

# MATLAB EXPO 2016

## New Capabilities in Testing

Fraser Macmillen



# 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?

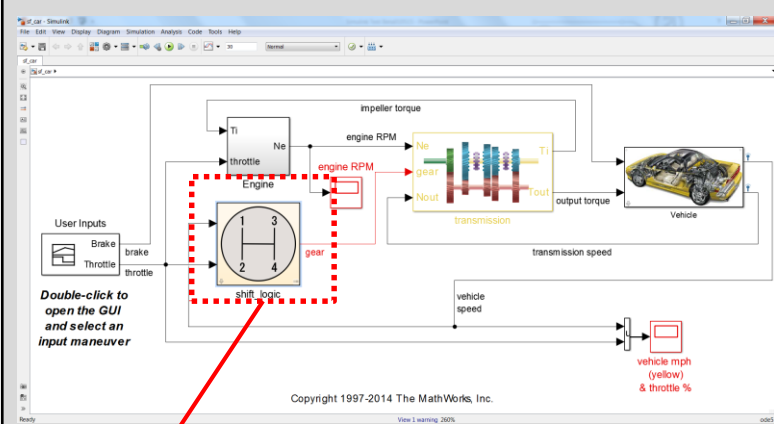
# Testing to date...

- 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

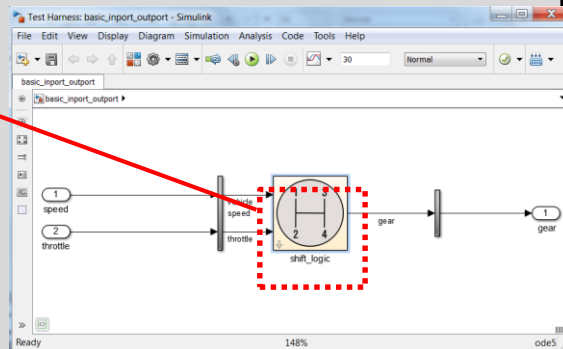
## 1. Test Harnesses

- Synchronized, simulatable test environment



Main Model

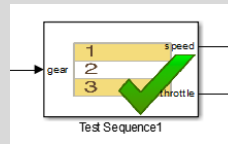
Component under test



Test Harness

## 2. Test Sequence Block

- Inputs and assessments based on logical, temporal conditions

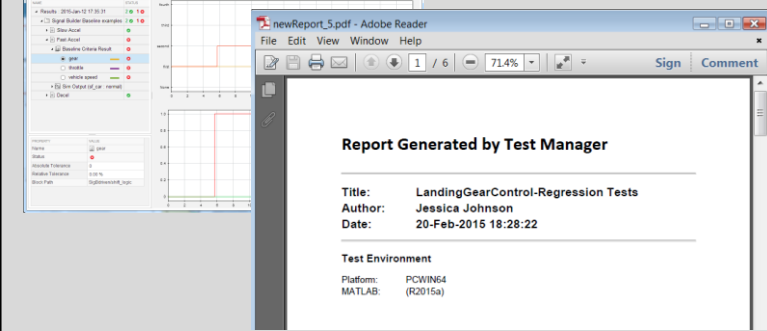
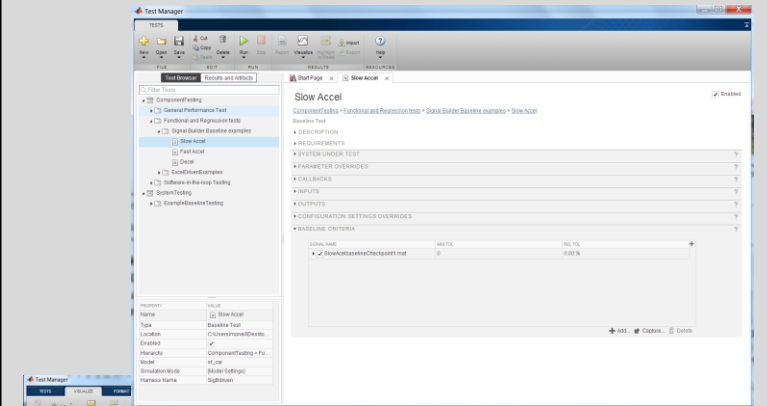


DoubleSTDriven/Test Sequence1 - Test Sequence Editor

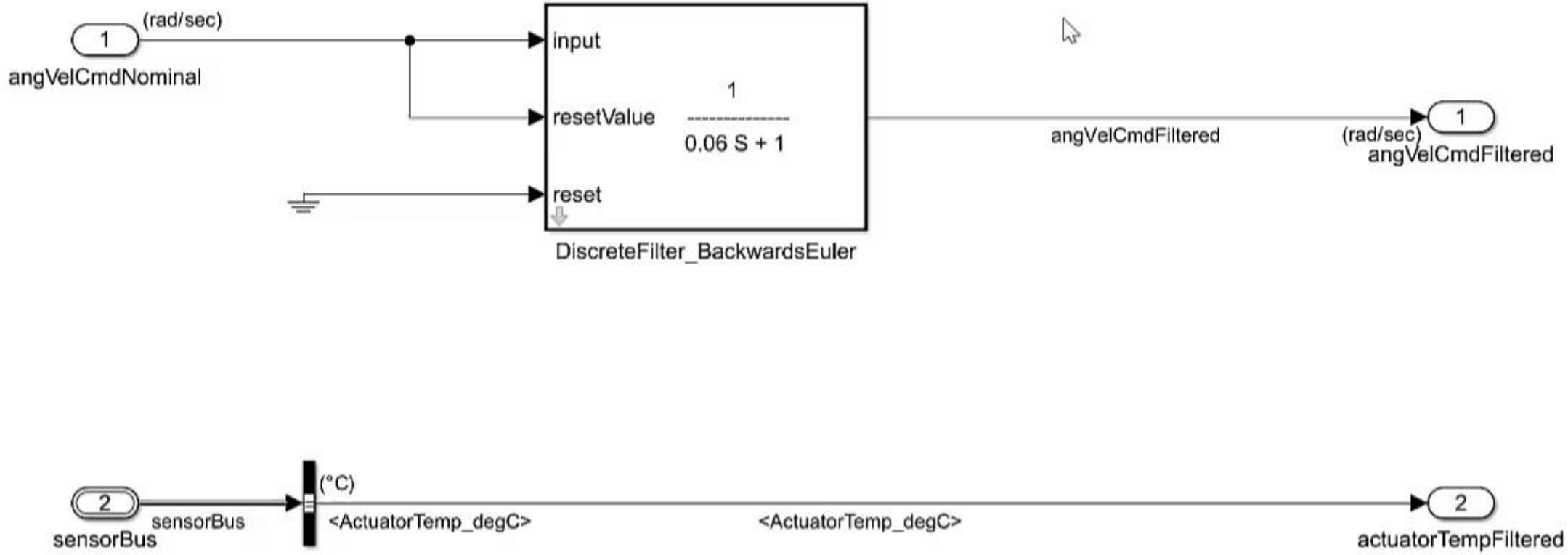
Step	Transition	Next Step
<b>init_step</b> speed = ramp (t); throttle = ramp (t);	1. after (2, sec)	step_2
<b>step_2</b> speed = 2* ramp (t); throttle = 2* ramp (t);  peak_speed = speed; peak_throttle = throttle;	1. gear == 3	step_3
<b>step_3</b>  if speed > 0 speed = peak_speed - ε throttle = peak_throttle - speed = 0; throttle = 0;		

## 3. Test Manager

- Author, execute, manage test cases
- Review, export, report

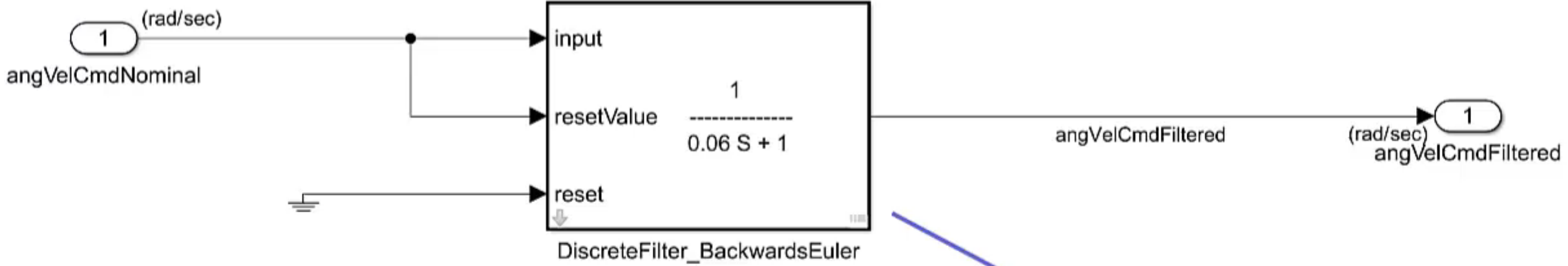
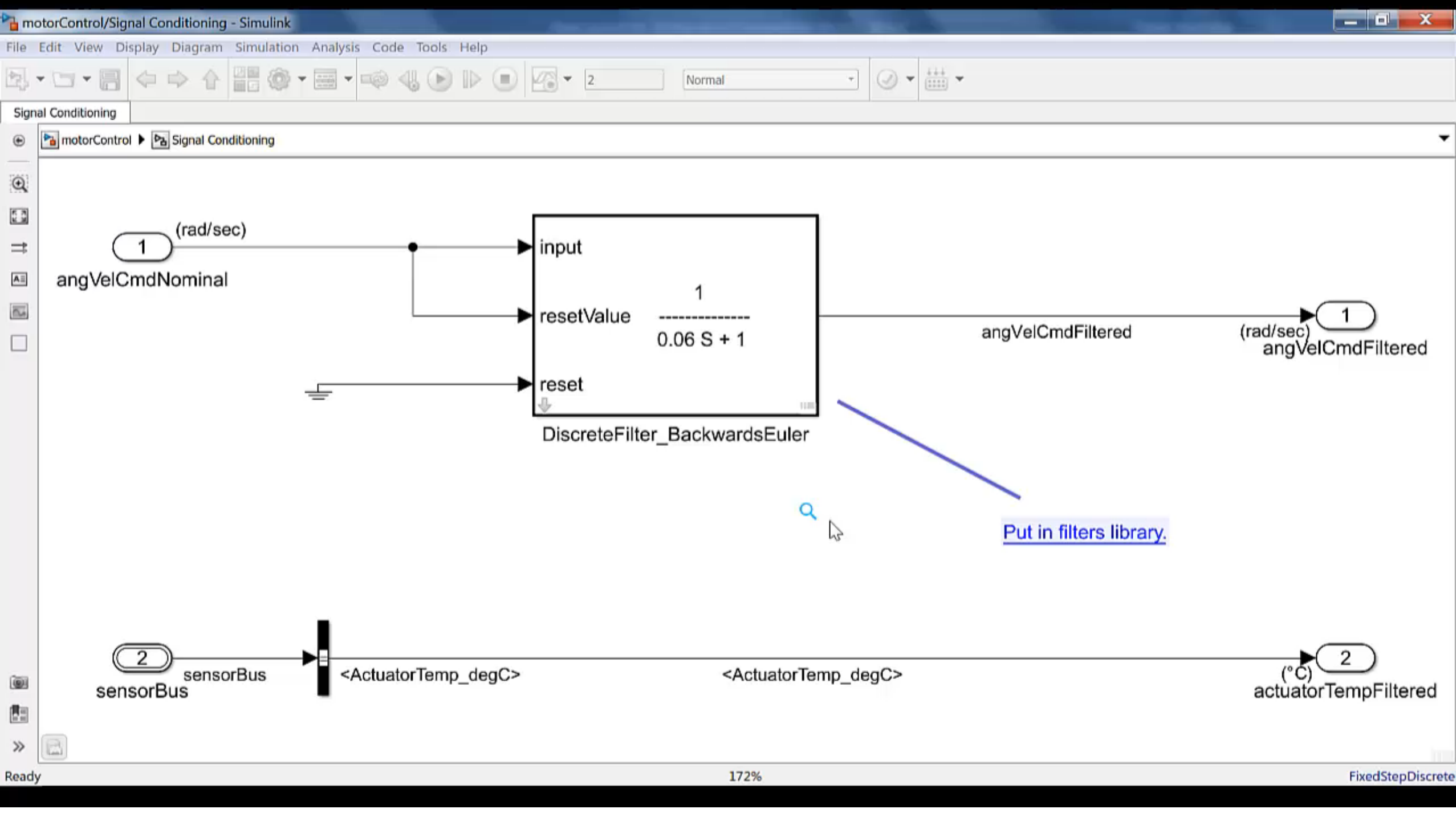


# Creating Test Harnesses

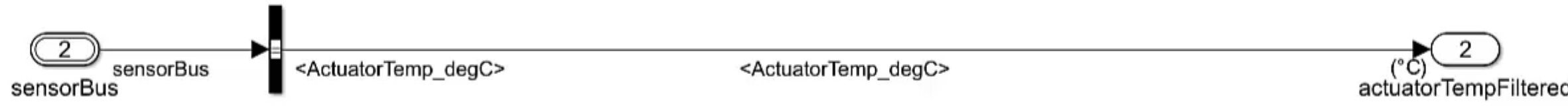


## But what if...

- 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



[Put in filters library.](#)

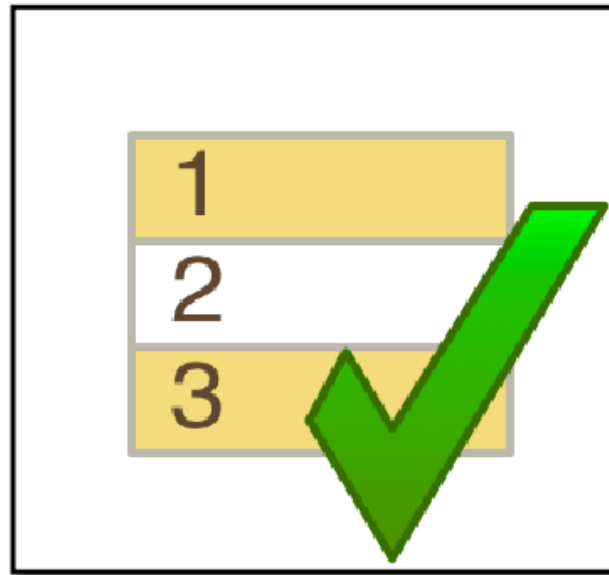




# Release Notes – Test Harnesses

- Test Harnesses for Libraries R2016a
- External Test Harnesses R2016a
- External Test Harnesses with Requirements Linking R2016b

# Test Sequence / Test Assessment block



Test Sequence

# Release Notes – Test Sequence

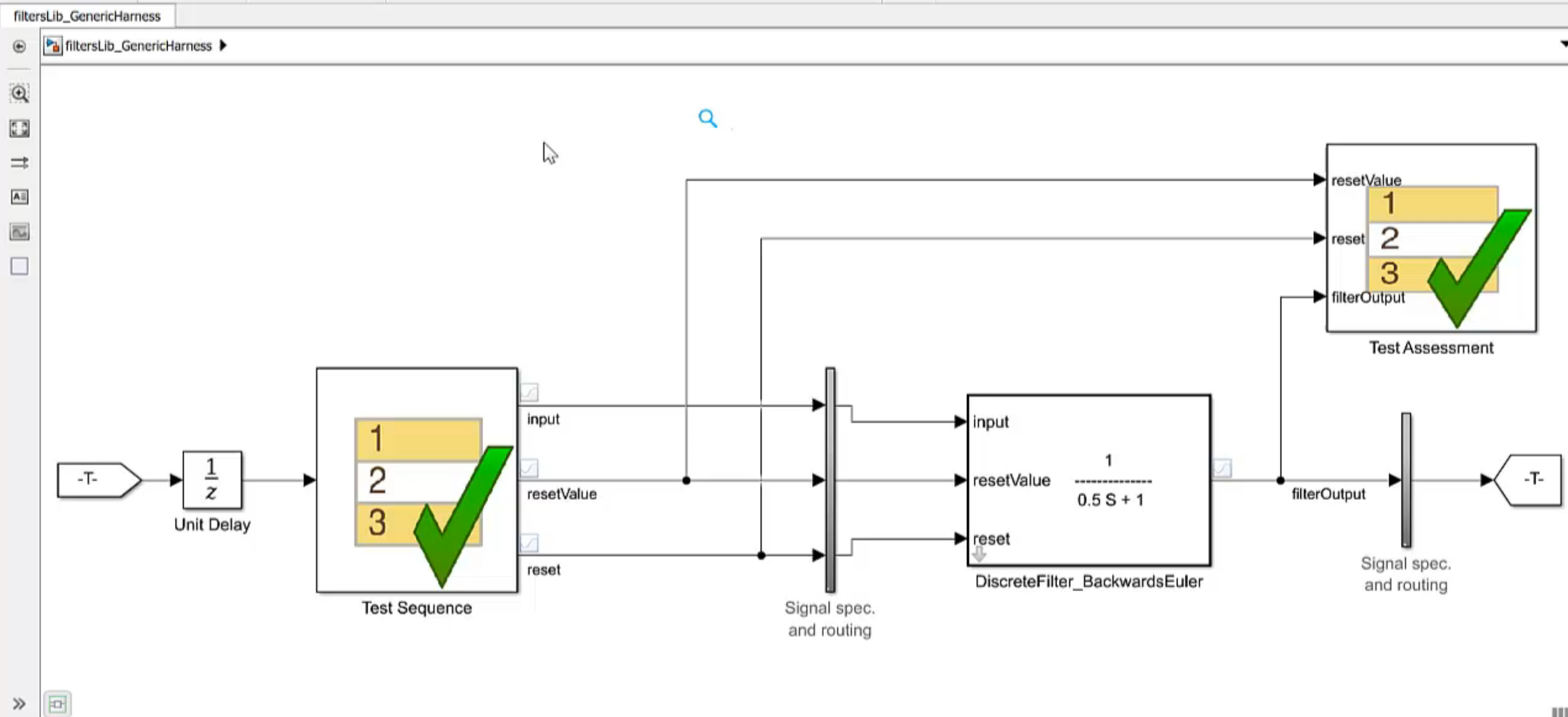
- description field R2016a
- tab complete & syntax highlighting R2016a
- port reordering R2016a
- support messages R2016a
- **“verify” statements** R2016a

# 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



**Create a test  
for multiple parameter values  
and verify response against a custom criteria**



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

Enabled

[testNewFiltersLib](#) » [filtersLib/DiscreteFilter\\_BackwardsEuler](#) » [filtersLib\\_GenericHarness](#)

Baseline Test

- TAGS
- DESCRIPTION
- REQUIREMENTS
- SYSTEM UNDER TEST
  - Model:
  - 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

TESTS

FILE EDIT RUN RESULTS RESOURCES

New Open Save Cut Copy Paste Delete Run Stop Parallel Report Visualize Highlight in Model Import Export Help

Test Browser Results and Artifacts

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

NAME	STATUS
Results: 2016-Sep-15 10:54:47	4
testNewFiltersLib	4
filtersLib/DiscreteFilter_BackwardsEuler	4
filtersLib_GenericHarness	
filtersLib_verifyTimeResponse	3

PROPERTY	VALUE
Name	filtersLib_GenericHarne...
Status	1
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 x Start Page x filtersLib\_verifyTimeResponse x

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
- Test iterations (parameter sweeps) R2016a
- Simulink Real-Time integration R2016a
- Tag test cases R2016b
- **Custom test criteria** R2016b
- **MATLAB Unit Test integration** R2016b

# **Extend requirements-based tests to achieve full coverage**

**(Simulink Test + Simulink Design Verifier)**



Subplots



Clear Subplot



Legend



ZOOM & PAN

2.5

Data Cursors



Highlight in Model



Send to Figure

MEASURE & TRACE

SHARE

Test Browser

Results and Artifacts

Start Page x

Visualize x

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

- ▶ testFiltersLib
- ▶ testMotorPlant
- ▶ testMotorSystem



## Getting Started

New Test File

Open Test File

### RECENT FILES

[motorFeedbackController\\_test1](#)

[motorFeedbackController\\_test](#)

[testNewFiltersLib](#)

[testMotorSystem](#)

[testMotorPlant](#)

[testFiltersLib](#)

[testNewFiltersLib](#)

[testMotorSystem](#)

[testMotorPlant](#)

[testFiltersLib](#)

### 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](#)



PROPERTY	VALUE
Name	testMotorSystem
Location	C:\fmacmill\Demos\Simuln...
Enabled	<input checked="" type="checkbox"/>
Record Coverage	<input checked="" type="checkbox"/>
Tags	type comma or space separati

**A file is modified;**

**What test(s) do I need to run?**

**(Simulink Test + Simulink Projects)**



TESTS VISUALIZE FORMAT

Subplots Clear Subplot Legend

2.5

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
  - 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

PROPERTY VALUE

Thermal requirement test x Start Page x Visualize x

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 ?

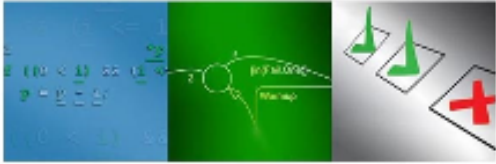
OUTPUTS ?

CONFIGURATION SETTINGS OVERRIDES ?

## Related talks...

- Simulink Projects... Gavin Walker, masterclass, after lunch
- Connecting to hardware.... Nicolas Gautier, AT2, after lunch
- Verification of generated code... Richard Anderson, AT2, last session

## Related demo stations...



### Verifying Models and Code Through Automated Testing and Analysis

Design models in Simulink must be supported by appropriate levels of testing: effective methods that identify defects as early as possible. Efficient testing is just as important in speeding up development as having capable design tools. Come and discover the range of verification and validation techniques that can be applied to models and code, centered on the framework for simulation-based testing provided by Simulink Test™.



### System Modelling, Project Management, and Simulation

System-level modelling and simulation requires flexibility in modelling style and testing frameworks. Through the example of a system-level aircraft model, discover how the latest capabilities of Simulink are used to ease modelling, testing, and project management tasks.

**Technology Focus:** System-level modelling, simulation

# 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

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 exceedance	✓
Gain lower bound exceedance	✓
Phase upper bound exceedance	✓
Phase lower bound exceedance	✓
chirpTempTests Table Iterations	⊘

### chirpCustomCriteriaTest

Baseline Test

TAGS: myMotorSystem

DESCRIPTION

REQUIREMENTS

SYSTEM UNDER TEST

Model: myMotorSystem

TEST HISTORY

SIMULATION SETTINGS OVERVIEW

PARAMETER OVERRIDES

CALLBACKS

INPUTS

OUTPUTS

#### Figure 1: chirpFreq\_

w/V Gain [dB]

w/V Phase / deg

Nonlinear

Freq / Hz

Questions?