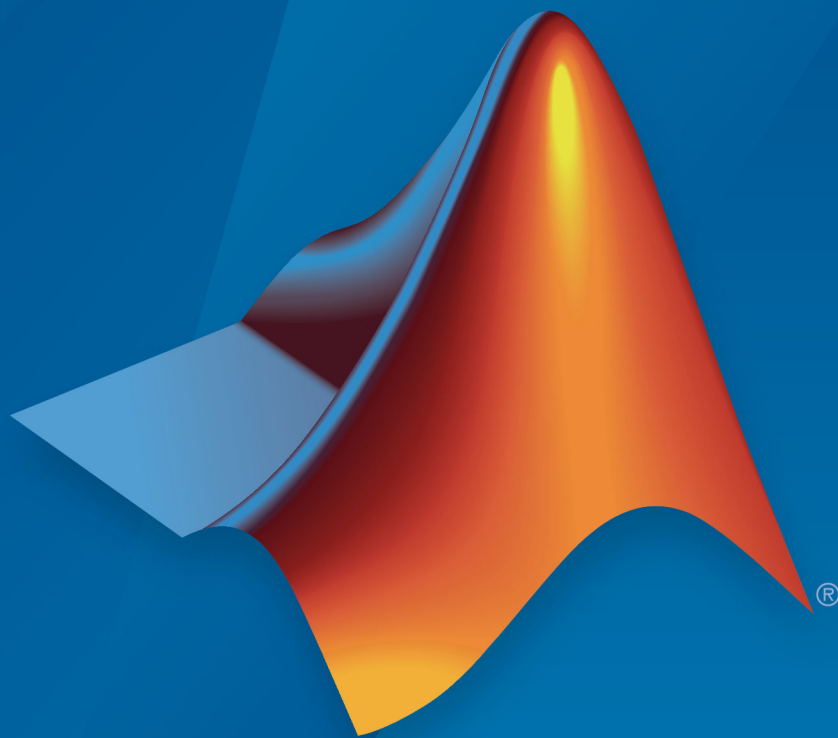


# Simulink® Requirements™

## Getting Started Guide



# MATLAB® & SIMULINK®

R2019b



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*Simulink® Requirements™ Getting Started Guide*

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March 2018	Online Only	Revised for Version 1.1 (Release 2018a)
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March 2019	Online Only	Revised for Version 1.3 (Release 2019a)
September 2019	Online Only	Revised for Version 1.4 (Release 2019b)

## **1** | **Getting Started with Simulink Requirements**

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# Getting Started with Simulink Requirements

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# 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 1-15.

### Author Requirements in Simulink

- “Author and Edit Requirements Content by Using Microsoft Word” on page 1-6
- “Customize Requirements Browser View” on page 1-6

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).

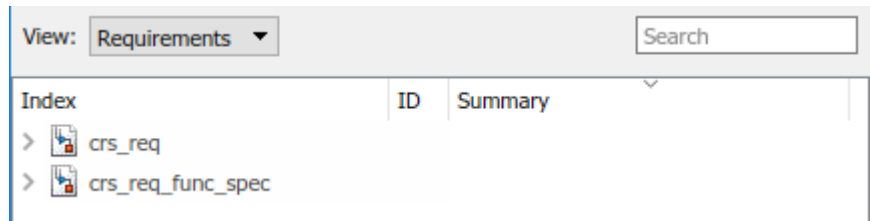
ID and Description	Rationale
R1: The maximum input throttle is 100%	The maximum value of the throttle from the acceleration pedal can be no greater than 100%.
R2: Cruise control has a speed operation range	Cruise control has a minimum and maximum operating speed.
R2.1: The vehicle speed must be at least 40 km/h	The speed of the vehicle must be at least 40 km/h for the cruise control system to engage.



ID and Description	Rationale
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`. You can choose whether to share requirements with other models.
- 6 Add a requirement to your requirement set by selecting the requirement set and clicking **Add Requirement** .
- 7 In the **Properties** pane, enter the details for the requirement. You can copy and paste or drag requirements from another source to the **Properties** pane. 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. Right-click R1 and select **Add Requirement After**. 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 right-clicking R2 and selecting **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 the   or by dragging requirements.

### 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.


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

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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

#### View or Hide Columns in the Requirements Editor

Right-click the header row and click **Select Columns** to change the view configuration of the Requirements Editor. Add, remove, and reorder attribute columns through the Column Selector dialog box. 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

To refine the display of requirements content in the Requirements Browser, use the **Search** text box at the top of the Requirements Browser. The **Search** text box can also help you find specific requirements within all loaded requirement sets based on a particular requirement attribute.

**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 asterisks (\*), as having any special meaning. For example, if you enter **fuel\*** in the **Search** text box, you return no results, even if several 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.

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**Tip** Clear the filtered contents by clicking **X** in the **Search** text box.

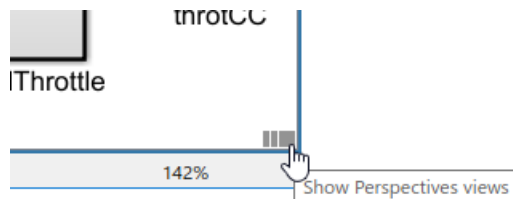
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## Link Blocks and Requirements

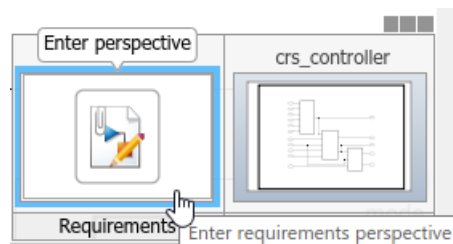
You can create links between your requirements and the Simulink blocks or Stateflow® objects that implement them. By linking between the model elements that implement requirements, you can track whether all your requirements have been implemented. You can also keep requirements and implementation in sync, for example, if a requirement changed or if the implementation causes you to revise your requirements.

In this tutorial, you use the Requirements Perspective View to work with your requirements in the cruise control model. As in the Requirements Editor, you can add requirement sets and requirements in the Requirements Perspective View. In both views, you can link requirements with blocks. In the Requirements Perspective View, visual elements help you to see the links between requirements and blocks. The Requirements Perspective View displays requirement and link information only for the model that is currently open in the Simulink editor.

- 1 In the `crs_controller` model, to preview the perspectives associated with the model, click the perspectives control in the lower-right corner.

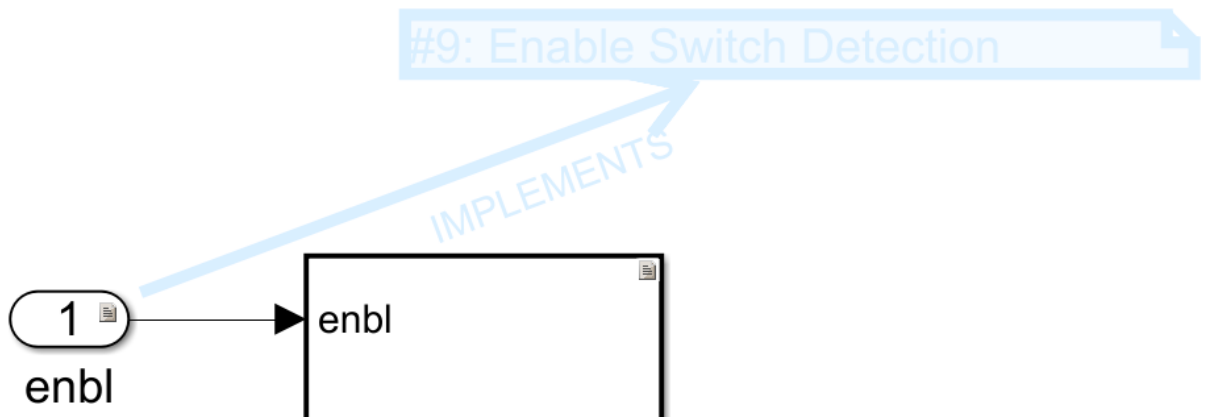


- 2 To open the Requirements Perspective View, click the **Requirements** image.

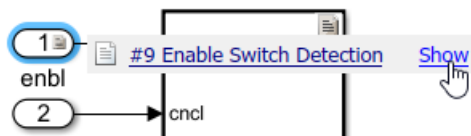


The Requirements Perspective View includes the Requirements Browser, docked at the bottom of the Simulink editor. When you select a requirement, the Property Inspector displays the Simulink Requirements **Properties** pane.

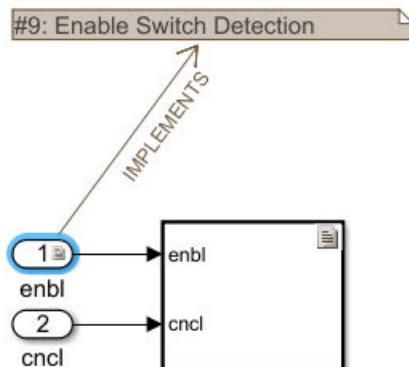
- 3 Link a requirement to the model element that implements it. Search for the requirement that you want to link from. In the Requirements Browser search box, enter `Enable Switch Detection`. As you type, matches are highlighted.
- 4 To create a link, select the matching requirement and drag it onto the `enbl` inport block. A markup guide appears on the canvas as a preview of the requirement annotation. Click the markup guide to place the requirement annotation on the canvas. You can also click anywhere else to create the link but not have the annotation display on the canvas.



- 5 A badge appears on the block to show that a 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**.

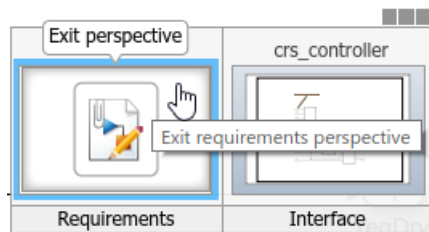


Clicking **Show** displays a requirement annotation on the model canvas.



The annotation displays the ID, the summary, and the relationship between the block and the requirement. In this example, the block implements the requirement. For other possible relationships, 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**. The requirement properties appear in the Property Inspector, where you can edit them.
- 6 Exit the Requirements Perspective View. Click the perspectives control and click the requirements image.



### 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 1-15
- “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.

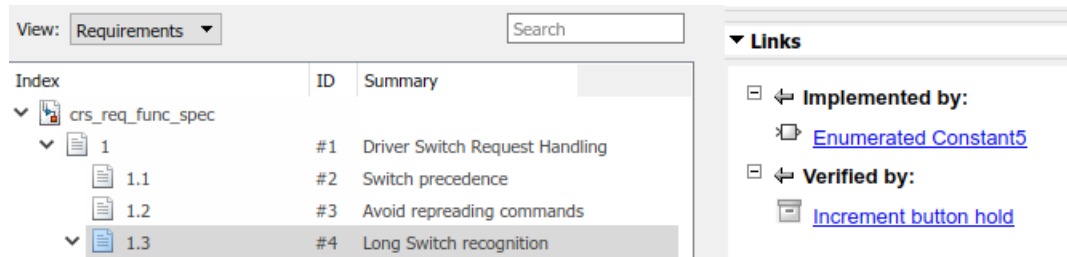
- 1 Open the project. At the MATLAB command prompt, enter:  
`slreqCCProjectStart`
- 2 Open the controller model. At the command prompt, enter:  
`open_system('models/crs_controller')`
- 3 Open the Test Manager. In the **Apps** tab, click **Simulink Test**. In the **Test** tab, click **Simulink Test Manager**.
- 4 In the Test Manager, from the **tests** folder, open the `DriverSwRequest_Tests.mldatx` test file.
- 5 In the test browser, 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.

You want to link the **Increment** button hold test to a requirement. Select that test case.

- 6 Open the Requirements Editor. In the **Apps** tab, click **Requirements Manager**. In the **Requirements** tab, click **Requirements Editor**.
- 7 Right-click the requirement with the ID 1.3 (Long Switch recognition) and select **Link from Selected Test Case**.

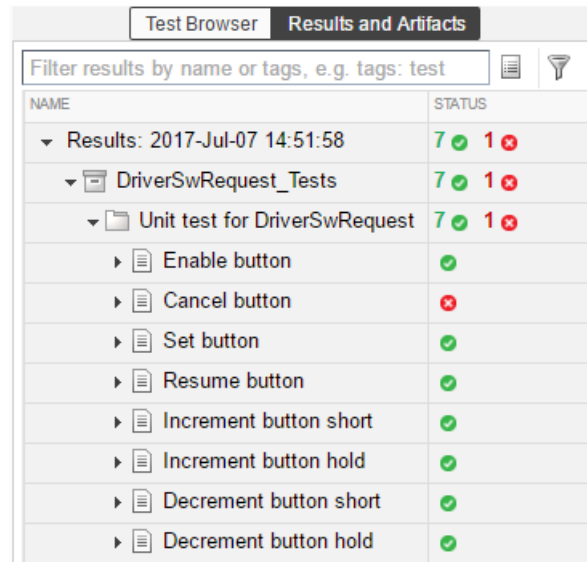
The link to the test case appears in the **Links** pane.





- 8 Look at some of the other requirements, for example 1.8, 1.6, 1.9, and 1.4. Select each requirement and look at the **Links** pane. You can see the test case links under **Verified by**.
- 9 Run all the tests that verify the linked requirements, including the linked test that you added. In the Test Manager, right-click the test file `DriverSwRequest_Tests` and select **Run**.

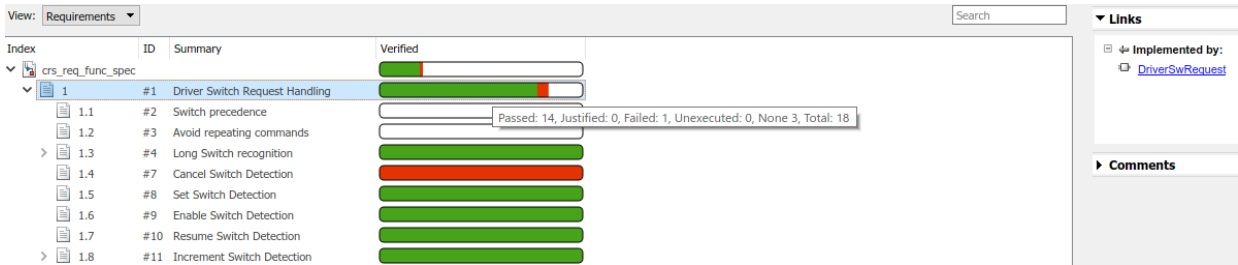
The **Results and Artifacts** pane in the Test Manager shows that 7 tests passed and 1 test failed. Expand the results. The `Cancel button` test failed and the other tests passed.



- 10 In the Requirements Editor, select **Display > 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.



## See Also

### More About

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

# Introduction to Simulink Requirements

## In this section...

- “Link Between Requirements and Implementation” on page 1-15
- “Link Between Requirements and Simulink Test” on page 1-16
- “Additional Requirements Traceability Links” on page 1-16
- “Share and Reuse Requirements” on page 1-17

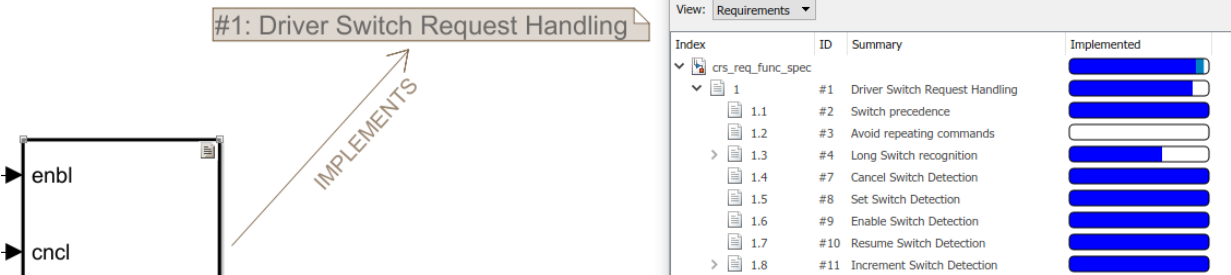
Simulink Requirements integrates requirements authoring and management with your modeling environment. You can author requirements in Simulink in the Requirements Editor, where you can organize and manage them. You can also import them from Microsoft Word or Excel. For details, see “Import Requirements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

## 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:

- See your progress toward implementing requirements, including identifying missing implementations.
- React to requirement changes, for example, by updating model elements as requirements change, and clarifying requirements as your model evolves. With Simulink Requirements, you can find changed requirements by using a single command.
- Ensure that changes that you make to the model conform to the associated requirement.

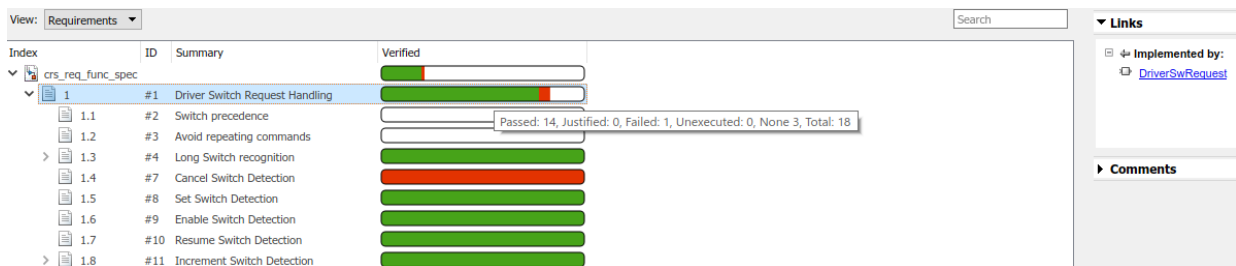


For more information, see “Requirement Links”.

## 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 avoids 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 your Simulink projects. When you open a project, you can load any included requirements sets into the Requirements Editor from the project explorer. For more information, see “Manage Requirements Across a Team”.

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 Tools”
- “Link to Test Cases from Requirements” on page 1-12

