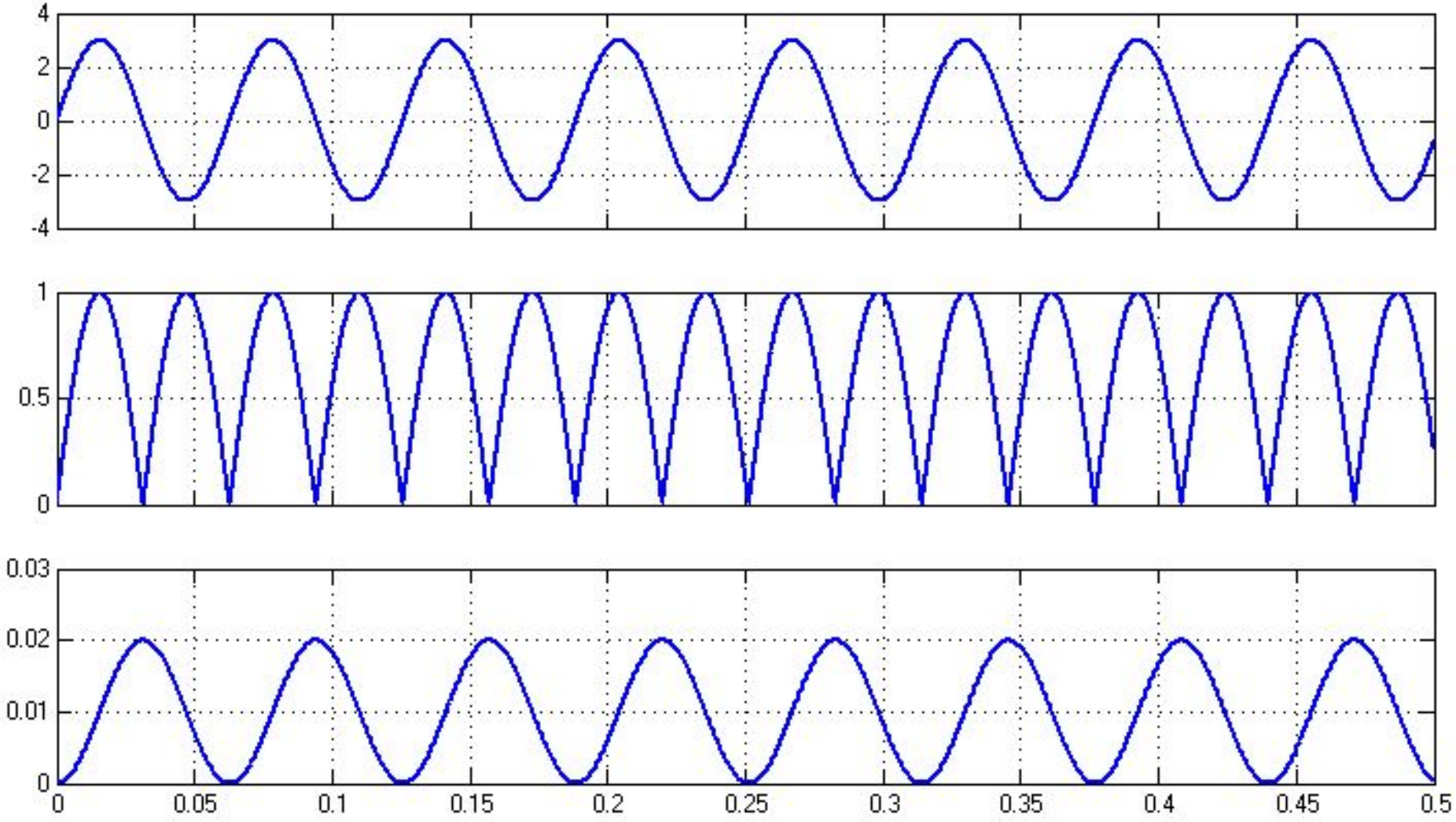
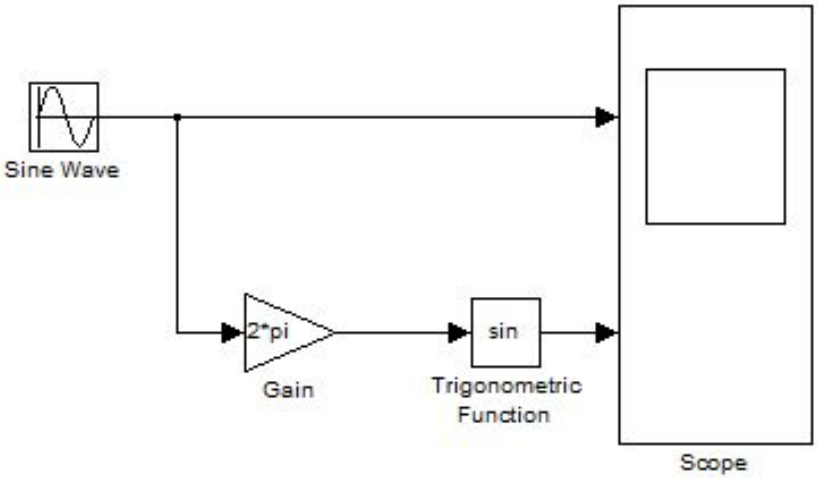
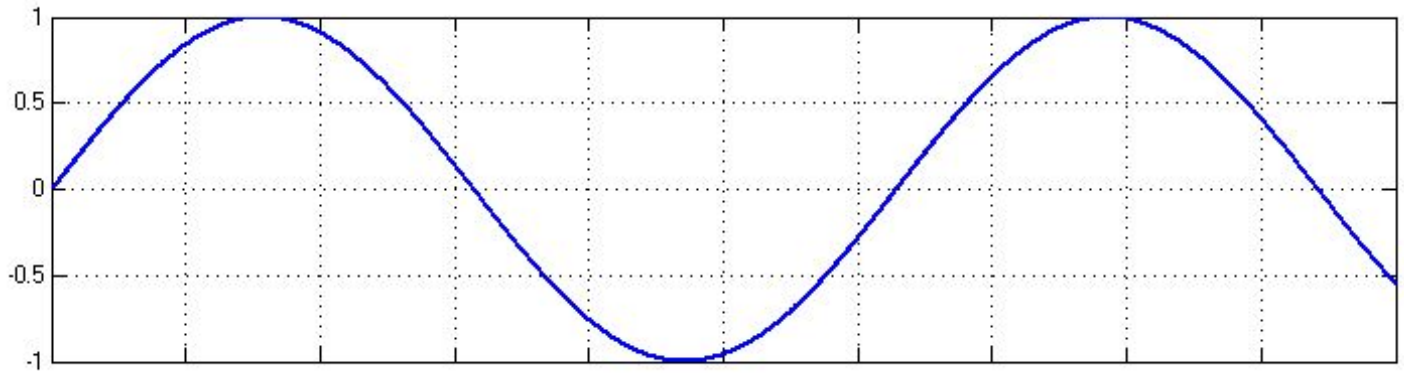
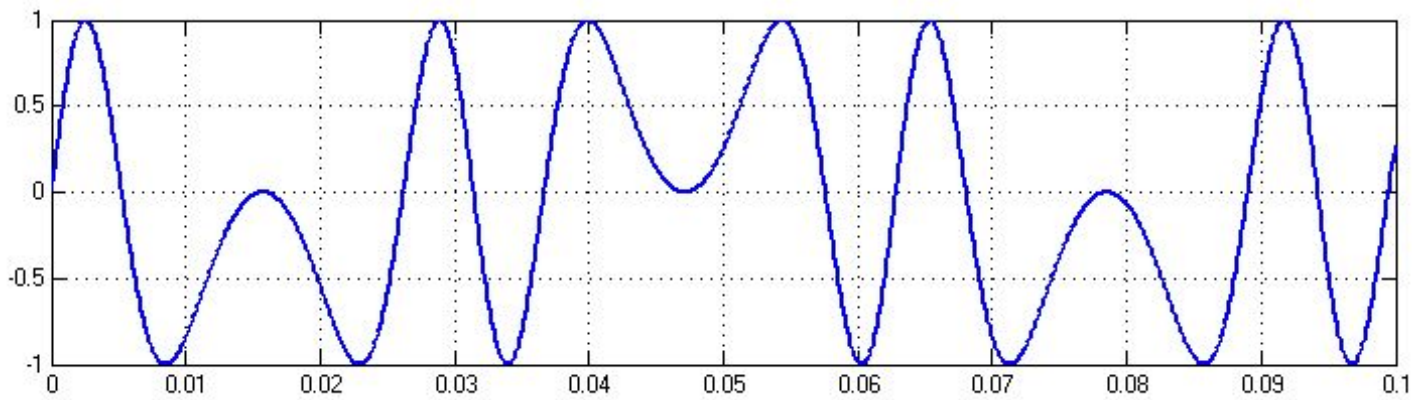
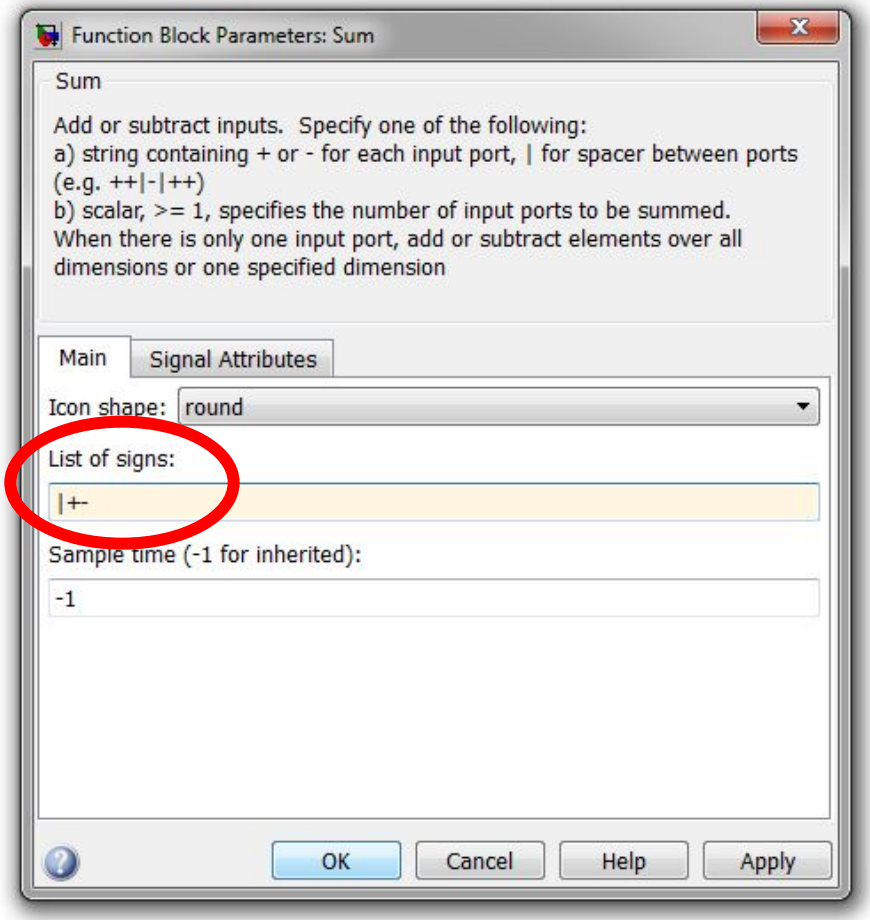
Simscape
Simulink 3D Animation
Simulink Coder
Simulink Extras
Simulink Verification and Vali...
Stateflow
Library: Simulink/Continuous
Search R
Derivative
Integrator
Integrator Limited
Integrator, Second-Order
Integrator, Second-Order Limit...
PID Controller
PID Controller (2DOF)
State-Space
Transfer Fcn
Transport Delay
Variable Time Delay
Variable Transport Delay
Zero-Pole
Showing: Simulink/Continuous
untitled *
File Edit View Simulation Format Tools Help
0.5
Normal
Gain
Sine Wave
Abs
Integrator
Scope
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:
3
Multiplication:
Element-wise(K.*u)
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply
Ready
100%
ode45
MATLAB R2012a
Simulink Library Bro...
untitled *
Function Block Para...
EN
15:10

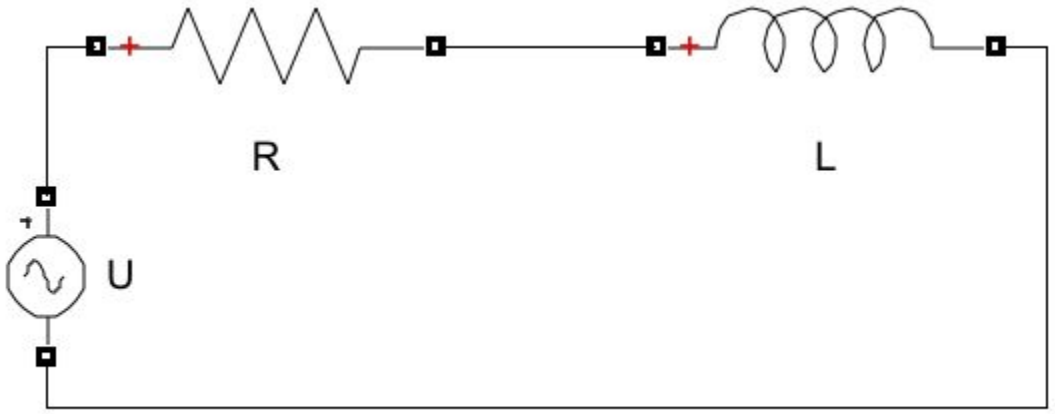

4
2
0
-2
-4
1
0.5
0
0.03
0.02
0.01
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5


Sine Wave
2*pi
Gain
sin
Trigonometric
Function
Scope


1
0.5
0
-0.5
-1


1
0.5
0
-0.5
-1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1


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):
-1
OK
Cancel
Help
Apply



$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$

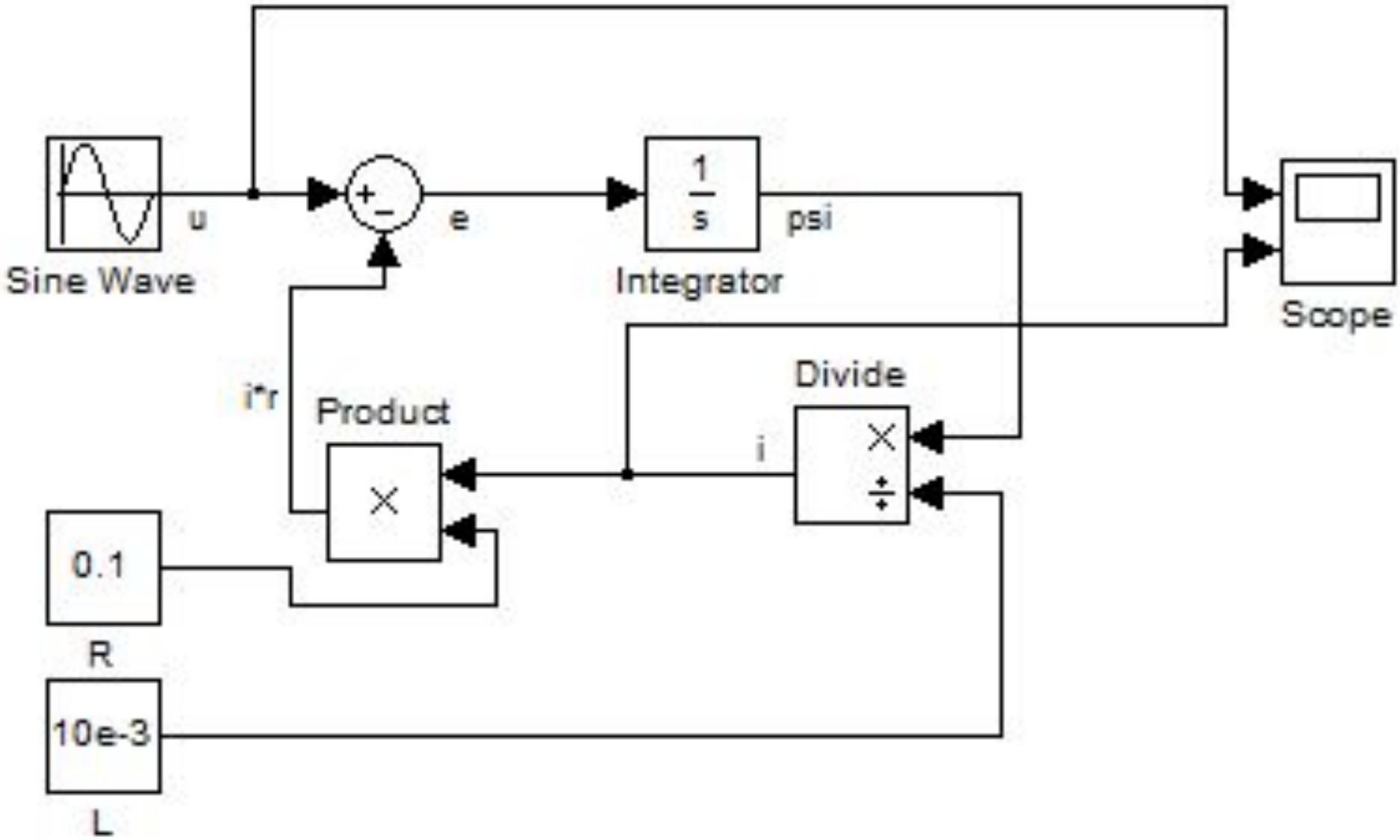
$$u(t) = e(t) + i(t) \cdot R$$

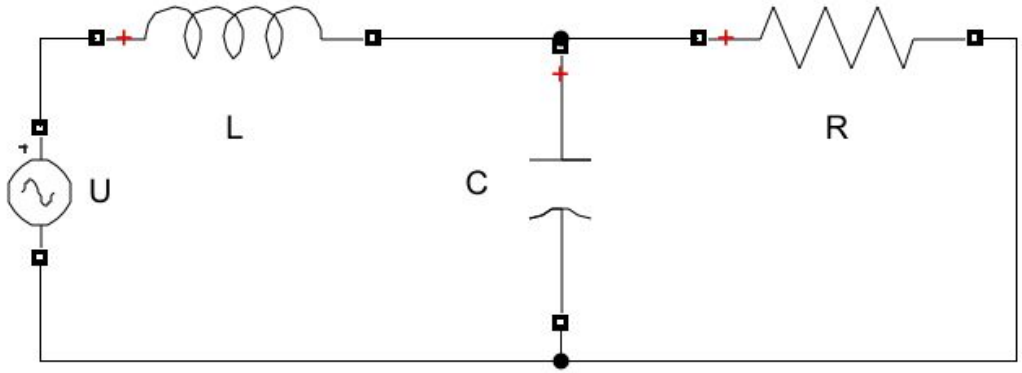
$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$


u
Sine Wave
e
1
s
psi
Integrator
Scope
i*r
Product
Divide
i
0.1
R
10e-3
L



$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$

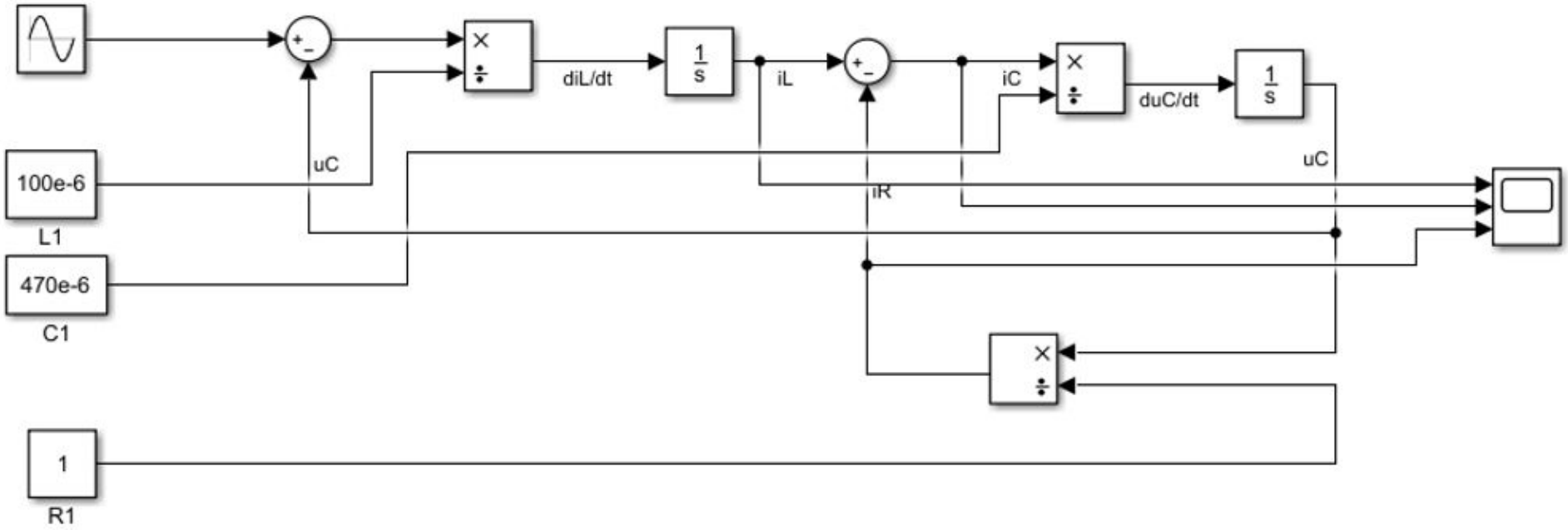
$$u(t) = e(t) + i(t) \cdot R$$

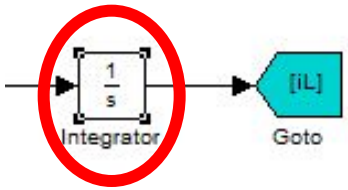
$$u(t) = e(t) + i(t) \cdot R$$

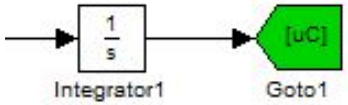
$$u(t) = e(t) + i(t) \cdot R$$

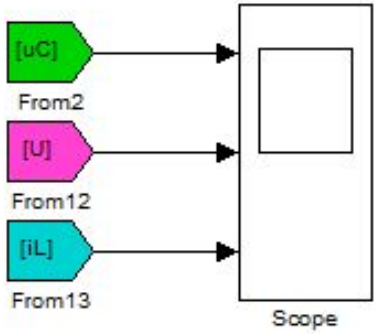
$$u(t) = e(t) + i(t) \cdot R$$

$$u(t) = e(t) + i(t) \cdot R$$


diL/dt
1
s
iL
iC
duC/dt
1
s
uC
uC
100e-6
L1
iR
470e-6
C1
1
R1







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:

0

☐ Show saturation port

☐ Show state port

Absolute tolerance:

auto

☐ Ignore limit and reset when linearizing

☑ Enable zero-crossing detection

State Name: (e.g., 'position')

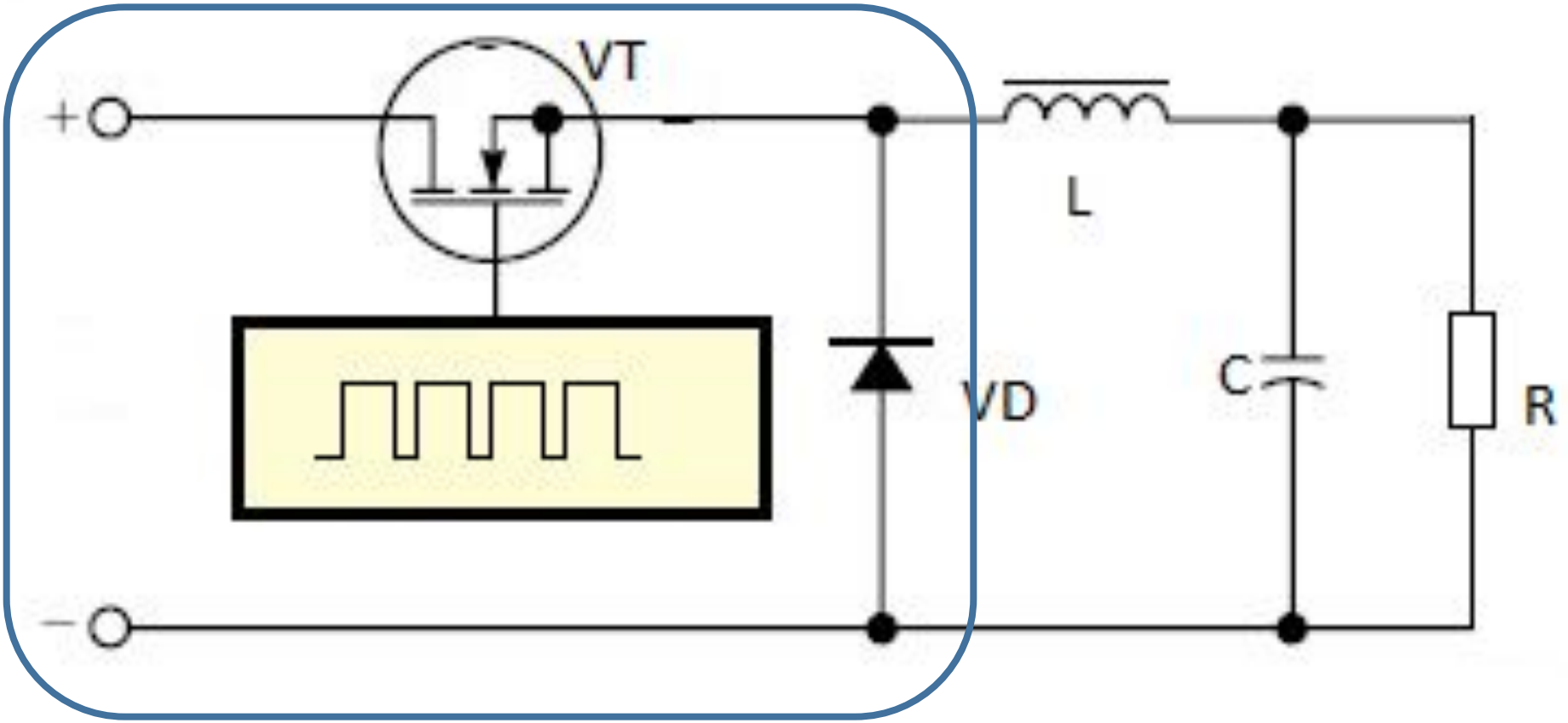
''

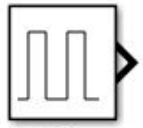
OK | Cancel | Help | Apply

Компьютерные технологии при разработке и проектировании электрооборудования автономных объектов

Лабораторная работа 1

Модель понижающего регулятора напряжения в среде Simulink


VT
+
−
L
VD
C
R



Pulse
Generator1

Source Block Parameters: Pulse Generator1

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, 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:

50

Period (secs):

5e-4

Pulse Width (% of period):

50

Phase delay (secs):

0

☑ Interpret vector parameters as 1-D

OK Cancel Help Apply

№ вар.	1	2	3	4	5	6
U_{in}, В	30	40	50	30	40	50
f, Гц	350	300	250	250	300	350
$R_н$, Ом	3.3	3.9	4.7	5.6	6.8	8.2

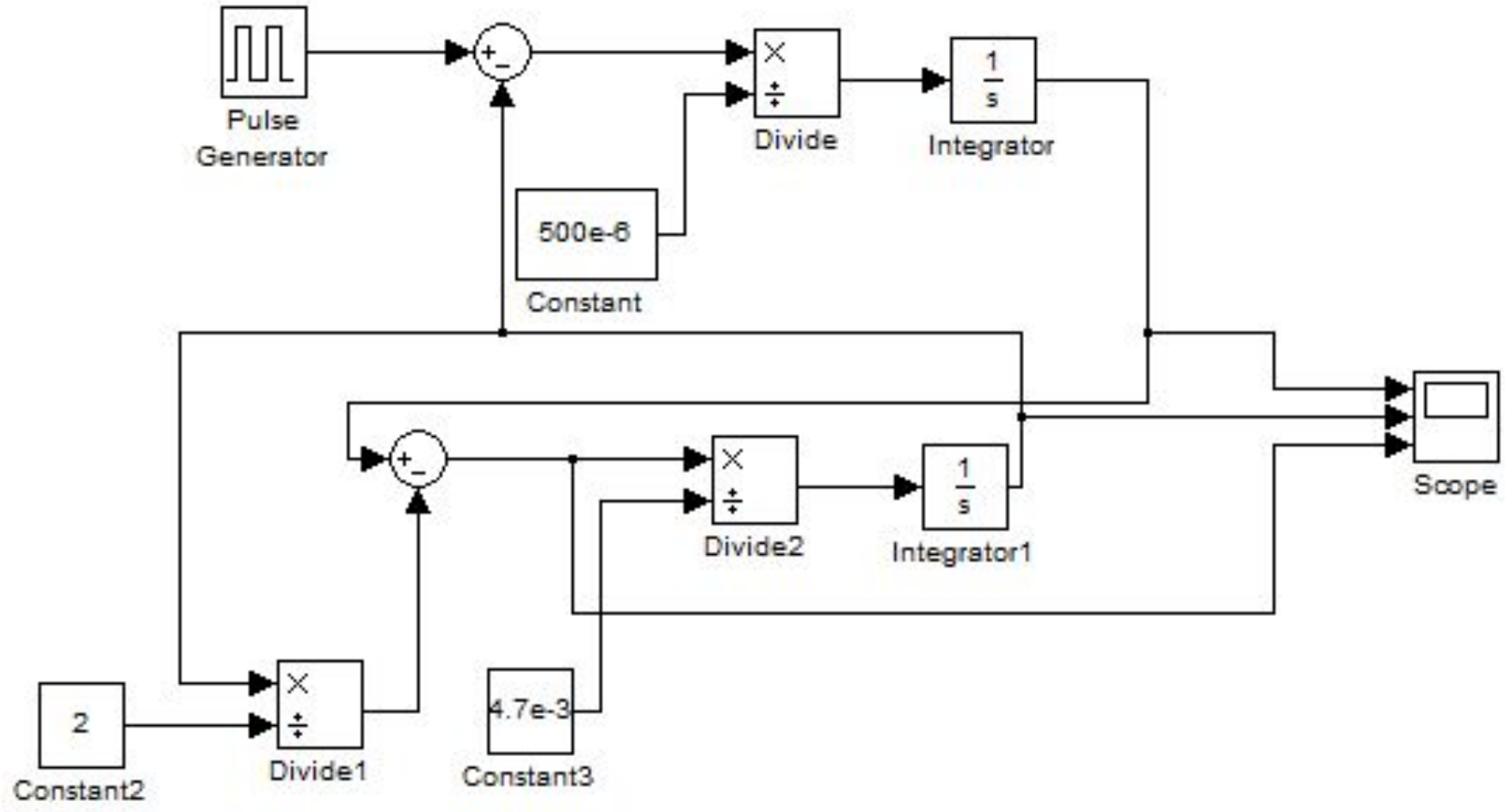
№ вар.	7	8	9	10	11	12	13	14	15
U_{in}, В	60	70	80	60	70	80	90	100	110
f, Гц	350	300	250	250	300	350	350	300	250
$R_н$, Ом	3.3	3.9	4.7	5.6	6.8	8.2	5.6	6.8	8.2

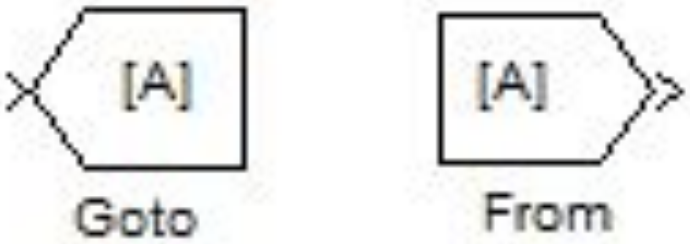
U_{in} – входное напряжение регулятора; f – частота переключения ключа;
R – сопротивление нагрузки

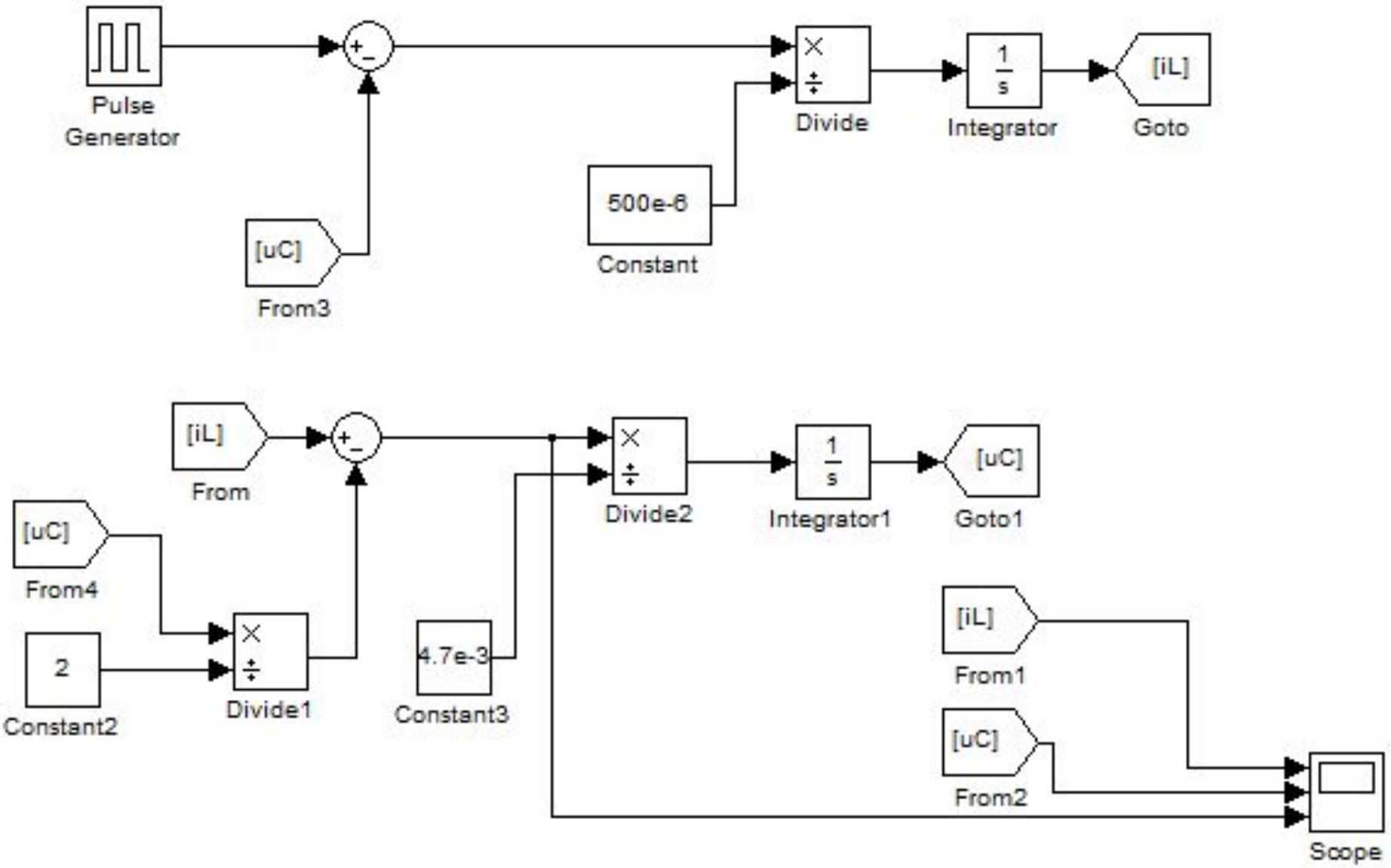
$$L \geq \frac{R_н}{2f}(1 - D_{\min}).$$

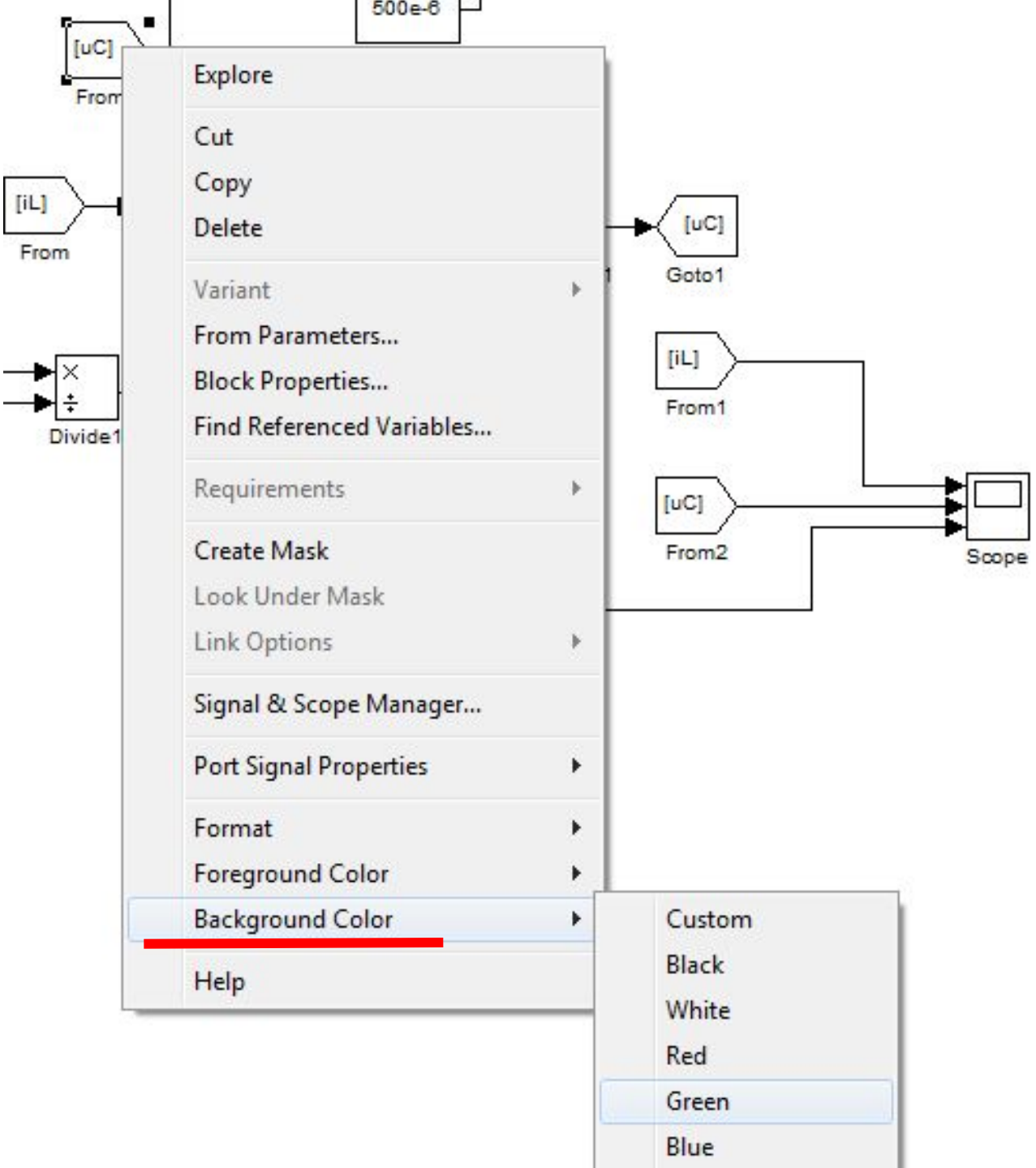
D_{min} – минимальное значение коэффициента заполнения равное 0,1

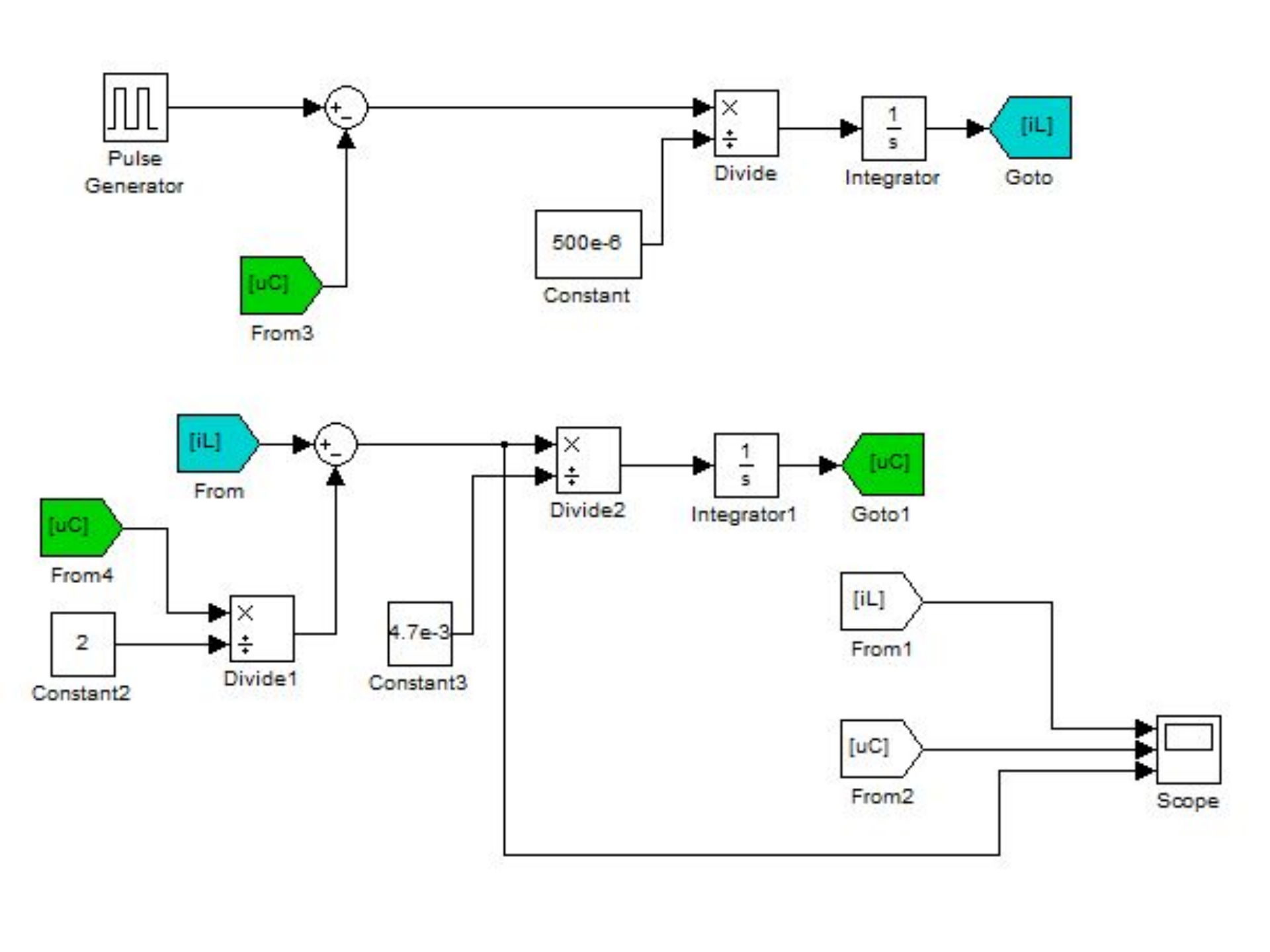
$$2\pi \cdot f \cdot C_{out} R_н >> 1.$$

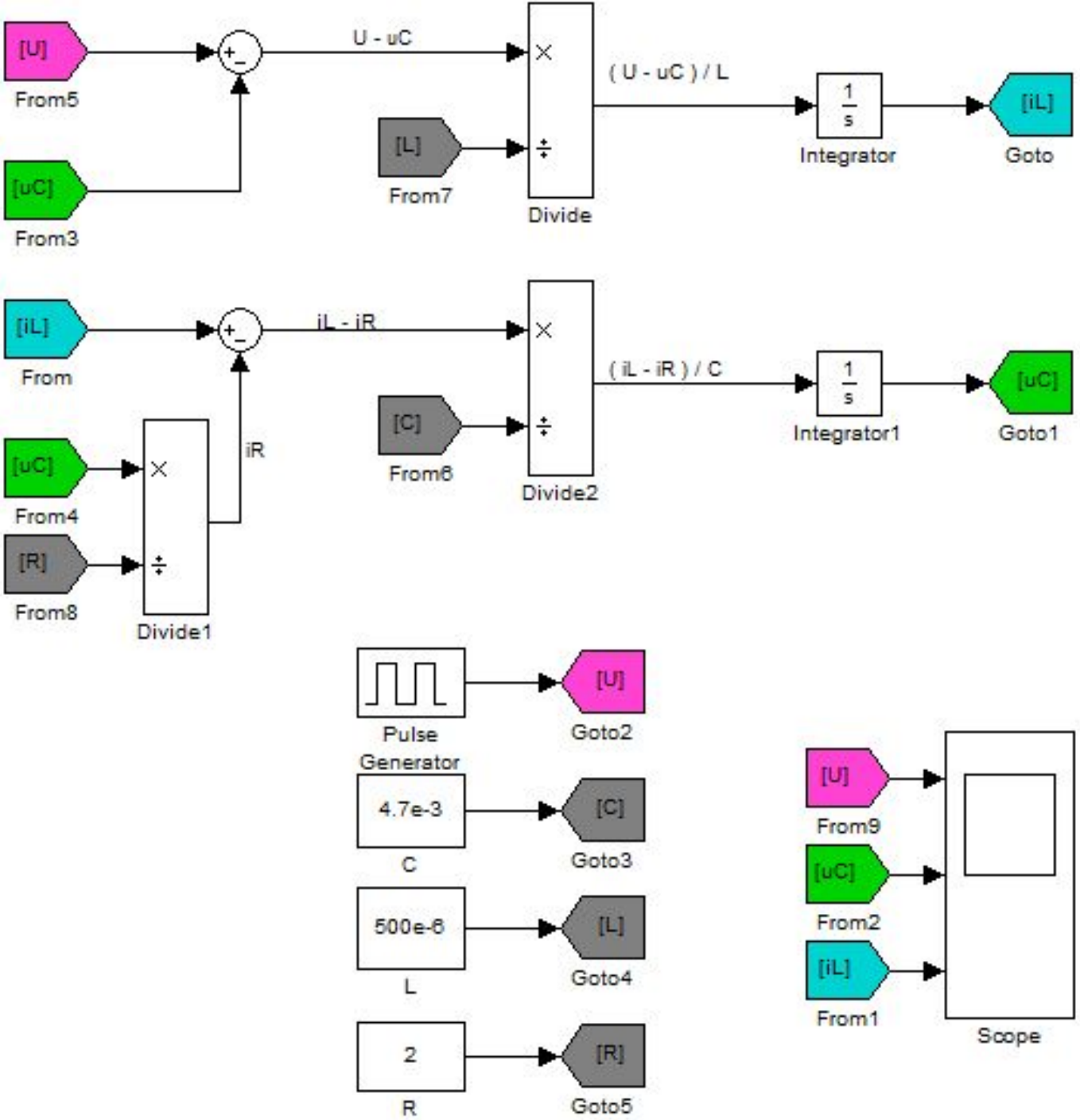

Pulse
Generator
Divide
1
s
Integrator
500e-6
Constant
Scope
Divide2
Integrator1
2
Constant2
Divide1
4.7e-3
Constant3

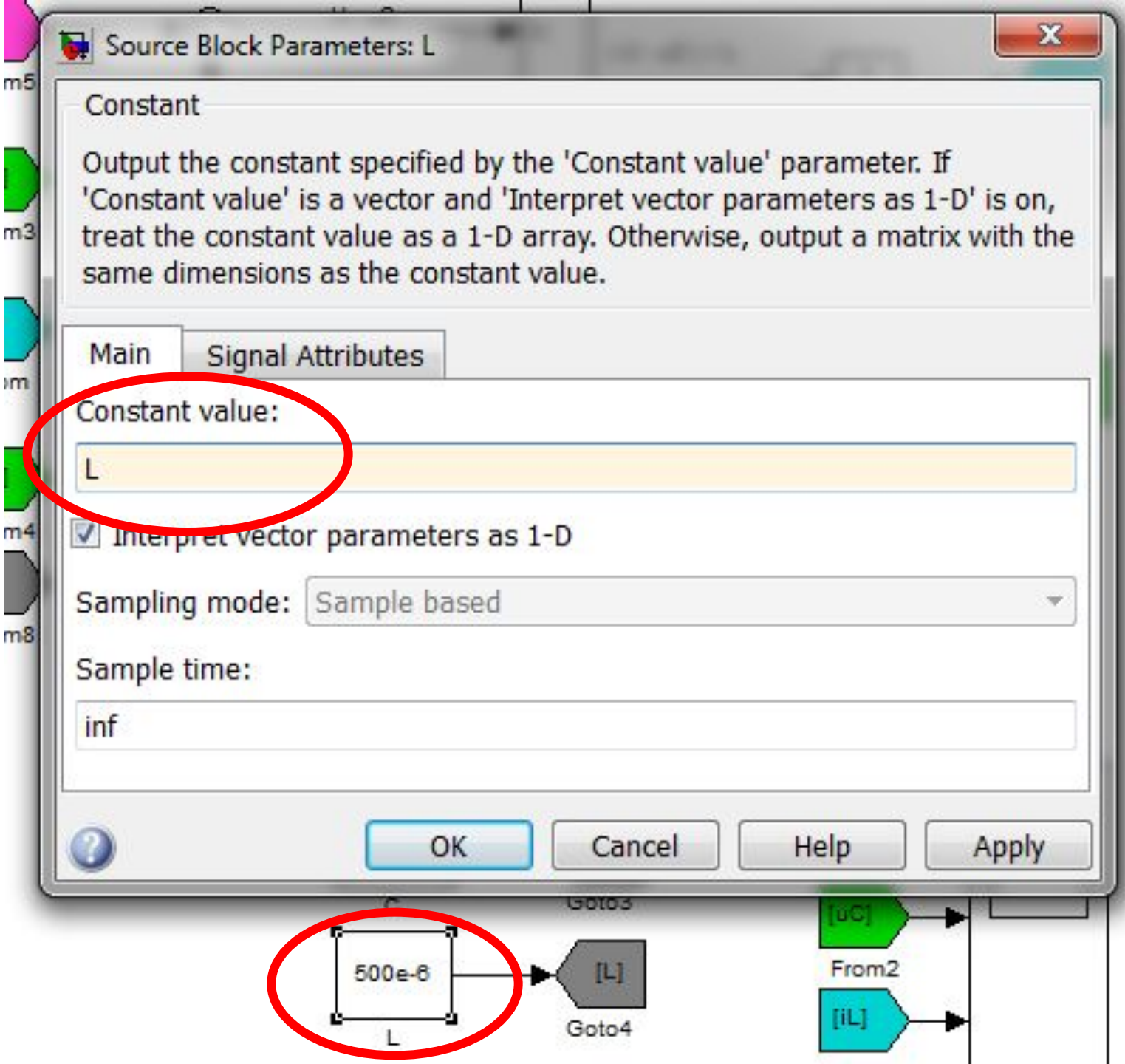

[A]
Goto
[A]
From

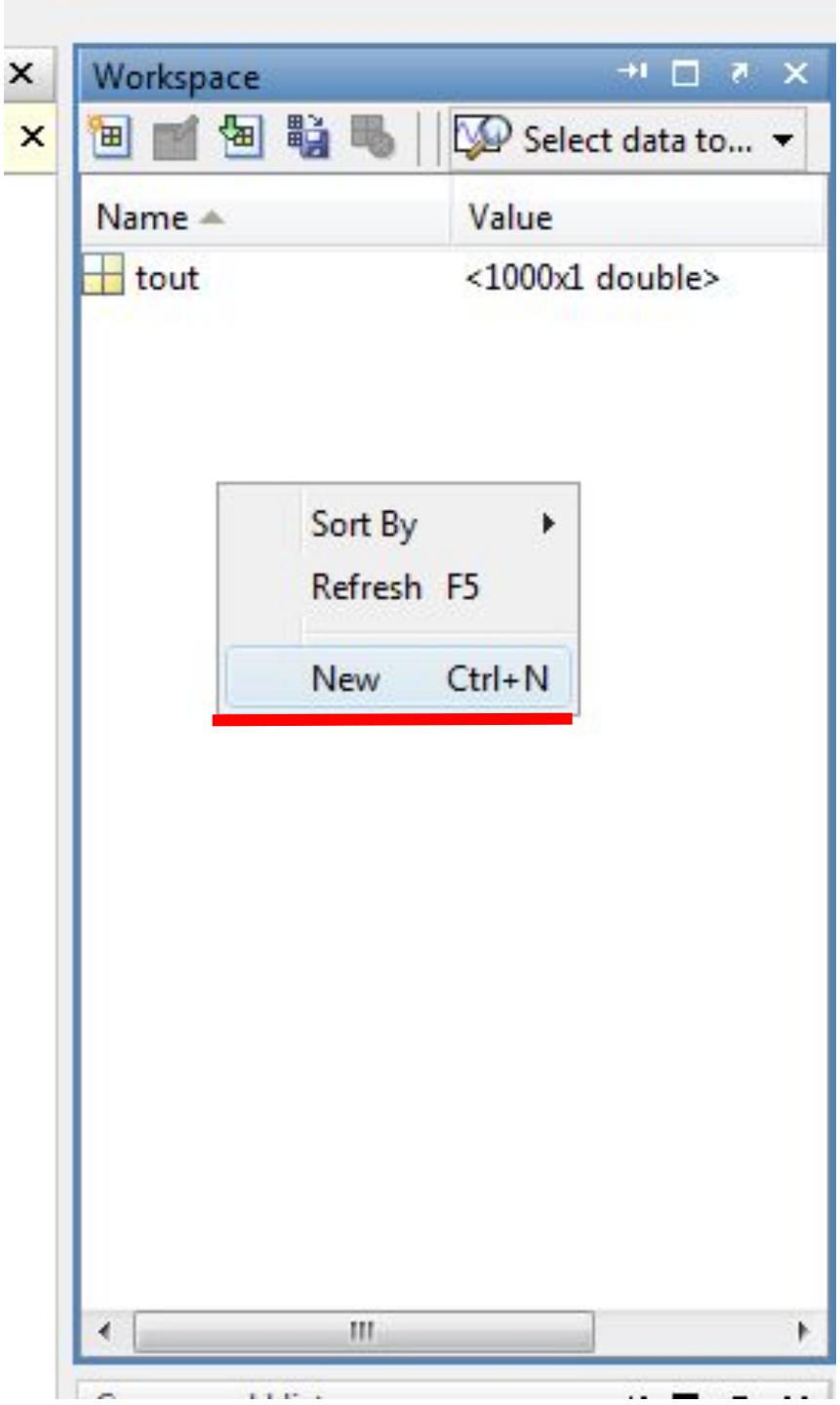

Pulse
Generator
[uC]
From3
500e-6
Constant
Divide
1
s
Integrator
[iL]
Goto
[iL]
From
[uC]
From4
2
Constant2
Divide1
4.7e-3
Constant3
Divide2
1
s
Integrator1
[uC]
Goto1
[iL]
From1
[uC]
From2
Scope

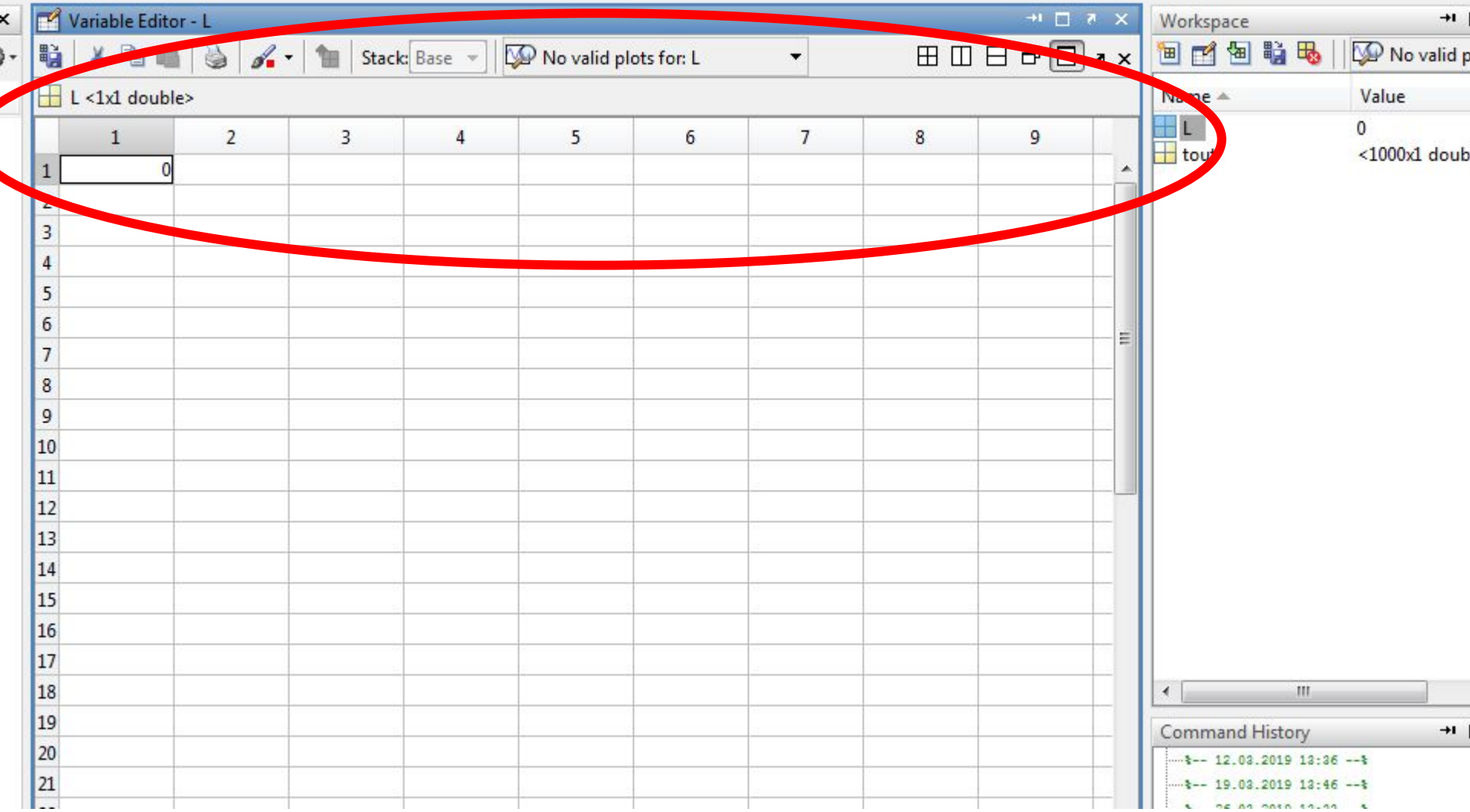

500e-6
[uC]
From
[iL]
From
Explore
Cut
Copy
Delete
Variant
From Parameters...
Block Properties...
Find Referenced Variables...
Requirements
Create Mask
Look Under Mask
Link Options
Signal & Scope Manager...
Port Signal Properties
Format
Foreground Color
Background Color
Help
Custom
Black
White
Red
Green
Blue
[uC]
Goto1
[iL]
From1
[uC]
From2
Scope
Divide1

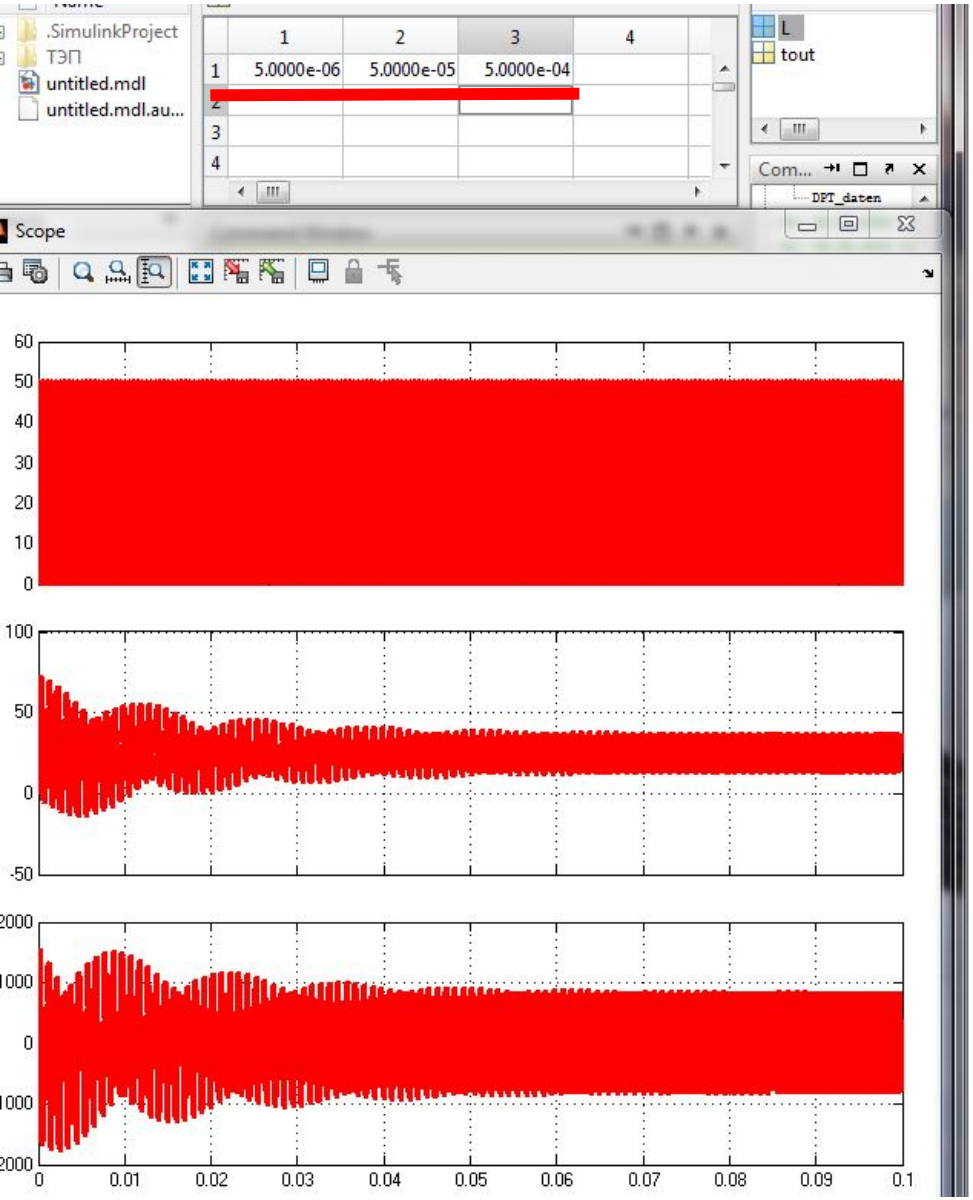

Pulse
Generator
[uC]
From3
500e-6
Constant
Divide
1
s
Integrator
[iL]
Goto
[iL]
From
[uC]
From4
2
Constant2
Divide1
4.7e-3
Constant3
Divide2
1
s
Integrator1
[uC]
Goto1
[iL]
From1
[uC]
From2
Scope

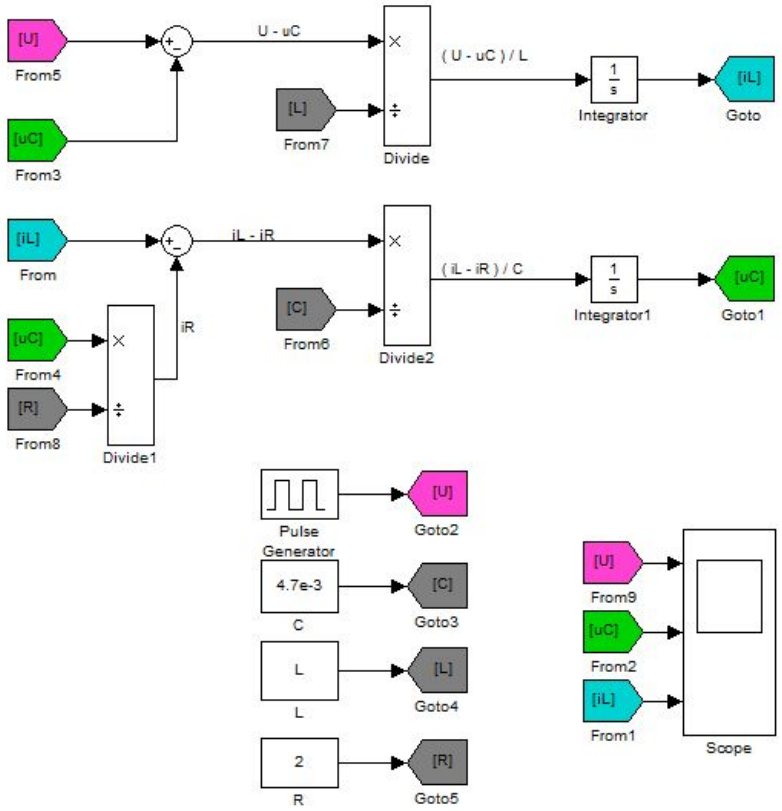

[U]
From5
U - uC
[uC]
From3
[L]
From7
Divide
(U - uC) / L
1
s
Integrator
[iL]
Goto
[iL]
From
iL - iR
[uC]
From4
[R]
From8
Divide1
iR
[C]
From6
Divide2
(iL - iR) / C
Integrator1
[uC]
Goto1
Pulse
Generator
[U]
Goto2
4.7e-3
C
[C]
Goto3
500e-6
L
[L]
Goto4
2
R
[R]
Goto5
[U]
From9
[uC]
From2
[iL]
From1
Scope

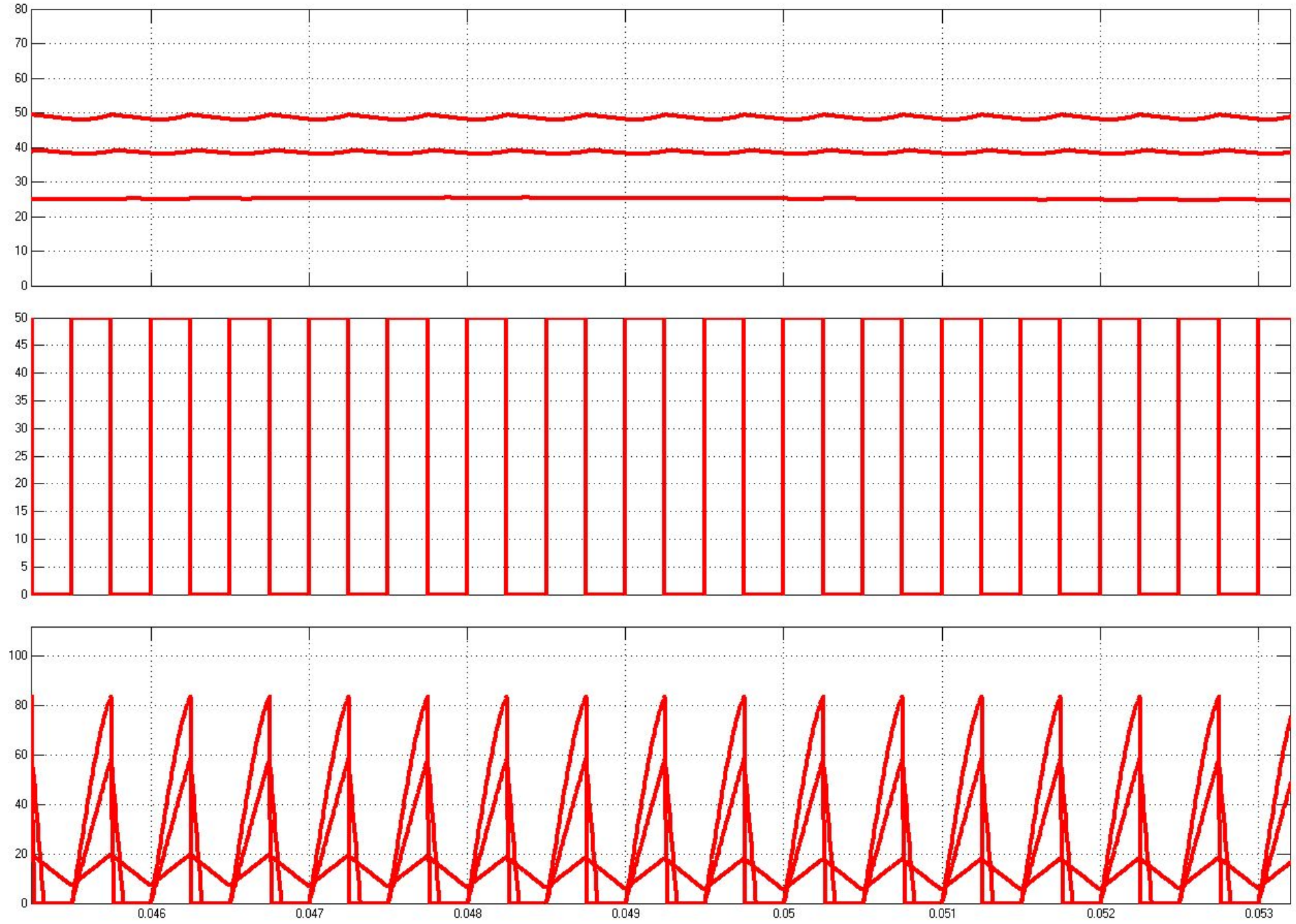

Source Block Parameters: L
Constant
Output the constant specified by the 'Constant value' parameter. If 'Constant value' is a vector and 'Interpret vector parameters as 1-D' is on, treat the constant value as a 1-D array. Otherwise, output a matrix with the same dimensions as the constant value.
Main
Signal Attributes
Constant value:
L
Interpret vector parameters as 1-D
Sampling mode:
Sample based
Sample time:
inf
OK
Cancel
Help
Apply
500e-6
L
[L]
Goto4
[uC]
From2
[iL]

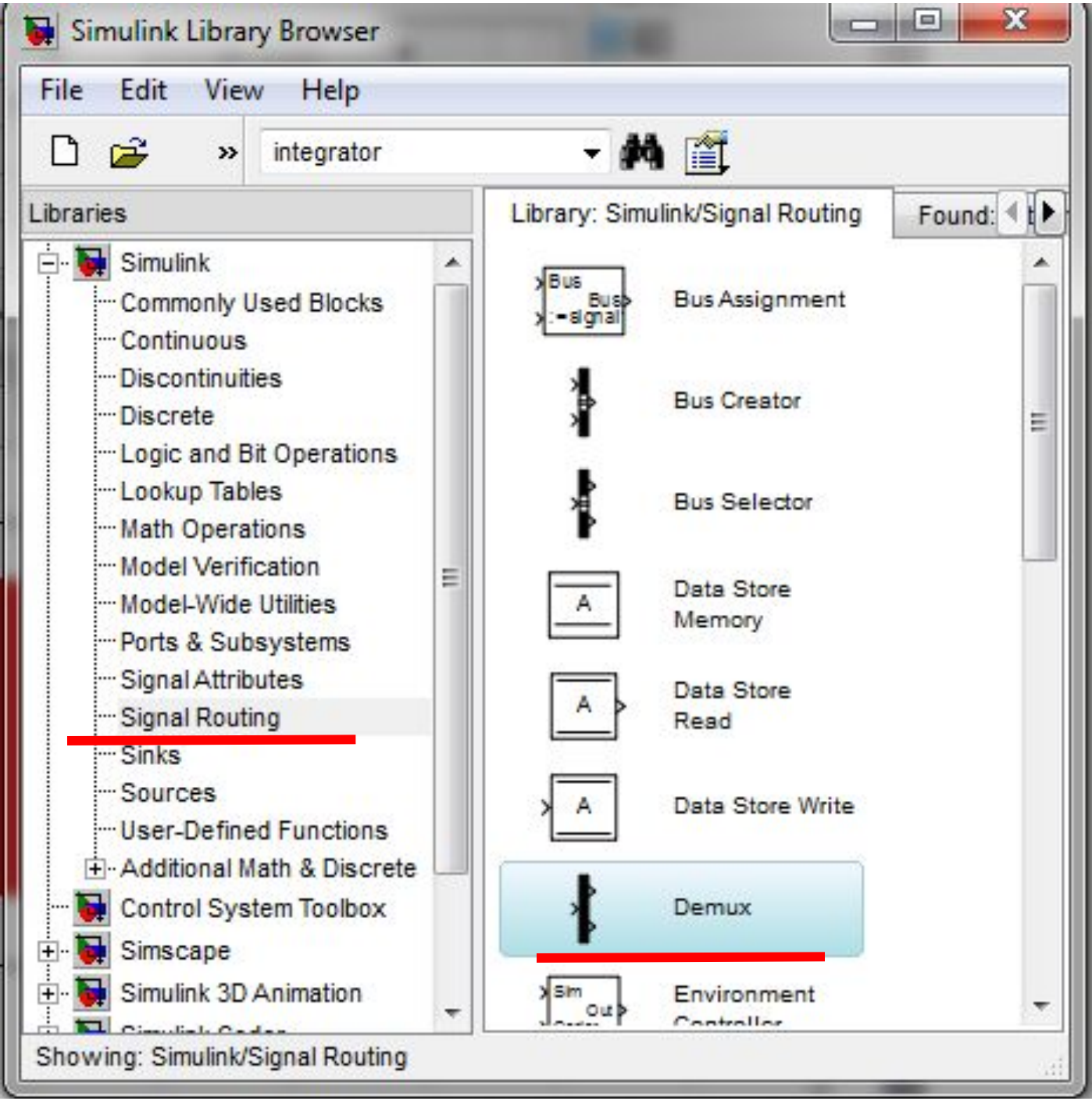

Workspace
Select data to...
Name
Value
tout
<1000x1 double>
Sort By
Refresh F5
New Ctrl+N

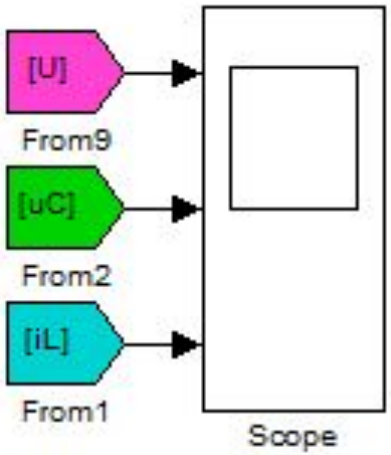

Variable Editor - L
Stack: Base
No valid plots for: L
L <1x1 double>
1 2 3 4 5 6 7 8 9
1 0
Workspace
No valid p
Name
Value
L
0
tou
<1000x1 doub
Command History
%-- 12.03.2019 13:36 --%
%-- 19.03.2019 13:46 --%

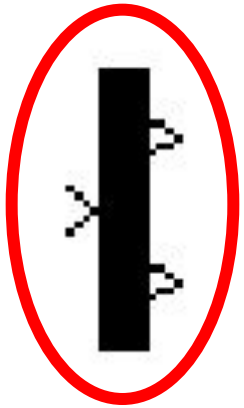

.SimulinkProject
ТЭП
untitled.mdl
untitled.mdl.au...
1 2 3 4
1 5.0000e-06 5.0000e-05 5.0000e-04
2
3
4
L
tout
Com...
DPT_daten
Scope
60
50
40
30
20
10
0
100
50
0
-50
2000
1000
0
1000
2000
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1

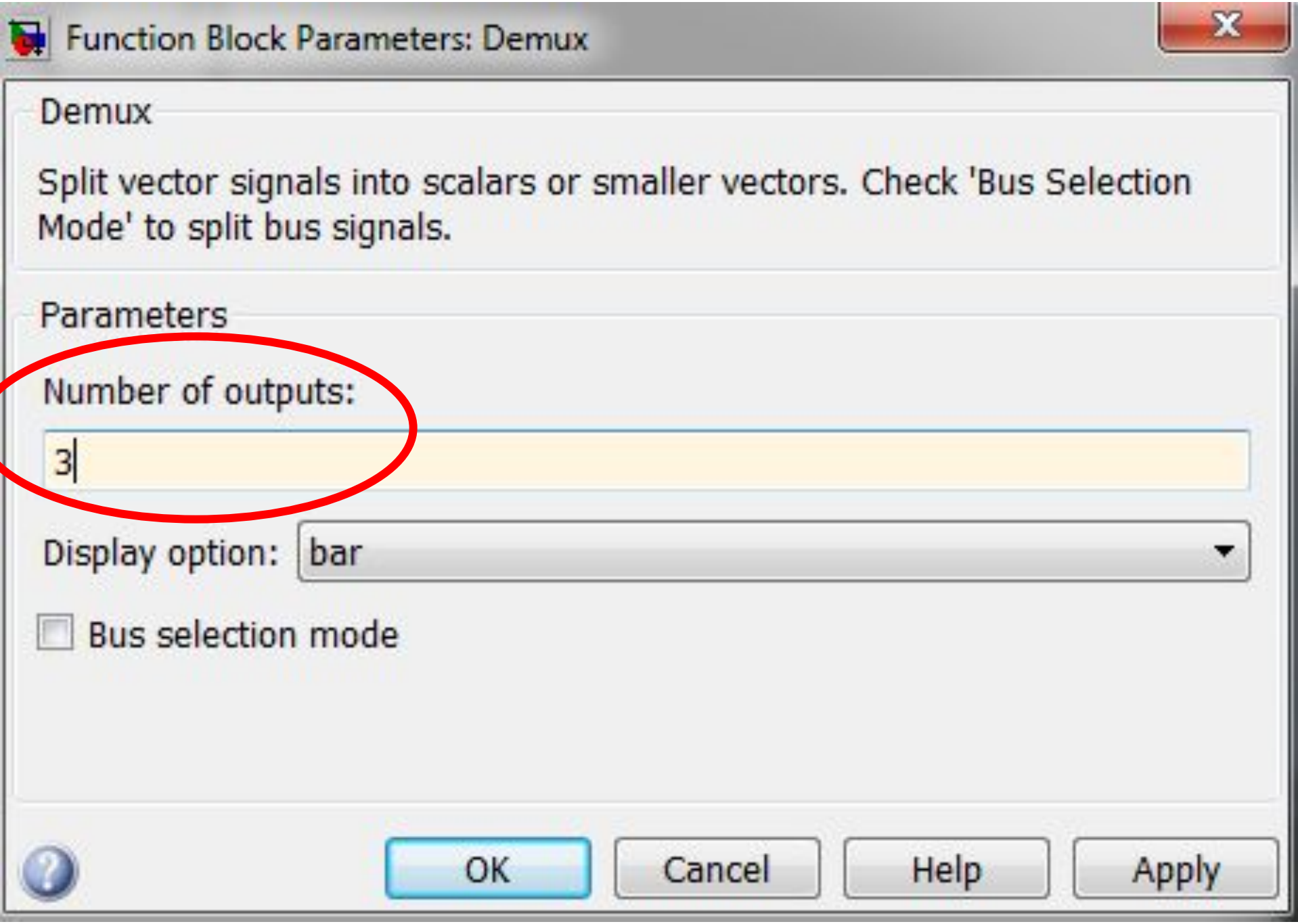

[U]
From5
U - uC
[uC]
From3
[L]
From7
Divide
(U - uC) / L
1/s
Integrator
[iL]
Goto
[iL]
From
iL - iR
[uC]
From4
[R]
From8
Divide1
iR
[C]
From6
Divide2
(iL - iR) / C
Integrator1
[uC]
Goto1
Pulse Generator
[U]
Goto2
4.7e-3
C
[C]
Goto3
L
L
[L]
Goto4
2
R
[R]
Goto5
[U]
From9
[uC]
From2
[iL]
From1
Scope

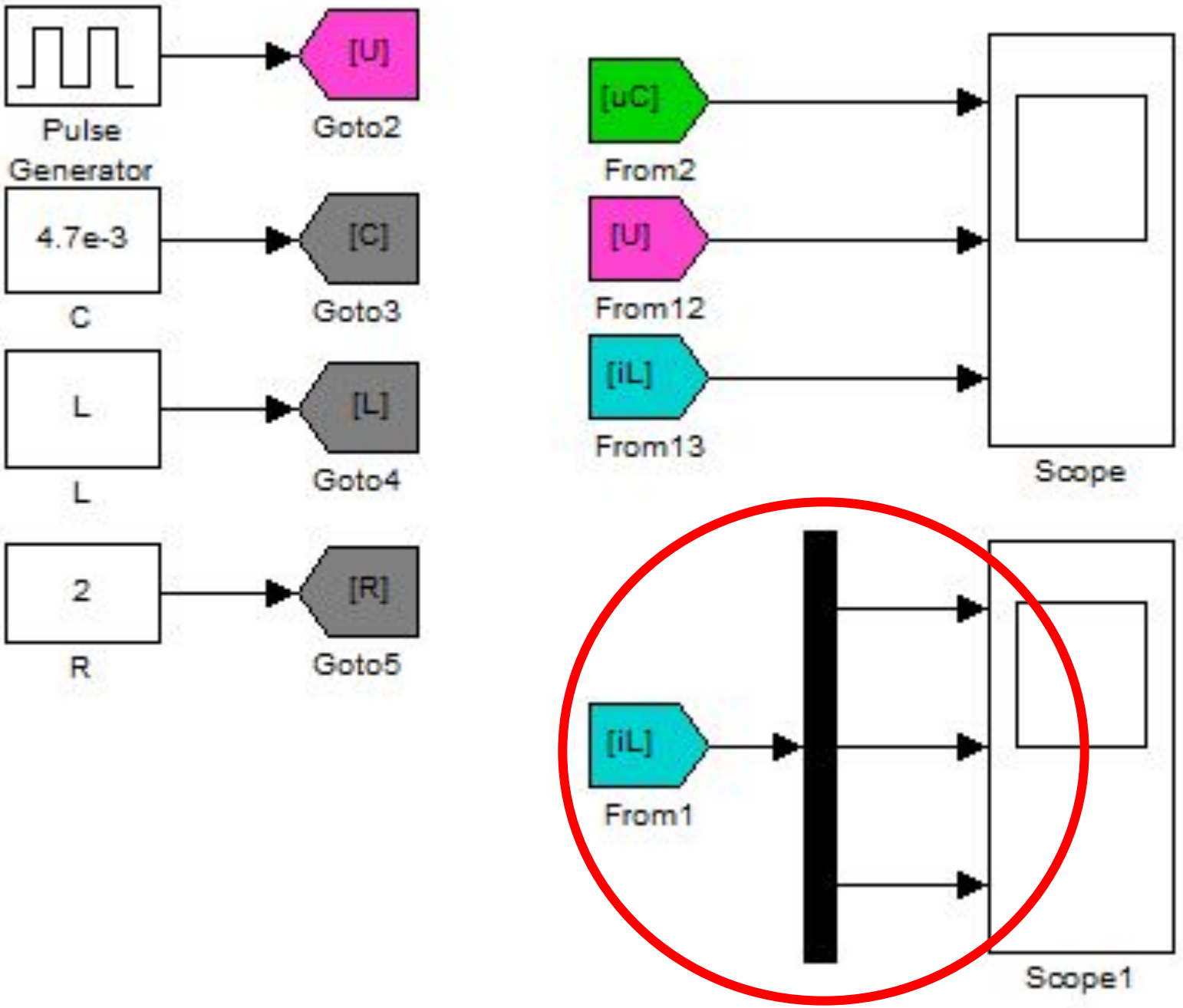

80
70
60
50
40
30
20
10
0
50
45
40
35
30
25
20
15
10
5
0
100
80
60
40
20
0
0.046
0.047
0.048
0.049
0.05
0.051
0.052
0.053

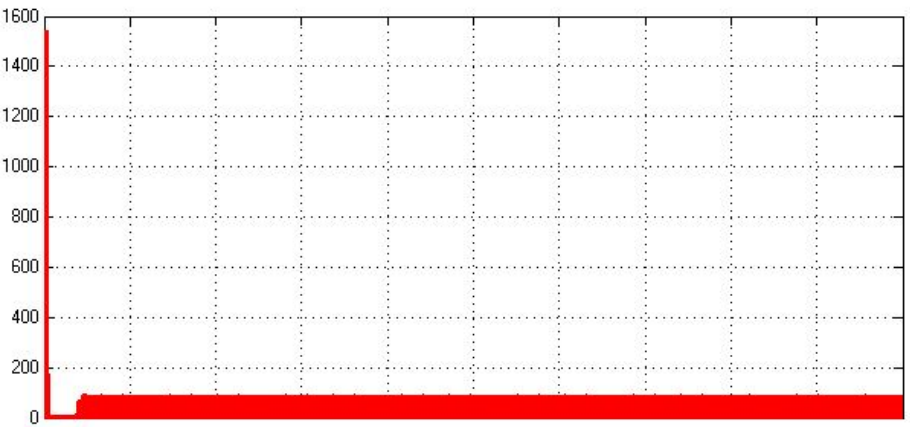

Simulink Library Browser
File
Edit
View
Help
integrator
Libraries
Simulink
Commonly Used Blocks
Continuous
Discontinuities
Discrete
Logic and Bit Operations
Lookup Tables
Math Operations
Model Verification
Model-Wide Utilities
Ports & Subsystems
Signal Attributes
Signal Routing
Sinks
Sources
User-Defined Functions
Additional Math & Discrete
Control System Toolbox
Simscape
Simulink 3D Animation
Library: Simulink/Signal Routing
Found:
Bus Assignment
Bus Creator
Bus Selector
Data Store Memory
Data Store Read
Data Store Write
Demux
Environment
Showing: Simulink/Signal Routing

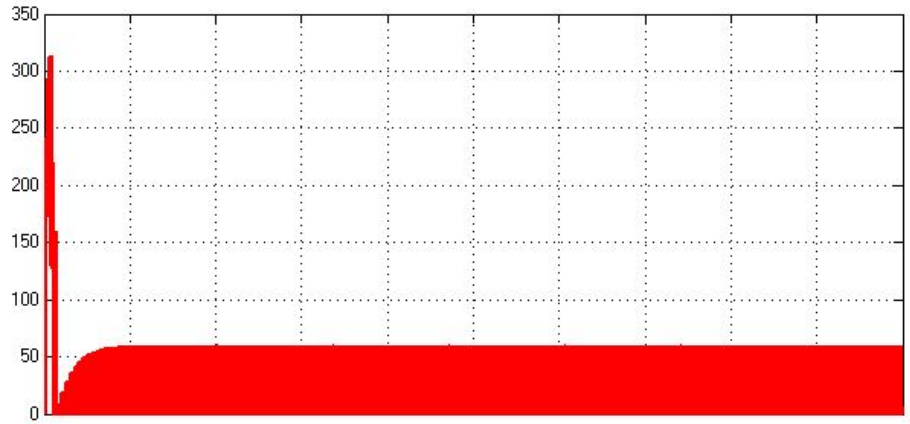

[U]
From9
[uC]
From2
[iL]
From1
Scope

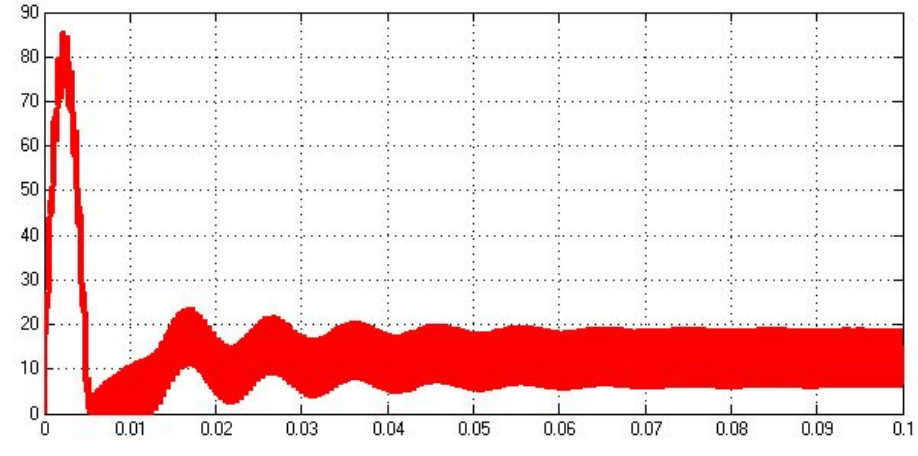


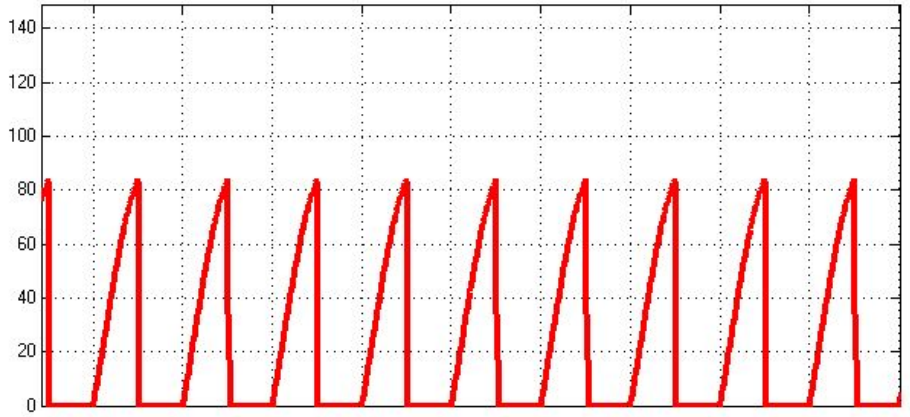

Function Block Parameters: Demux
Demux
Split vector signals into scalars or smaller vectors. Check 'Bus Selection Mode' to split bus signals.
Parameters
Number of outputs:
3
Display option:
bar
Bus selection mode
OK
Cancel
Help
Apply

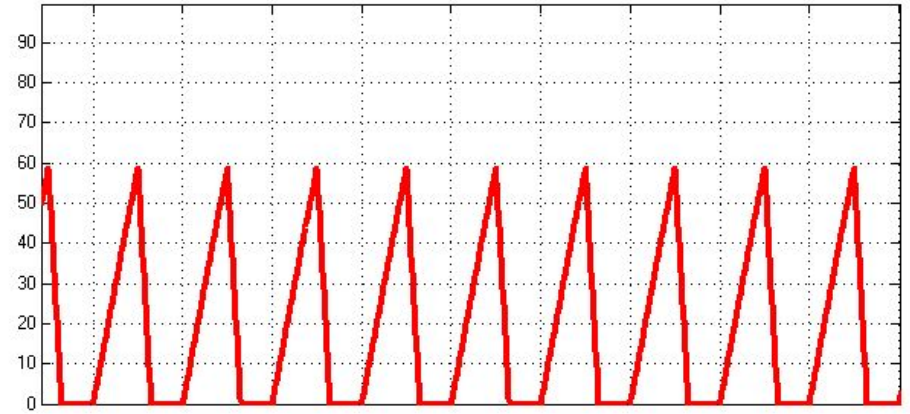

Pulse
Generator
[U]
Goto2
4.7e-3
C
[C]
Goto3
L
[L]
Goto4
2
R
[R]
Goto5
[uC]
From2
[U]
From12
[iL]
From13
Scope
[iL]
From1
Scope1

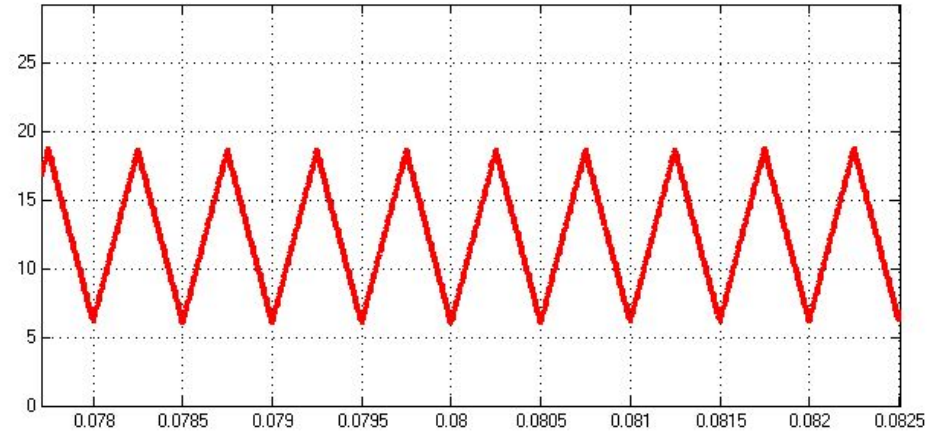

1600
1400
1200
1000
800
600
400
200
0


350
300
250
200
150
100
50
0


90
80
70
60
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1


140
120
100
80
60
40
20
0


90
80
70
60
50
40
30
20
10
0


25
20
15
10
5
0
0.078
0.0785
0.079
0.0795
0.08
0.0805
0.081
0.0815
0.082
0.0825

Задание на защиту ЛР1

1. Сформировать мат. модель понижающего регулятора напряжения с данными ранее параметрами для каждой бригады
2. Каждый из 2х человек в бригаде должен сделать индивидуальное задание, а именно:

- Параметрически изменяя индуктивность в пределах 10 … 190 % (минимум 5 значений) получить осциллограммы тока дросселя и напряжения на нагрузке

- Параметрически изменяя емкость в пределах 10 … 190 % (минимум 5 значений) получить осциллограммы тока дросселя и напряжения на нагрузке

Полученные осциллограммы, а так же принцип работы модели каждый должен уметь пояснить!