

Simulink® Requirements™

Getting Started Guide



MATLAB® & SIMULINK®

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Simulink® Requirements™ Getting Started Guide

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1

Getting Started with Simulink Requirements

Simulink Requirements Product Description	1-2
Key Features	1-2
Work with Requirements in the Simulink Editor	1-3
Author Requirements in Simulink	1-3
Link Blocks and Requirements	1-6
Link to Test Cases from Requirements	1-10
Requirements Definition for a Cruise Control Model	1-13
Introduction to Simulink Requirements	1-14
Link Between Requirements and Implementation	1-14
Link Between Requirements and Simulink Test	1-14
Additional Requirements Traceability Links	1-15
Share and Reuse Requirements	1-15

Getting Started with Simulink Requirements

- “Simulink Requirements Product Description” on page 1-2
- “Work with Requirements in the Simulink Editor” on page 1-3
- “Link to Test Cases from Requirements” on page 1-10
- “Requirements Definition for a Cruise Control Model” on page 1-13
- “Introduction to Simulink Requirements” on page 1-14

Simulink Requirements Product Description

Author, manage, and trace requirements to models, generated code, and test cases

Simulink® Requirements™ lets you author, analyze, and manage requirements within Simulink. You can create rich text requirements with custom attributes and link them to designs, code, and tests. Requirements can be imported from external sources and you can receive automatic notification when requirements change. You can view the requirements and design together, establish links with drag and drop, annotate diagrams with requirements content, analyze requirements traceability, and navigate between requirements, designs, generated code, and tests.

Simulink Requirements indicates when changes occur to linked requirements, designs, or tests. It calculates the implementation and verification status of your requirements, enabling you to assess project completeness.

Support for industry standards is available through IEC Certification Kit (for ISO 26262 and IEC 61508) and DO Qualification Kit (for DO-178).

Key Features

- Requirements Editor for requirements authoring, editing, and organization
- Requirements Perspective for viewing, linking, and managing requirements within the Simulink graphical editor
- Requirements import and synchronization from third-party tools such as Microsoft® Word and Microsoft Excel®
- Change tracking and differencing to automatically identify and manage changing requirements
- Consolidated status metrics for requirements implementation and verification
- Reports documenting requirement attributes, traceability, and status
- Bidirectional traceability between requirements, designs, generated code, and tests

Work with Requirements in the Simulink Editor

Simulink Requirements enables you to author, organize, and edit requirements in the Simulink Editor. A specialized view, the Requirements Perspective, helps you to visualize the links between requirements and the parts of a model. Using an integrated environment simplifies linking requirements to the parts of your model that implement them.

This integrated environment has other advantages. For details, see “Introduction to Simulink Requirements” on page 1-14.

Author Requirements in Simulink

- “Author and Edit Requirements Content by Using Microsoft Word” on page 1-5
- “Customize Requirements Browser View” on page 1-5
- “Filter Requirements Content” on page 1-5

In Simulink Requirements, you organize your requirements in groups called requirement sets. In each requirement set, you can create additional levels of hierarchy if you need to further describe a requirement's details.

In this tutorial, you use the Requirements Editor to create a requirement set, organize related requirements, and add requirements to the set.

Suppose that you are writing requirements for a controller model of an automobile cruise control system. You develop these requirements using your company's numbering standard (R1, R2, and so on).

ID and Description	Rationale
R1: The maximum input throttle is 100%	The maximum value of the throttle from the acceleration pedal can be no greater than 100%.
R2: Cruise control has a speed operation range	Cruise control has a minimum and maximum operating speed.
R2.1: The vehicle speed must be at least 40 km/h	The speed of the vehicle must be at least 40 km/h for the cruise control system to engage.
R2.2: The vehicle speed cannot be greater than 100 km/h	The maximum operational speed of the cruise control system for the vehicle is 100 km/h.

Add these requirements to a model called `crs_controller`.

- 1 Open the project that includes the model and supporting files. At the MATLAB® command prompt, enter:

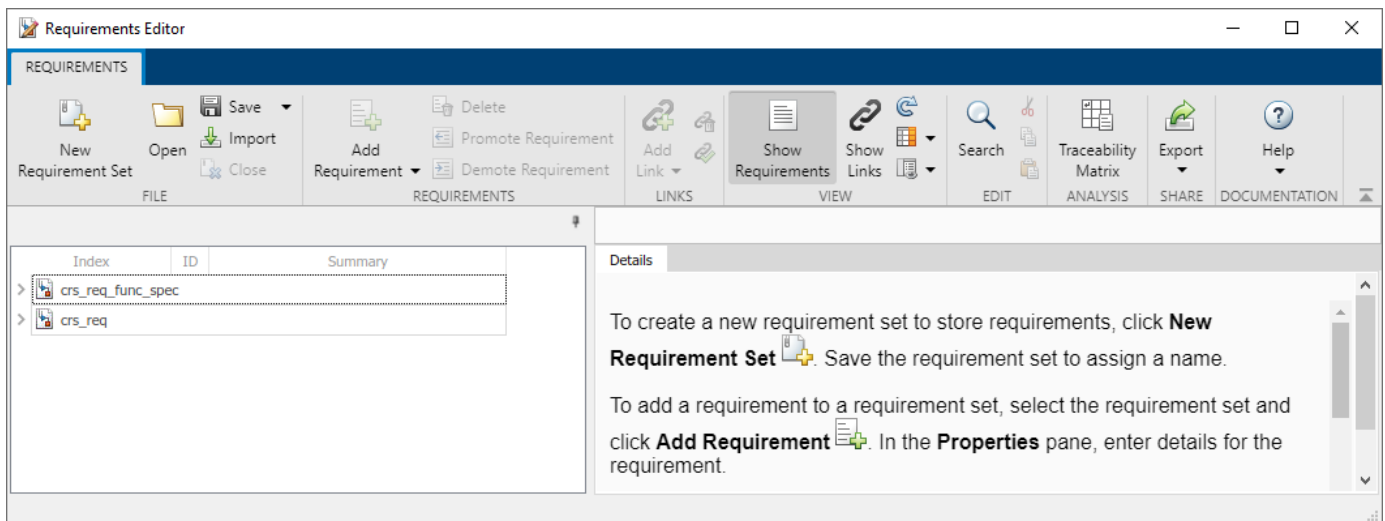
```
slreqCCProjectStart
```

- 2 Open the model. At the command prompt, enter:







```
open_system('models/crs_controller')
```

- 3 Open the Requirements Editor. In the **Apps** tab, click **Requirements Manager**. In the **Requirements** tab, click **Requirements Editor**.

The Requirements Editor displays the requirements in the Requirements Browser arranged by requirement set. The `crs_controller` model has two requirement sets: `crs_req_func_spec` and `crs_req`.



- 4 Add a requirement set in the Requirements Browser. From the Requirements Editor toolbar, click **New Requirement Set**.
 - 5 Save the requirement sets to external files. Save your requirement set to a writable location and name it `cruise_control_reqset.slreqx`.
 - 6 Add a requirement to your requirement set by selecting the requirement set and clicking **Add Requirement**.
 - 7 In the **Details** pane, under **Properties**, enter the details for the requirement. Enter the details for the requirement:
 - **Custom ID:** R1
 - **Summary:** Max input throttle %
 - **Description:** The maximum input throttle is 100%.
- If you do not specify a custom ID, the Requirements Editor numbers requirements in order. Custom IDs enable you to use your company standards for labeling requirements and to set the numeric order. (Custom IDs cannot contain a # character.) You can also use an ID to help locate a requirement when searching. Keywords aid in searching for a requirement.
- 8 Create the requirement R2. Click **Add Requirement**. Enter the details for the requirement:
 - **Custom ID:** R2
 - **Summary:** Cruise control speed operation range
 - **Description:** Cruise control has a minimum and maximum operating speed.
 - 9 Create child requirements for R2 by selecting R2 and clicking **Add Requirement > Add Child Requirement**. Enter the details for the requirement:
 - **Custom ID:** R2.1
 - **Summary:** Minimum vehicle speed
 - **Description:** The speed of the vehicle must be at least 40 km/h for the cruise control system to engage.

Index	ID	Summary
>  crs_req		
>  crs_req_func_spec		
▼  cruise_control_reqset*		
 1	R1	Max input throttle %
▼  2	R2	Cruise control speed operation range
 2.1	R2.1	Minimum vehicle speed

Repeat this step to add other child requirements to R2.

You can rearrange the hierarchy by using  **Promote Requirement** or  **Demote Requirement**.


Author and Edit Requirements Content by Using Microsoft Word

To author and edit the **Description** and **Rationale** fields of your requirements, open Microsoft Word from within the Requirements Editor or the Requirements Perspective View.

Note This functionality is available only on Microsoft Windows® platforms.


Using Microsoft Word to edit rich text requirements enables you to:

- Spell-check requirements content.
- Resize images.
- Insert and edit equations.
- Insert and edit tables.

On the Edit field toolbar, in either the **Description** or **Rationale** fields, click the  icon. Save the changes to your requirements content within Microsoft Word to see them reflected in Simulink Requirements.

When you use Microsoft Word to edit requirements content, you cannot edit requirements in the built-in editor.

Customize Requirements Browser View

You can view or hide columns in the Requirements Editor when you click  **Columns > Select Attributes**. Add, remove, and reorder attribute columns in the Column Selector. The view configuration is saved across sessions. You can export view settings to a MAT-file by using the `slreq.exportViewSettings` function and import them by using the `slreq.importViewSettings` function. You can reset view configurations by using the `slreq.resetViewSettings` function.

Filter Requirements Content

You can search requirements content by clicking **Search**. You can find specific requirements within loaded requirement sets based on requirement attributes and descriptions.

Specify Filter Text Strings — As you enter text in the **Search** text box, the Requirements Browser performs a dynamic search and displays the results. The search operation applies only to attributes you choose to display in the Requirements Browser.

The text strings you enter must be consistent with the guidelines described in the following sections.

Case Sensitivity — By default, the Requirements Browser ignores case as it filters.

If you want the Requirements Browser to respect case sensitivity, put that text string in quotation marks.

Specify Attributes and Attribute Values — To restrict the filtering to requirements with a specific attribute, type the attribute name, followed by a colon. The Requirements Browser displays only the requirements that have that attribute.

To filter for requirements for which a specific attribute has a specific value, type the attribute name, followed by a colon (:), then the value. For example, to filter the contents to display only the requirements where the Summary attribute has a value that includes Aircraft, enter Summary: Aircraft (alternatively, you could put the whole string in quotation marks to enforce case sensitivity).

Wildcards and MATLAB Expressions Are Not Supported — The Requirements Browser does not recognize wildcard characters, such as *. For example, searching fuel* returns no results, even if requirements contain the text string fuel.

Also, if you specify a MATLAB expression in the **Search** text box, the Requirements Browser interprets that string as literal text, not as a MATLAB expression.

Link Blocks and Requirements

You can track requirements implementation by linking requirements to model elements that implement the requirements. Linking also enables change notification, so that you can review and act on changes to requirements or models.

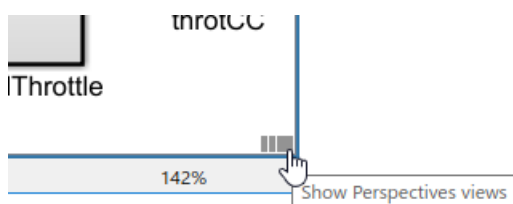
In this tutorial, link requirements to a model by using the model requirements perspective. Visual elements highlight links between requirements and blocks.

- 1 Open the example project by entering

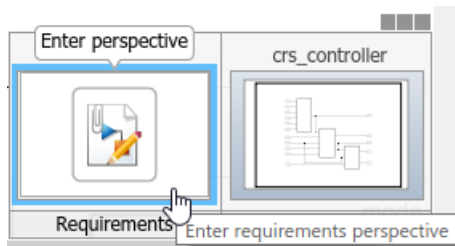
```
slreqCCProjectStart
```

Open crs_controller from the models folder.

- 2 In the model canvas, click the perspectives control in the lower-right corner.

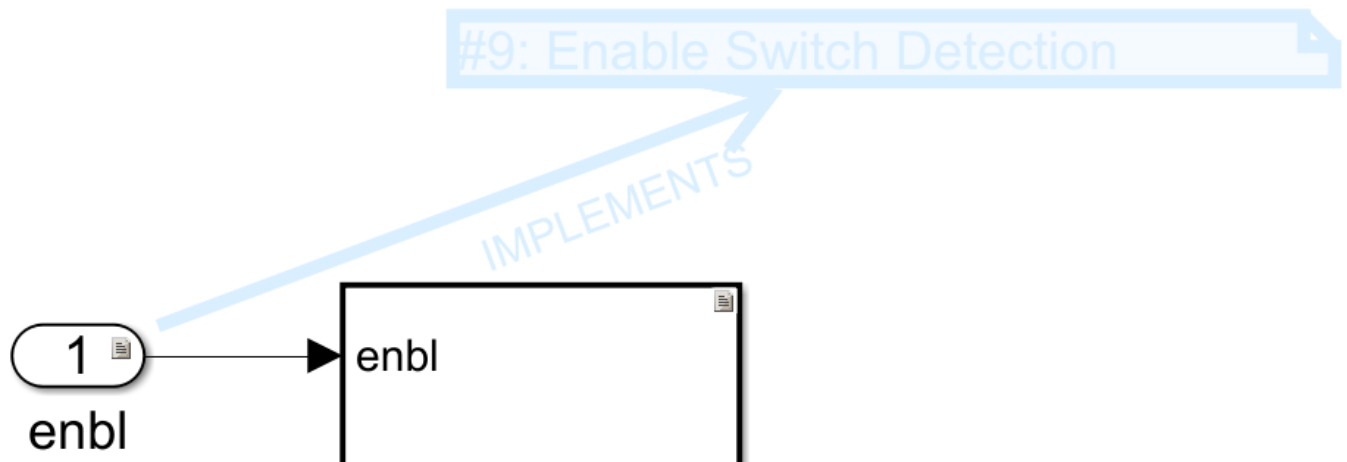


- 3 Open the requirements perspective by clicking the **Requirements** icon.

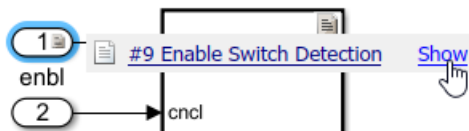


The Requirements Browser appears at the bottom of the model canvas. When you select a requirement, the Property Inspector displays the requirement's properties.

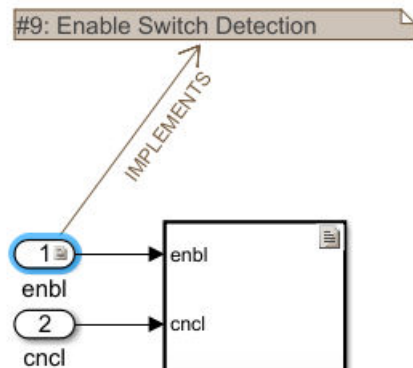
- 4 Link a requirement to a model element:
 - 1 In the Requirements Browser, search for **Enable Switch Detection**.
 - 2 Link to the **enbl** Inport block by clicking and dragging the requirement to the block. An annotation template appears.
 - 3 Place the requirement annotation by clicking on the canvas. Create a link without an annotation by clicking outside the canvas.



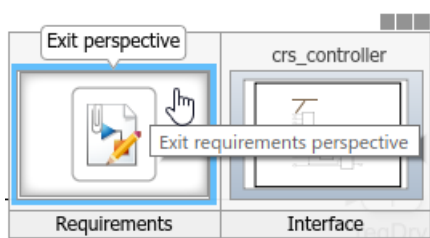
- 5 The block displays a link badge. To display information about the requirement, click the badge and select **Show**.



Clicking **Show** displays the requirement ID, requirement summary, and link type. For information on link types, see "Requirement Links".



- To see the requirement description, double-click the annotation.
 - To edit the requirement, right-click the annotation and select **Select in Requirements Browser**. Edit the requirement properties in the Property Inspector.
- 6 Exit the requirements perspective. Click the perspectives control and click the requirements icon.



Work with Simulink Annotations

Convert Simulink Annotations to Requirements

You can convert the annotations in your Simulink models to requirements by using the context menu in the Requirements Perspective View and by using the API. See `slreq.convertAnnotation` for more information on converting annotations to requirements by using the API.

To convert annotations to requirements by using the context menu in the Requirements Perspective View:

- 1 Open the Simulink model and enter the Requirements Perspective View.
- 2 Select a requirement set from the Requirements Browser. This is the destination requirement set for the new requirement.
- 3 Right click the annotation you want to convert to a requirement and click **Convert to Requirement**.
- 4 The annotation is converted to a requirement and is linked to the system or subsystem at which the annotation was present.

Link Requirements to Simulink Annotations

Use the Requirements Perspective View to link requirements to text and area annotations on the Simulink Editor. To create a link, select a requirement and drag it onto the annotation. If you link requirements to an area annotation, a badge appears on the annotation to show that the link was created. You see badges only in the Requirements Perspective View. To see more information about the requirement, click the badge and select **Show**.

See Also

More About

- “Introduction to Simulink Requirements” on page 1-14
- “Requirement Links”
- “Define Requirements Hierarchy”

Link to Test Cases from Requirements

If you have Simulink Test™ and Simulink Requirements, you can link your requirements to test cases in the Test Manager. Linking to tests lets you see how requirements are confirmed with tests.

These links also help you to see your progress toward verifying the implementation of each requirement. Simulink Requirements can display verification status. Verification status helps you to see the requirements that are verified, the requirements that are missing tests, and whether tests associated with your requirements passed or failed.

In this tutorial, you link requirements to test cases associated with a controller model of an automobile cruise control system, managed in a project. After you run the tests, you include the results in the Requirements Editor.

- 1 Open the project. At the MATLAB command prompt, enter:

```
slreqCCProjectStart
```

- 2 Open the controller model. At the command prompt, enter:

```
open_system('models/crs_controller')
```

- 3 Open the Test Manager. In the **Apps** tab, click **Simulink Test**. In the **Test** tab, click **Simulink Test Manager**.

- 4 In the Simulink Test Test Manager, from the **tests** folder, open the `DriverSwRequest_Tests.mldatx` test file.

- 5 In the **Test Browser** pane, expand the test case hierarchy. The test file contains the test cases for several of the requirements in the `crs_controller` model. Most of these tests cases already link to requirements.

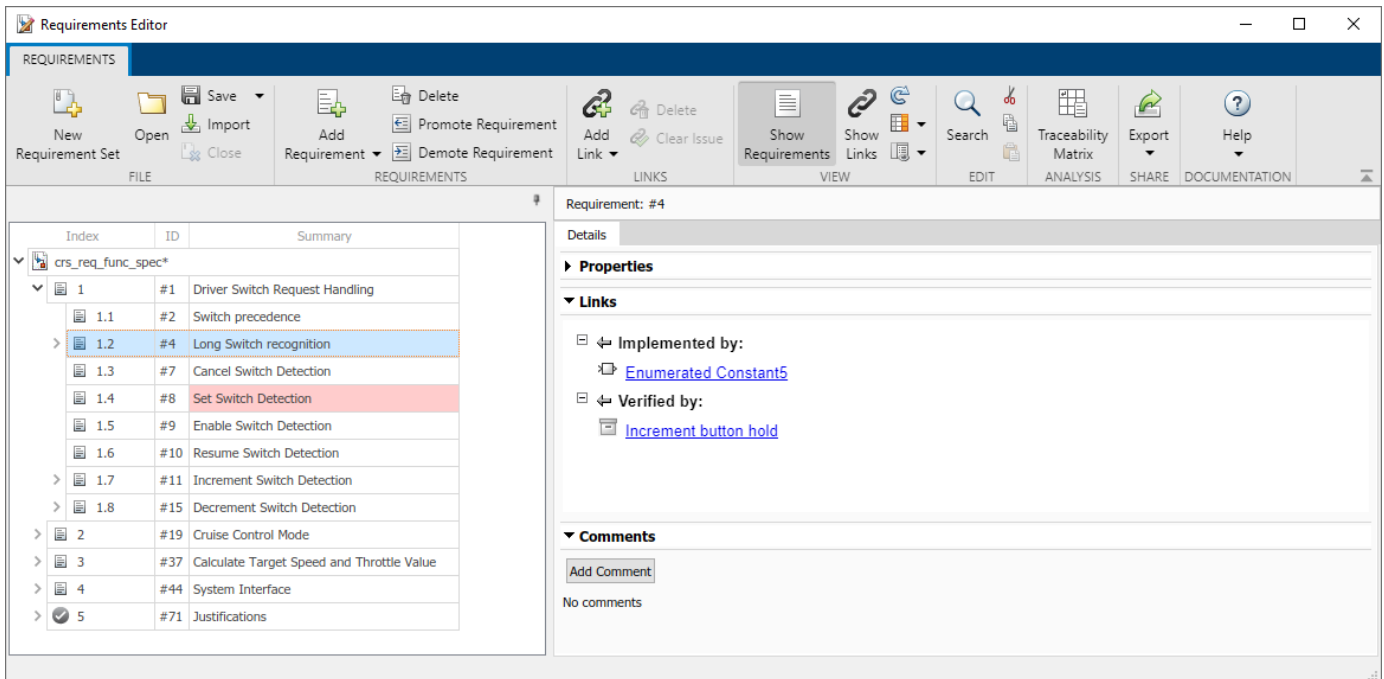
Link the **Increase** button hold test to a requirement. Select that test case.

- 6 Open the Requirements Editor. Navigate back to the `crs_controller` Simulink model. In the **Apps** tab, click **Requirements Manager**. In the **Requirements** tab, click **Requirements Editor**.

- 7 Click **Show Requirements**. Display the requirements hierarchy for `crs_req_func_spec`.

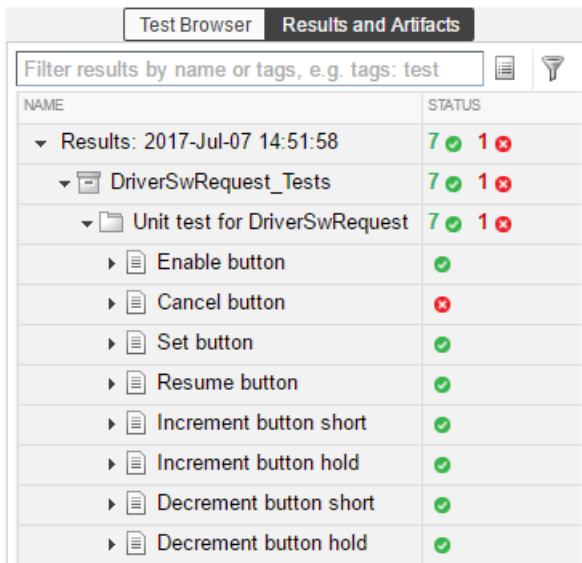
- 8 Right-click the requirement with the ID 1.3 (Long Switch recognition) and select **Link from Selected Test Case**.

The link to the test case appears in the **Details** pane, under **Links**.



- 9 View verification information for other requirements 1.4, 1.6, 1.8, and 1.9 by selecting each requirement. The links are displayed in the **Details** pane under **Links** under **Verified by**.
- 10 To run linked tests, in the Test Manager, select the top node in the test hierarchy in the **Test Browser** pane, then click **Run**.

The **Results and Artifacts** pane in the Test Manager shows that 7 tests passed and 1 test failed. Expand the results. The Cancel button test failed and the other tests passed.

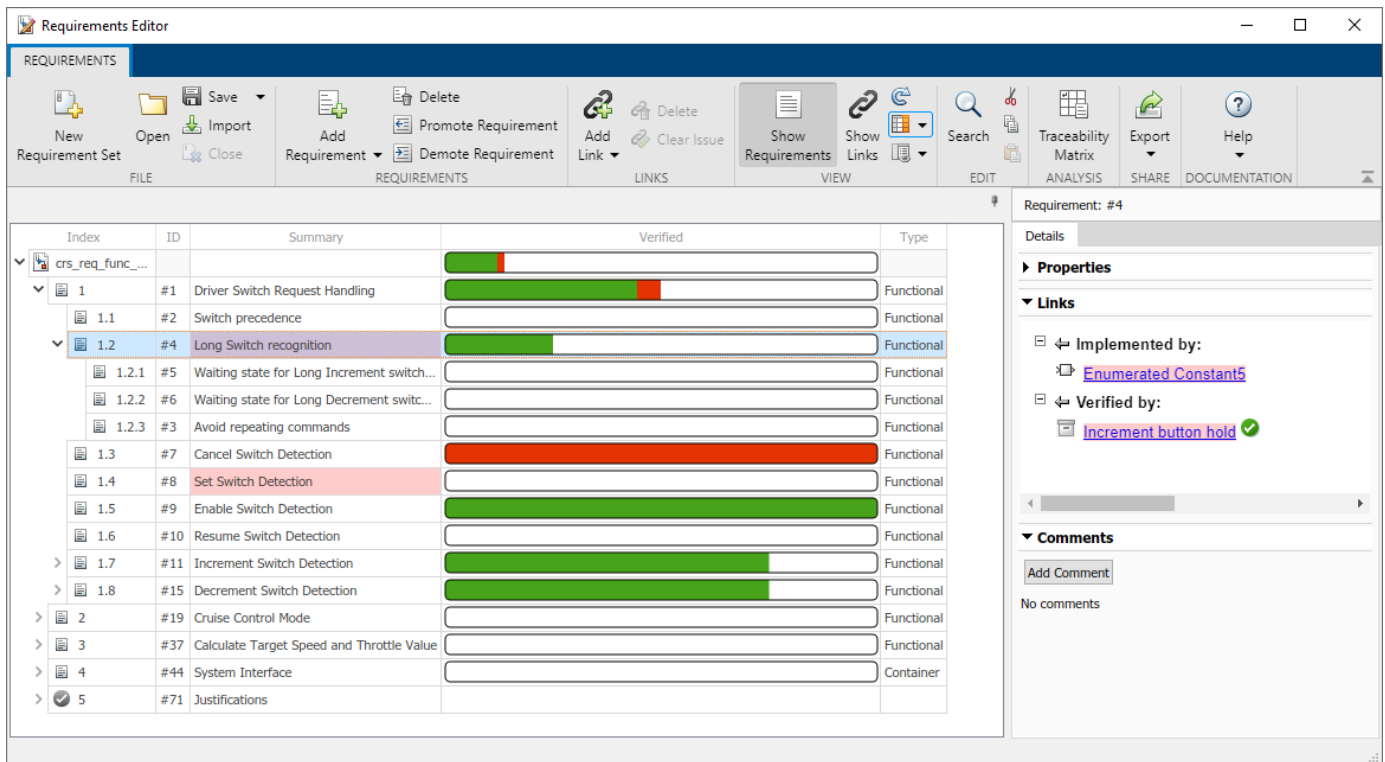


- 11 In the Requirements Editor, select  **Columns > Verification Status**. Resize the requirements browser window to see the **Verified** column.

This view shows you the progress toward verification. Some requirements do not yet have tests. Some requirements are fully verified. The width of the verified display shows the proportion of

subrequirements that have links to verification. The color of the display indicates the proportion of tests that have passed, failed, or not run.

Here, the `Cancel Switch Detection` verification status shows that the test failed. Some requirements are partially verified because the subrequirements are not yet verified, such as requirement 1.8 in the figure. Hover over the verification status bar for details about the subrequirements. Other requirements are unverified because they are not linked to a test case.



See Also

More About

- “Requirement Links”
- “Link Test Cases to Requirements Documents”
- “Work with Requirements in the Simulink Editor” on page 1-3

Requirements Definition for a Cruise Control Model

This is a comprehensive example for Requirements-driven MBD with multiple related design artifacts managed in a project. Use the following code to open this project: `sl reqCCProjectStart()`

This will place the necessary files in a working directory, which will allow you to modify links between artifacts, run tests, generate reports, play around with implementation and verification status updates.

The screenshot displays the Simulink Requirements tool interface for a project named 'crs_controller'. The main workspace shows a block diagram with three primary blocks: 'DriverSwRequest', 'CruiseControlMode', and 'TargetSpeedThrottle'. 'DriverSwRequest' has inputs 1-6 (enbl, cncl, set, resume, inc, dec) and outputs reqDrv, brakeP, vehSp, key, gear, throtDrv. 'CruiseControlMode' has inputs reqDrv, brakeP, vehSp, key, gear and outputs status, mode, throtCC. 'TargetSpeedThrottle' has inputs mode, vehSp and outputs targetSp, throtCC. Requirements are linked to these blocks: '#1: Driver Switch Request Handling' is implemented by reqDrv; '#19: Cruise Control Mode' is implemented by CruiseControlMode; and '#37: Calculate Target Speed and T...' is implemented by TargetSpeedThrottle.

The Requirements table at the bottom shows the following data:

Index	Summary	Implemented	Verified
crs_req_f...			
1	Driver Switch Request Handling	<div style="width: 100%; background-color: blue;"></div>	<div style="width: 50%; background-color: yellow;"></div>
1.1	Switch precedence	<div style="width: 100%; background-color: blue;"></div>	<div style="width: 0%; background-color: yellow;"></div>
1.2	Avoid repeating commands	<div style="width: 100%; background-color: blue;"></div>	<div style="width: 0%; background-color: yellow;"></div>
1.3	Long Switch recognition	<div style="width: 100%; background-color: blue;"></div>	<div style="width: 0%; background-color: yellow;"></div>
1.4	Cancel Switch Detection	<div style="width: 100%; background-color: blue;"></div>	<div style="width: 50%; background-color: yellow;"></div>
1.5	Set Switch Detection	<div style="width: 100%; background-color: blue;"></div>	<div style="width: 0%; background-color: yellow;"></div>

The Property Inspector on the right shows details for Requirement #19: 'Cruise Control Mode'. It is a Functional requirement with Index 2 and Custom ID #19. The description states: 'The Cruise Control Mode module determines the operation mode of the cruise control system. The operation mode is determined by two types of sources: 1. Output of the Driver Switch Request model, 2. Environmental conditions. This module also controls the status indicator used in the instrument panel.' The Links section shows it is implemented by 'CruiseControlMode'.

Introduction to Simulink Requirements

In this section...

“Link Between Requirements and Implementation” on page 1-14

“Link Between Requirements and Simulink Test” on page 1-14

“Additional Requirements Traceability Links” on page 1-15

“Share and Reuse Requirements” on page 1-15

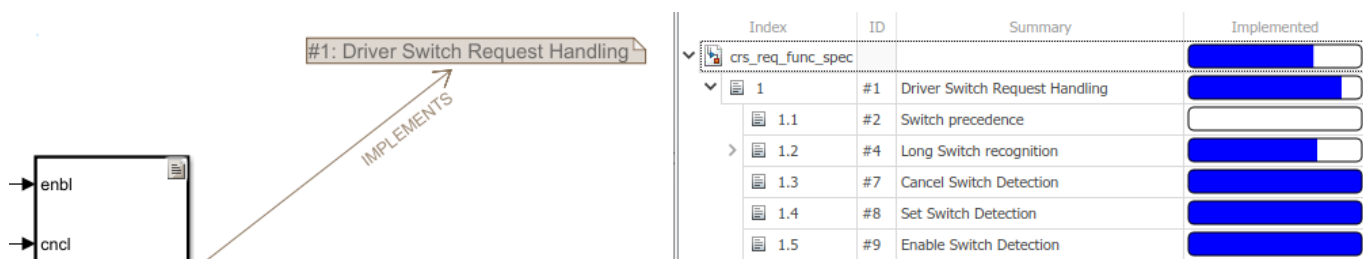
Simulink Requirements integrates requirements authoring and management with your modeling environment. You can author requirements in Simulink in the Requirements Editor, where you can organize and manage them. You can also import them from Microsoft Word or Excel on some platforms. For details, see “Import Requirements from Third-Party Applications”.

Link Between Requirements and Implementation

You can link from requirements to the Simulink blocks or Stateflow® objects that implement them. The connection is bidirectional, meaning that you can locate a requirement from a model element and a model element from a requirement.

You can:

- View implementation progress, including identifying missing implementations.
- React to requirement changes by updating model elements as requirements change, and clarifying requirements as your model evolves. You can find changed requirements by using a single command.
- Confirm that model changes conform to the associated requirement.

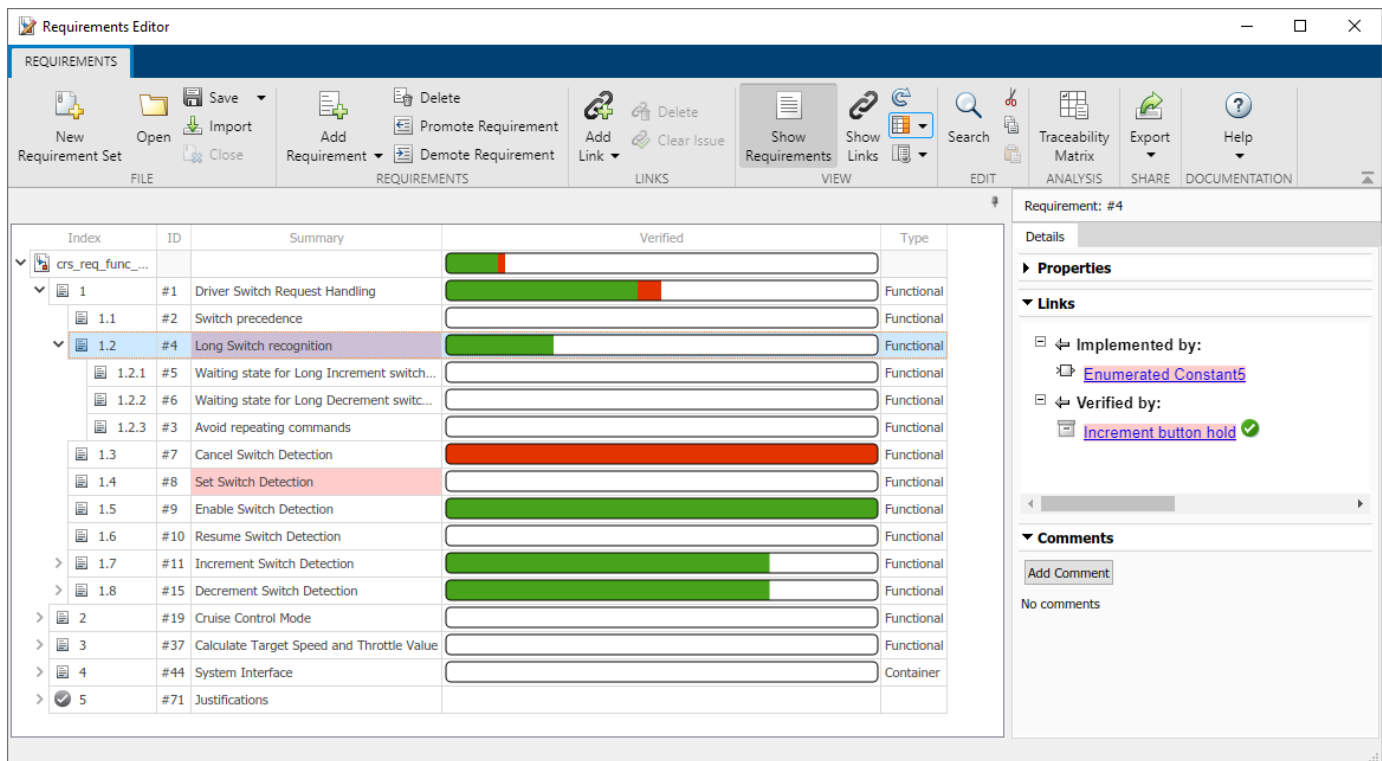


For more information, see “Requirement Links”.

Link Between Requirements and Simulink Test

If you have Simulink Test, you can link between requirements and tests that verify them. You can associate a requirement or set of requirements with tests that you create in Test Manager. When you run a test in Test Manager that you linked to a requirement, you can see the pass/fail results in the Requirements Editor.

Because you can track test results in Simulink Requirements, you can see the progress toward verification. The verification status also helps you to identify missing information and clusters of requirements associated with failing tests. You can use this information to understand the impact and complexity of those requirements.



For more information, see “Link Test Cases to Requirements Documents”.

Additional Requirements Traceability Links

With Simulink Requirements, you can create several other types of traceability links and establish many relationships within your model and to external documents. You can create these types of traceability links:

- Implements, in which a design element implements a requirement
- Verifies, in which a test case verifies a requirement
- Related to, in which you establish a trace relationship between a model element and a requirement
- Derives, in which a requirement is derived from another requirement
- Refines, in which one requirement refines another requirement

You can link between other types of documents, for example, HTML or DOORS® items, and requirements and to additional model elements such as dictionary objects.

For more information, see “Requirement Links”.

Share and Reuse Requirements

You save requirements files separately from your model files. You can then reference requirement files from multiple models, and each model can reference multiple requirement files. Saving requirements in separate files lets you modularize common requirements across models while also

managing requirements that are model-specific. This approach minimizes potential for copy-and-paste errors and keeps the requirements in sync across the models that share them.

You can compare requirements files (.slreqx files) by using the MATLAB file comparison tool. This tool helps you to identify differences in similar requirement sets. For more information, see “Compare Requirements Sets”.

You can also include requirements files in Projects. When you open a project, load requirement sets into the Requirements Editor from the project explorer. For more information, see “Requirements-Based Development in Projects”.

Another way to share information about requirements is to generate a report that includes the requirements definition, links, implementation details, verification status, and so on. For more information, see “Generate Requirements Reports Using Simulink”.

See Also

More About

- “Work with Requirements in the Simulink Editor” on page 1-3
- “Import Requirements from Third-Party Applications”
- “Link to Test Cases from Requirements” on page 1-10