MATLAB TOUR 2017

Modelización , simulación y pruebas en Simulink

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Why Test?

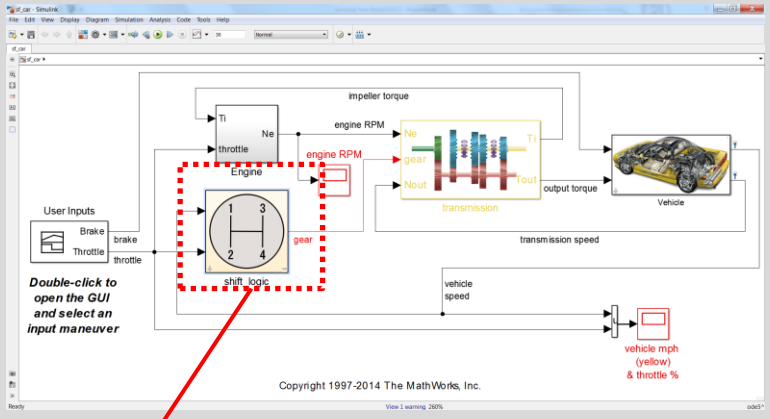
- Does the subsystem/system meet the design requirements?
- The model worked last week… does it still?
- The model / algorithm has been modified… is it still working ok?
- Do these legacy models / libraries work in this new application?
- Does it work real-time, integrated with hardware?
- Does running the generated embedded code match running the model?

Testing to date…

- Create harness models
  - to exercise model references or subsystems
- Write MATLAB code
  - to run the tests
- Write more MATLAB code
  - to verify the test results
- Write some more MATLAB code / using Report Generator
  - to report on the test results
- Creating custom GUIs to manage running of tests

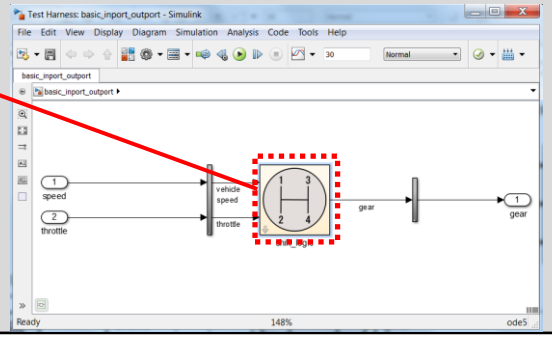
Simulink Test Overview

1. Test Harnesses	2. Test Sequence Block	3. Test Manager
• Synchronized, simulatable test environment	• Inputs and assessments based on logical, temporal conditions	• Author, execute, manage test cases • Review, export, report

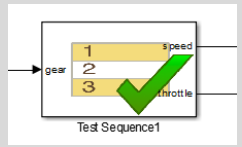


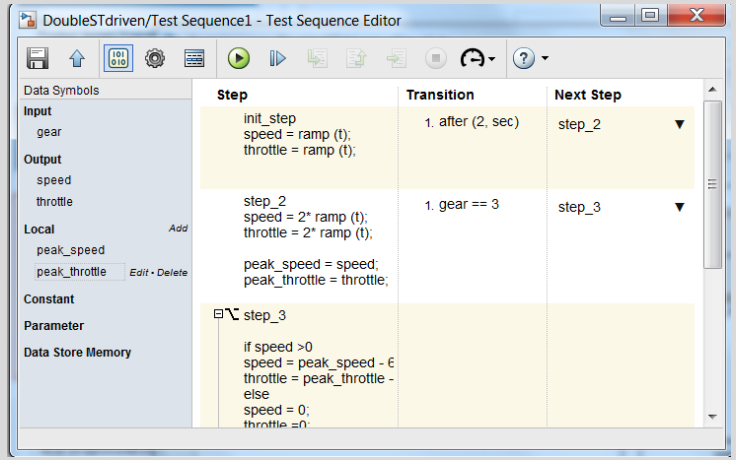
Main Model

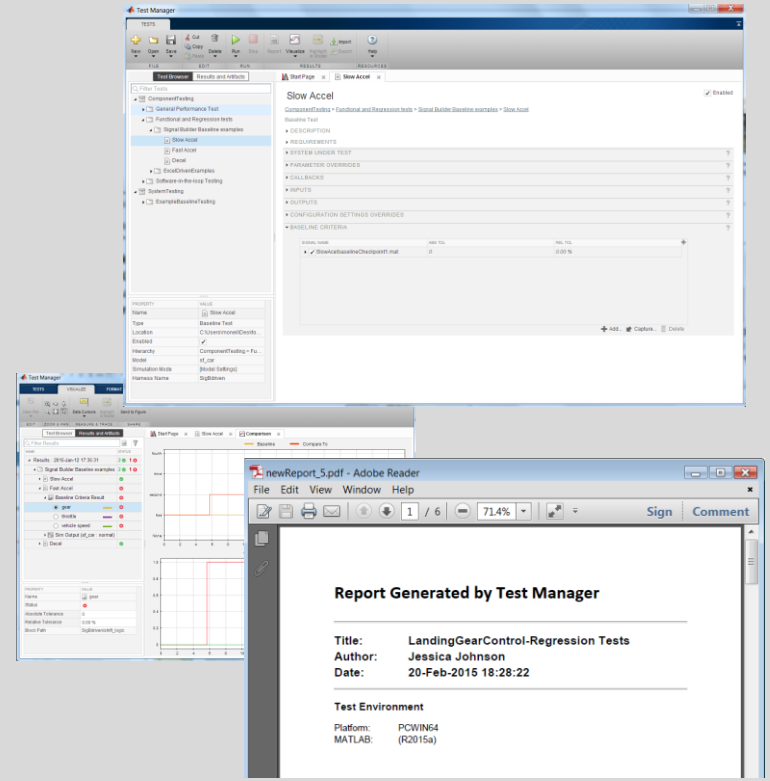
Component under test



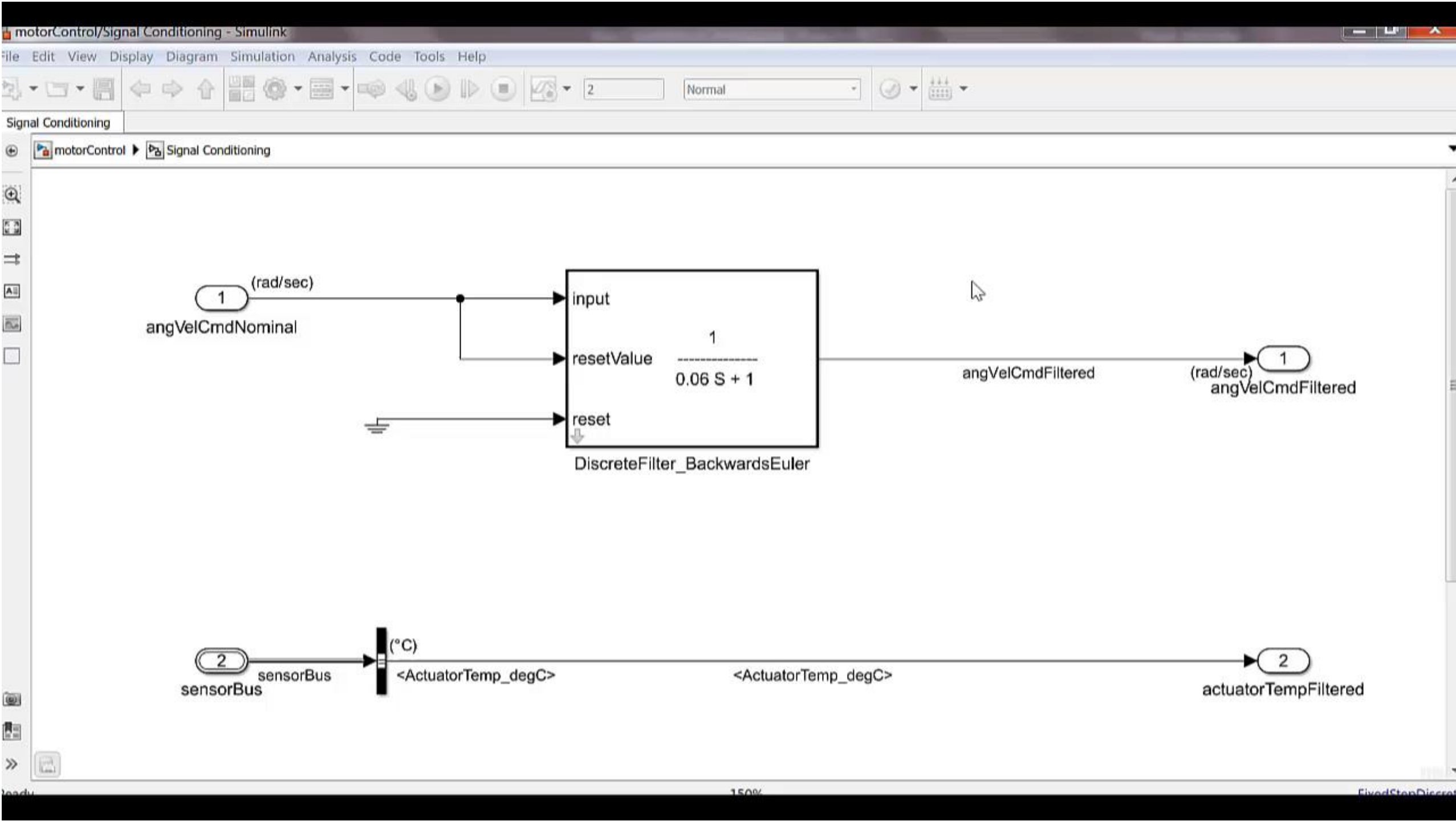
Test Harness







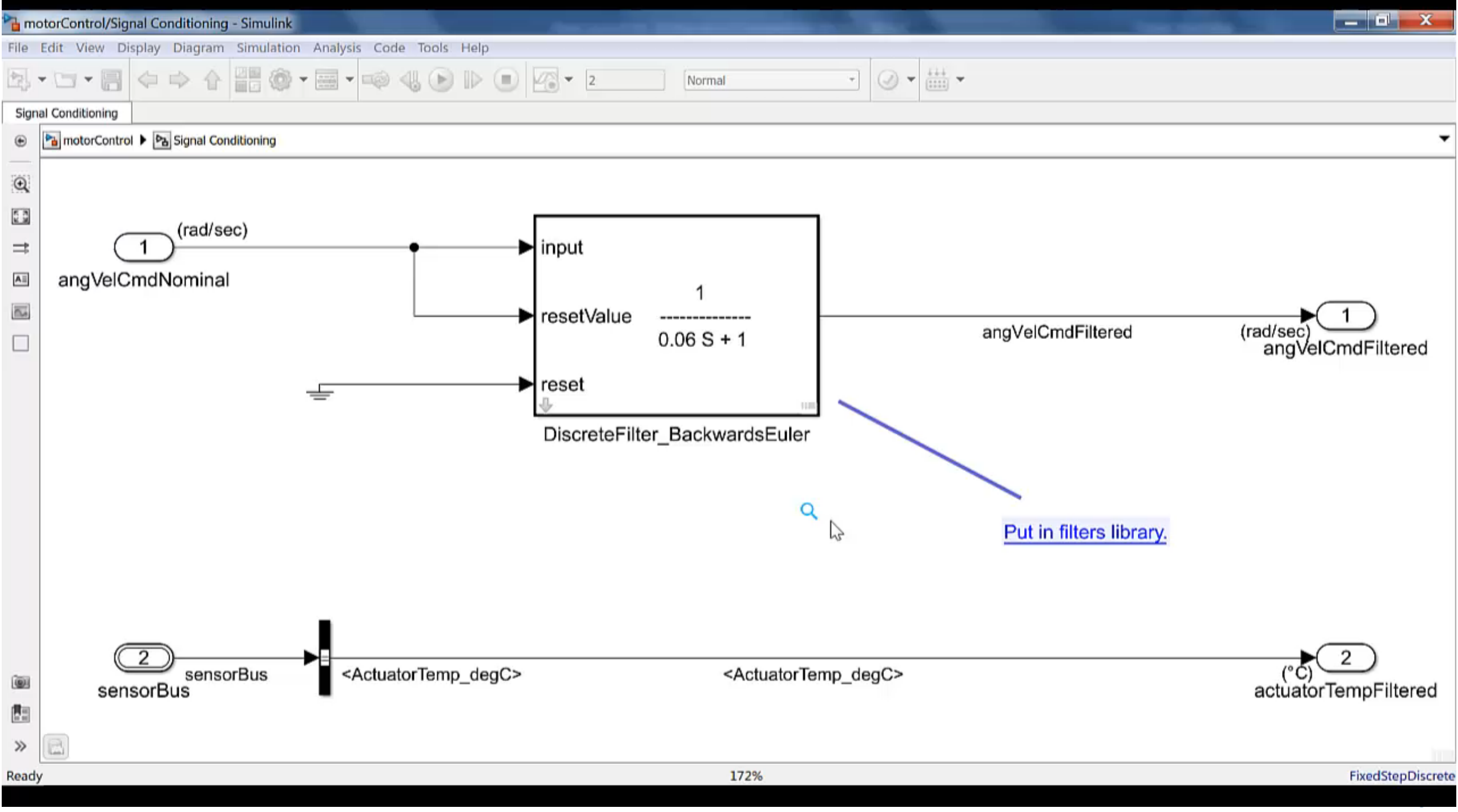
Creating Test Harnesses


motorControl/Signal Conditioning - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
Normal
Signal Conditioning
motorControl
Signal Conditioning
1
(rad/sec)
angVelCmdNominal
input
resetValue
reset
1
0.06 S + 1
DiscreteFilter_BackwardsEuler
angVelCmdFiltered
1
(rad/sec)
angVelCmdFiltered
2
sensorBus
sensorBus
(°C)
<ActuatorTemp_degC>
<ActuatorTemp_degC>
2
actuatorTempFiltered

But what if…

- The component is in a library
- The reset should be relative to the time constant of the filter
- We want to verify a requirement that:

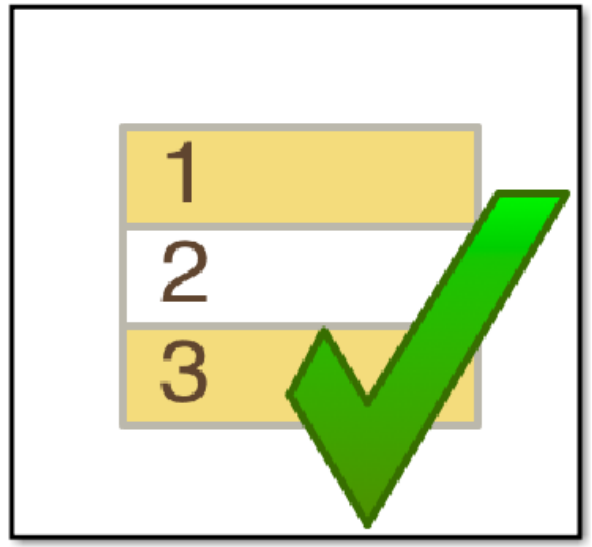
  filter output shall equal resetValue when reset is true


motorControl/Signal Conditioning - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
Signal Conditioning
motorControl
Signal Conditioning
1
(rad/sec)
angVelCmdNominal
input
resetValue
reset
1
0.06 S + 1
DiscreteFilter_BackwardsEuler
angVelCmdFiltered
1
(rad/sec)
angVelCmdFiltered
Put in filters library.
2
sensorBus
sensorBus
<ActuatorTemp_degC>
<ActuatorTemp_degC>
2
(°C)
actuatorTempFiltered
Ready
172%
FixedStepDiscrete

Release Notes – Test Harnesses

- Test Harnesses for Libraries R2016a
- External Test Harnesses R2016a
- External Test Harnesses with Requirements Linking R2016b
- Move/Clone test harnesses R2017a

Test Sequence / Test Assessment block



Test Sequence

Release Notes – Test Sequence

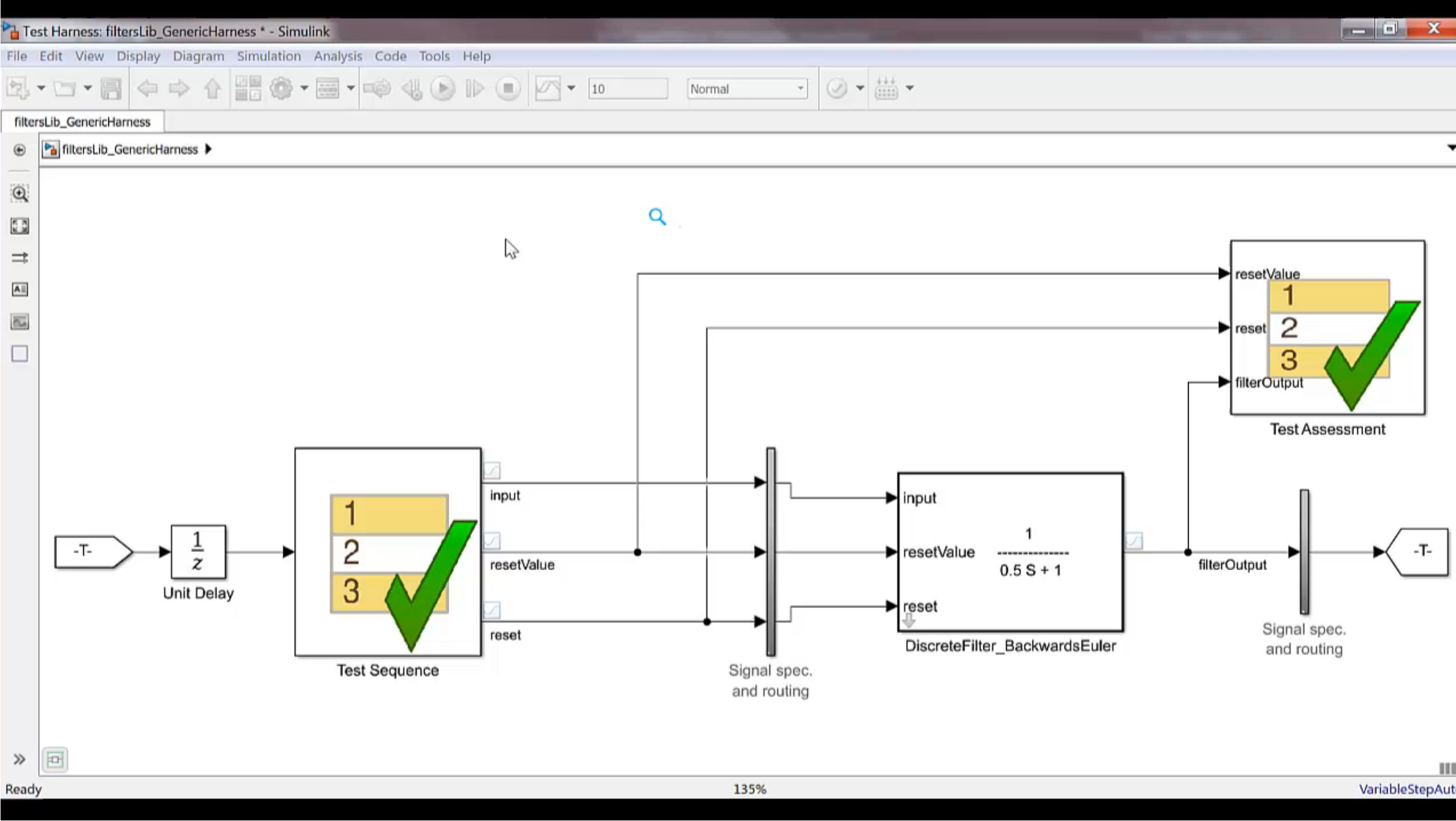
▪ description field	R2016a
▪ tab complete & syntax highlighting	R2016a
▪ port reordering	R2016a
▪ support messages	R2016a
▪ “verify” statements	R2016a
▪ proof objective support for verify statements	R2017a

Test Manager

Simulation Testing

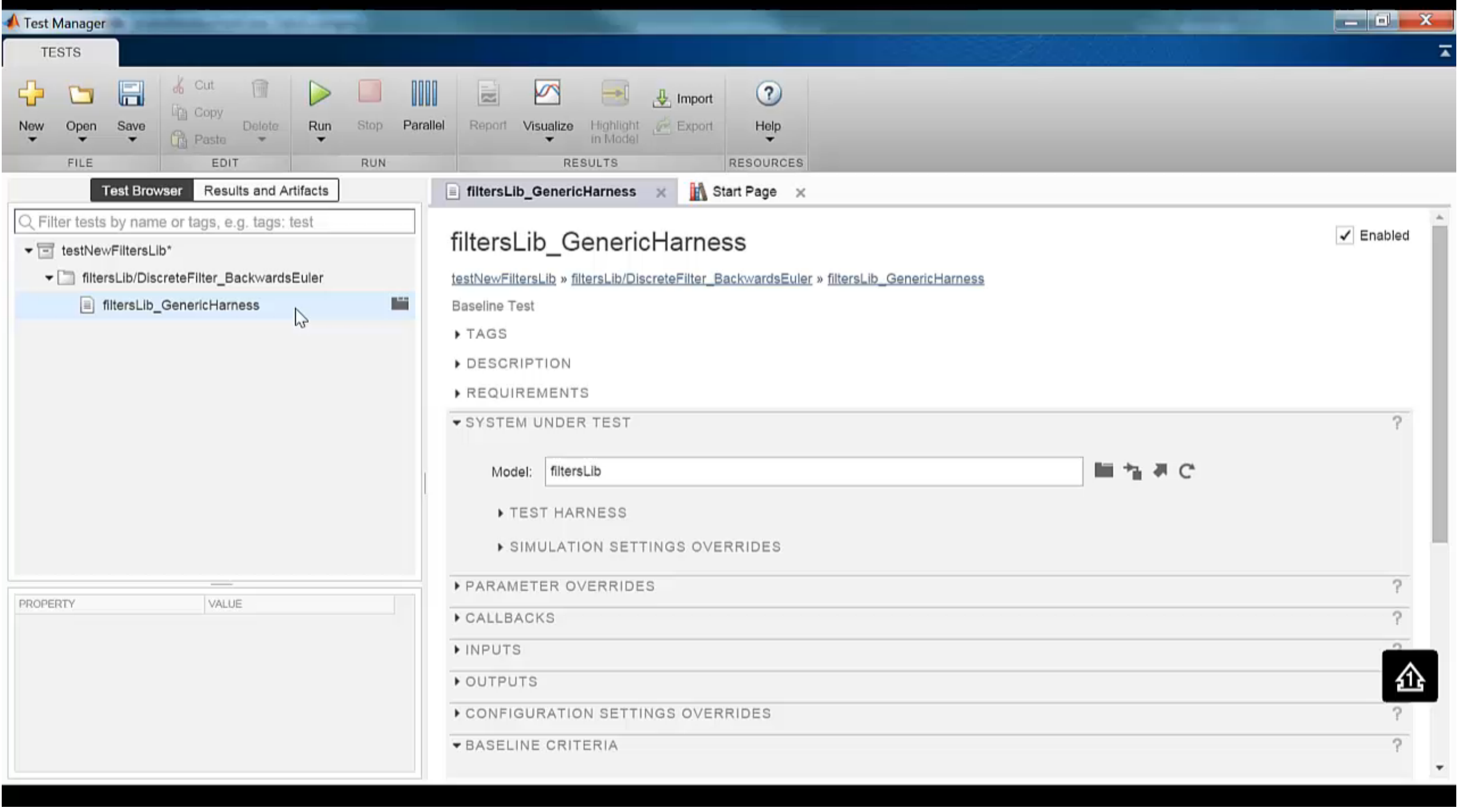
- Requirement Based (Simulation) Testing
  - Does my design comply with my requirements?
- Equivalence Testing
  - Do these models match? Does generated code match this model?
- Regression (Baseline) Testing
  - Have I broken anything with the change I've just made?

Create a baseline test


Test Harness: filtersLib_GenericHarness * - Simulink
File Edit View Display Diagram Simulation Analysis Code Tools Help
10
Normal
filtersLib_GenericHarness
filtersLib_GenericHarness
-T-
1
z
Unit Delay
1
2
3
Test Sequence
input
resetValue
reset
Signal spec.
and routing
input
resetValue
1
0.5 S + 1
reset
DiscreteFilter_BackwardsEuler
filterOutput
Signal spec.
and routing
-T-
resetValue
reset
filterOutput
Test Assessment
Ready
135%
VariableStepAut

Create a test
for multiple parameter values

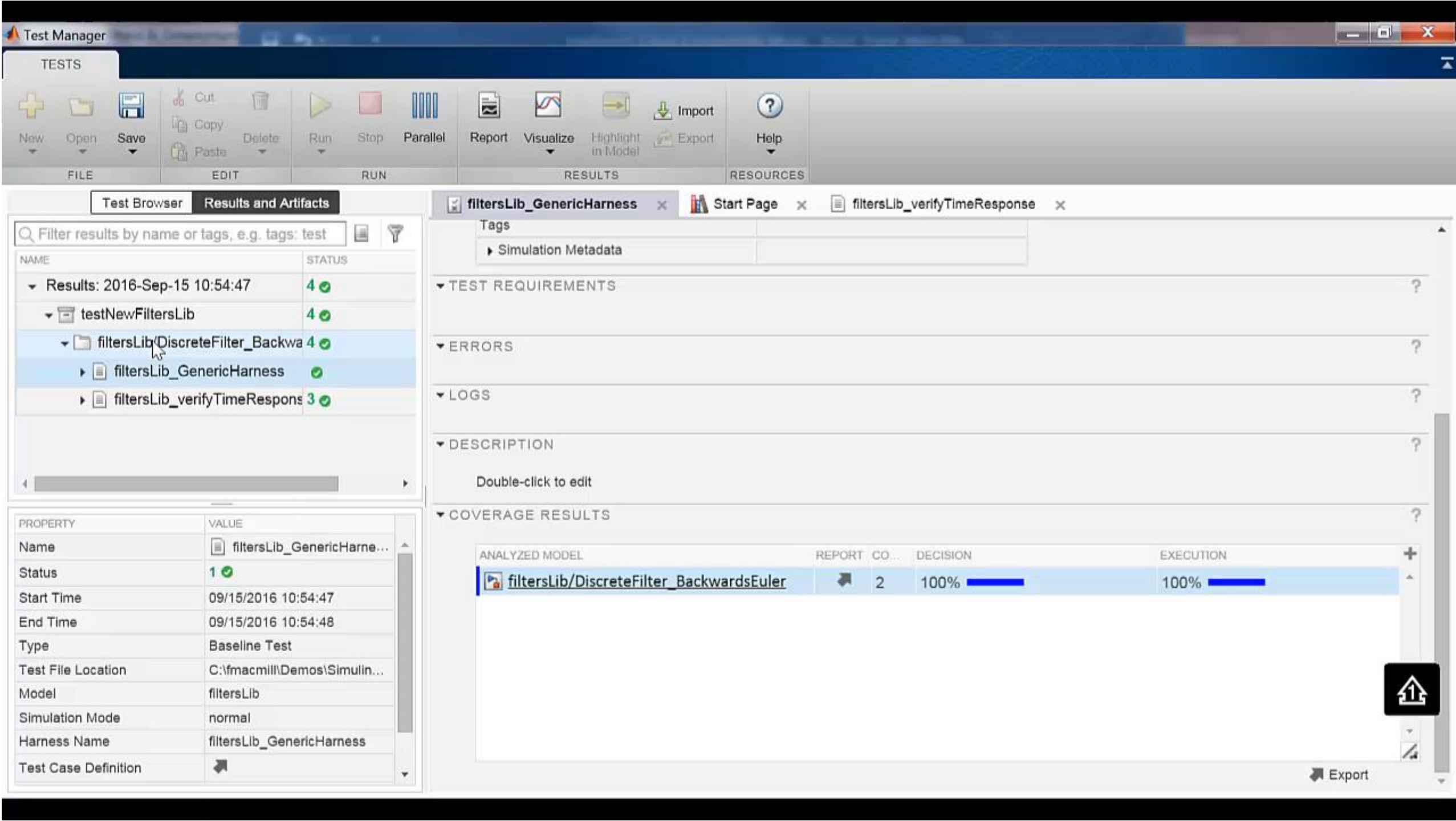
and verify response against a custom criteria


Test Manager
TESTS
New
Open
Save
Cut
Copy
Paste
Delete
Run
Stop
Parallel
Report
Visualize
Highlight in Model
Import
Export
Help
FILE
EDIT
RUN
RESULTS
RESOURCES
Test Browser
Results and Artifacts
Filter tests by name or tags, e.g. tags: test
testNewFiltersLib*
filtersLib/DiscreteFilter_BackwardsEuler
filtersLib_GenericHarness
PROPERTY
VALUE
filtersLib_GenericHarness
Start Page
filtersLib_GenericHarness
Enabled
testNewFiltersLib » filtersLib/DiscreteFilter_BackwardsEuler » filtersLib_GenericHarness
Baseline Test
TAGS
DESCRIPTION
REQUIREMENTS
SYSTEM UNDER TEST
Model:
filtersLib
TEST HARNESS
SIMULATION SETTINGS OVERRIDES
PARAMETER OVERRIDES
CALLBACKS
INPUTS
OUTPUTS
CONFIGURATION SETTINGS OVERRIDES
BASELINE CRITERIA

Test Iterations

- Define by table or script
- Combine with Parallel Computing Toolbox &/or fast restart as appropriate
- Run via UI or programmatically
- Easy to re-run selected iterations

Reporting

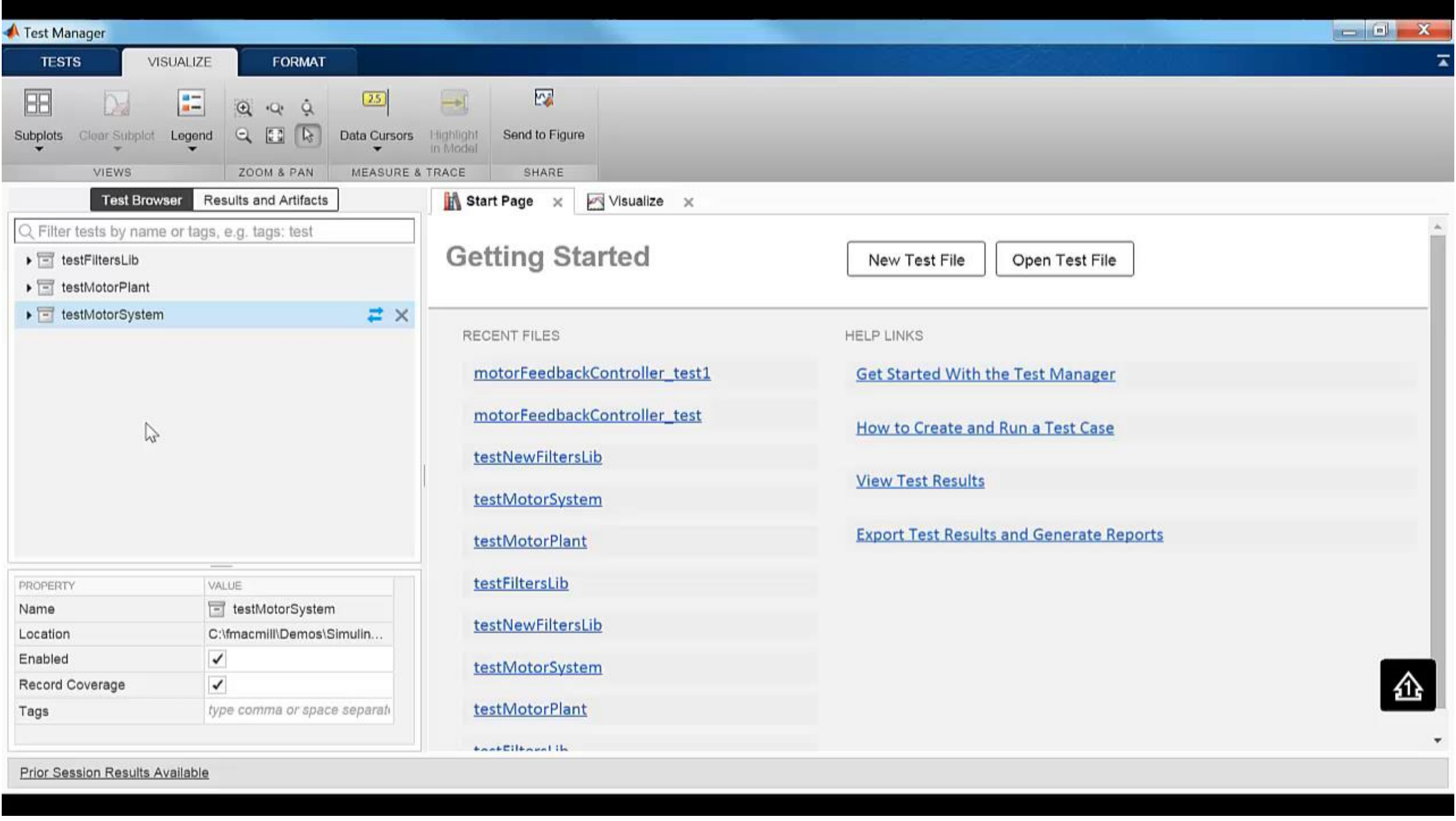

Test Manager
TESTS
New
Open
Save
Cut
Copy
Paste
Delete
Run
Stop
Parallel
Report
Visualize
Highlight in Model
Import
Export
Help
FILE
EDIT
RUN
RESULTS
RESOURCES
Test Browser
Results and Artifacts
Filter results by name or tags, e.g. tags: test
NAME
STATUS
Results: 2016-Sep-15 10:54:47
testNewFiltersLib
filtersLib/DiscreteFilter_Backwa
filtersLib_GenericHarness
filtersLib_verifyTimeRespons
PROPERTY
VALUE
Name
filtersLib_GenericHarne...
Status
Start Time
09/15/2016 10:54:47
End Time
09/15/2016 10:54:48
Type
Baseline Test
Test File Location
C:\fmacmill\Demos\Simulin...
Model
filtersLib
Simulation Mode
normal
Harness Name
filtersLib_GenericHarness
Test Case Definition
filtersLib_GenericHarness
Start Page
filtersLib_verifyTimeResponse
Tags
Simulation Metadata
TEST REQUIREMENTS
ERRORS
LOGS
DESCRIPTION
Double-click to edit
COVERAGE RESULTS
ANALYZED MODEL
REPORT
CO...
DECISION
EXECUTION
filtersLib/DiscreteFilter_BackwardsEuler
2
100%
100%
Export

Release Notes – Test Manager

▪ Parallel Computing Toolbox integration	R2016a
▪ Simulink Real-Time integration	R2016a
▪ Custom test criteria	R2016b
▪ MATLAB Unit Test integration	R2016b
▪ Simulink Design Verifier integration	R2017a
▪ Time Tolerance	R2017a

Extend requirements-based tests to achieve full coverage

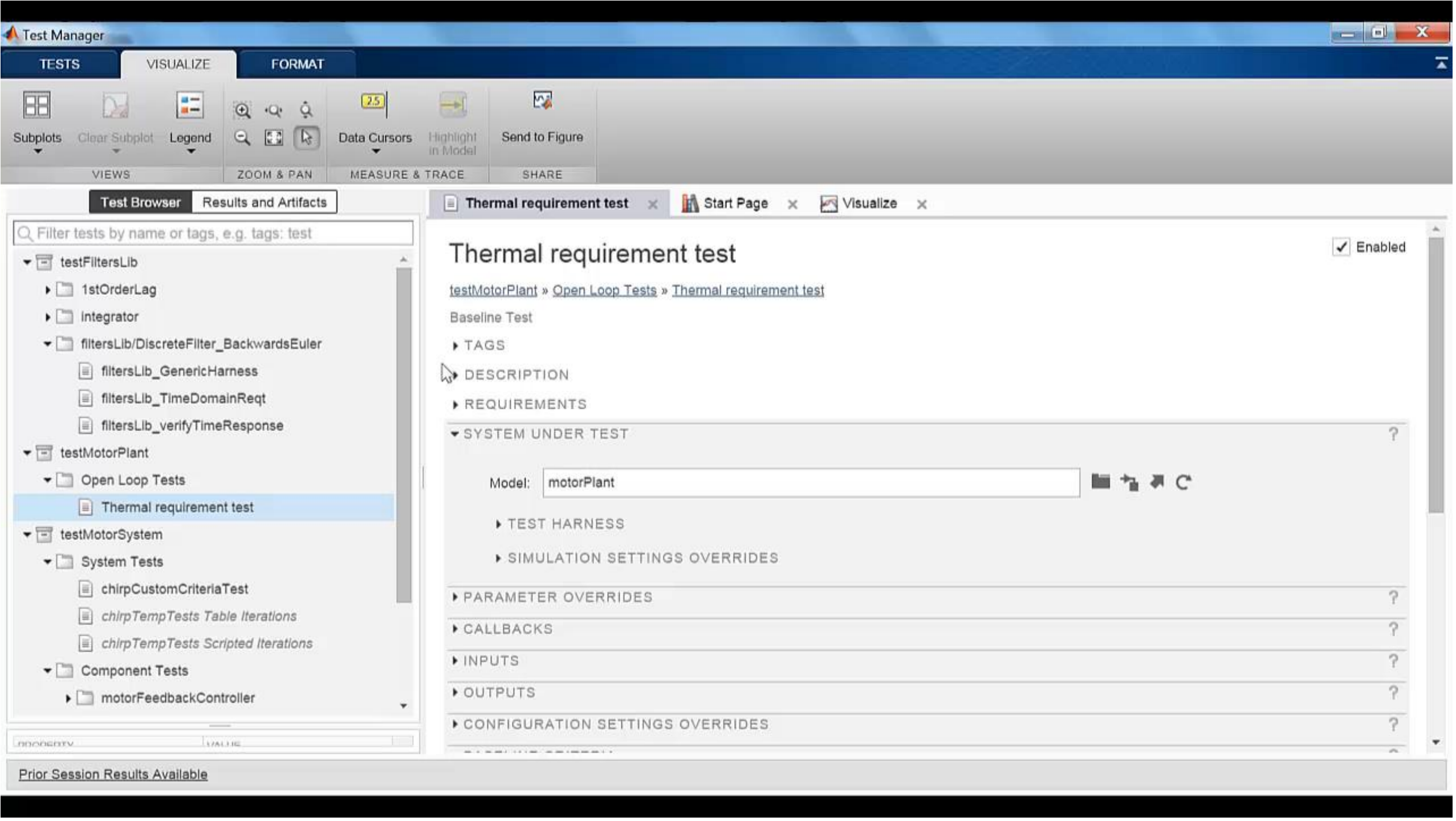
(Simulink Test + Simulink Design Verifier)


Test Manager
TESTS
VISUALIZE
FORMAT
Subplots
Clear Subplot
Legend
Data Cursors
Highlight in Model
Send to Figure
VIEWS
ZOOM & PAN
MEASURE & TRACE
SHARE
Test Browser
Results and Artifacts
Filter tests by name or tags, e.g. tags: test
testFiltersLib
testMotorPlant
testMotorSystem
PROPERTY
VALUE
Name
testMotorSystem
Location
C:\fmacmill\Demos\Simulin...
Enabled
Record Coverage
Tags
type comma or space separat
Start Page
Visualize
Getting Started
New Test File
Open Test File
RECENT FILES
motorFeedbackController_test1
motorFeedbackController_test
testNewFiltersLib
testMotorSystem
testMotorPlant
testFiltersLib
testNewFiltersLib
testMotorSystem
testMotorPlant
HELP LINKS
Get Started With the Test Manager
How to Create and Run a Test Case
View Test Results
Export Test Results and Generate Reports
Prior Session Results Available

A file is modified;

What test(s) do I need to run?

(Simulink Test + Simulink Projects)


Test Manager
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testFiltersLib
1stOrderLag
Integrator
filtersLib/DiscreteFilter_BackwardsEuler
filtersLib_GenericHarness
filtersLib_TimeDomainReqt
filtersLib_verifyTimeResponse
testMotorPlant
Open Loop Tests
Thermal requirement test
testMotorSystem
System Tests
chirpCustomCriteriaTest
chirpTempTests Table Iterations
chirpTempTests Scripted Iterations
Component Tests
motorFeedbackController
Thermal requirement test
Start Page
Visualize
Thermal requirement test
Enabled
testMotorPlant » Open Loop Tests » Thermal requirement test
Baseline Test
TAGS
DESCRIPTION
REQUIREMENTS
SYSTEM UNDER TEST
Model:
motorPlant
TEST HARNESS
SIMULATION SETTINGS OVERRIDES
PARAMETER OVERRIDES
CALLBACKS
INPUTS
OUTPUTS
CONFIGURATION SETTINGS OVERRIDES
Prior Session Results Available

Simulink Test... makes testing easier...

- Flexible
  - Ease authoring different types of test
  - Desktop or real-time
- Scalable
  - Hierarchical
  - Integration with Parallel Computing Toolbox
- Simple & Efficient
  - Less time writing infrastructure code
  - Integration with other V & V tools
  - Automated reporting

Test Manager

TESTS | VISUALIZE | FORMAT

Subplots | Clear Subplot | Legend | Data Cursors | Highlight in Model | Send to Figure

VIEWS | ZOOM & PAN | MEASURE & TRACE | SHARE

Test Browser | Results and Artifacts

Filter results by name or tags, e.g. tags: test

NAME	STATUS
Results: 2016-Sep-19 14:06:01	2 1
testMotorPlant	1
Open Loop Tests	1
Thermal requirement test	
testMotorSystem	1 1
System Tests	1 1
chirpCustomCriteriaTest	
Sim Output (myMotorSystem	
Custom Criteria Result	
Gain upper bound exceedence:	
Gain lower bound exceedence:	
Phase upper bound exceedence	
Phase lower bound exceedence	
chirpTempTests Table Iterations	

chirpCustomCriteriaTest | Start

chirpCustomCriteriaTest

testMotorSystem » System Tests » chirpCustom

Baseline Test

TAGS

myMotorSystem

DESCRIPTION

REQUIREMENTS

SYSTEM UNDER TEST

Model: myMotor

TEST HARNESS

SIMULATION SETTINGS OVERR

PARAMETER OVERRIDES

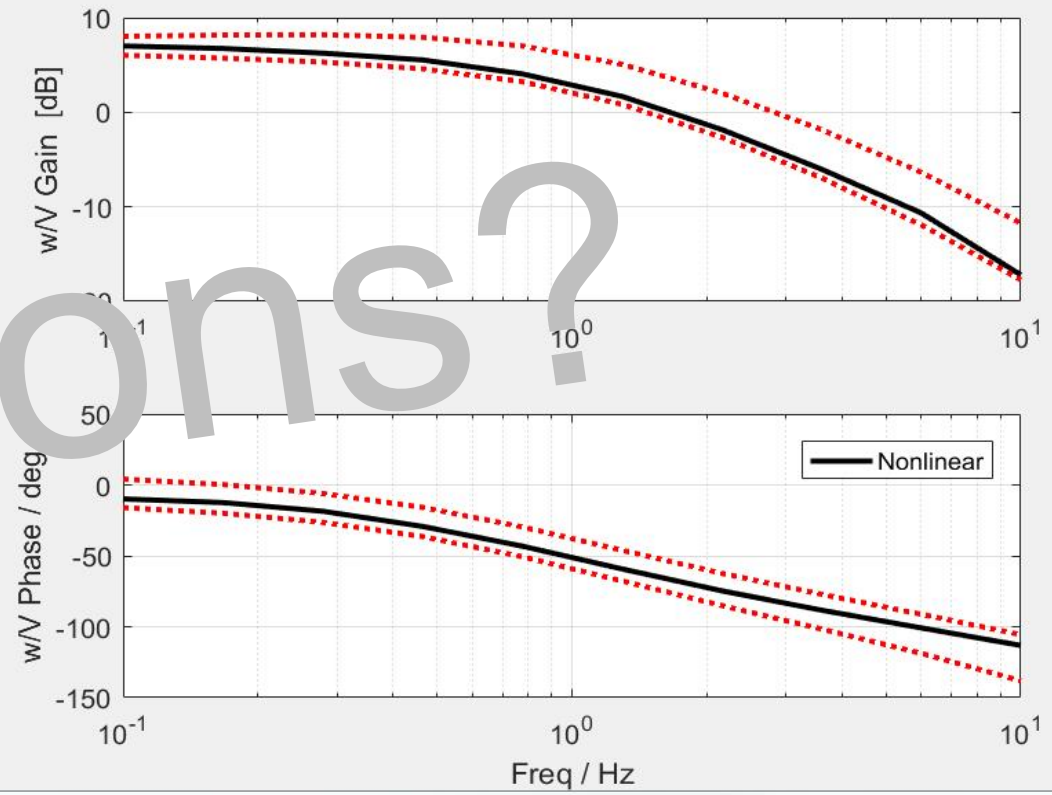
CALLBACKS

INPUTS

OUTPUTS

Figure 1: chirpFreq_

File Edit View Insert Tools Desktop Window Help



Questions?