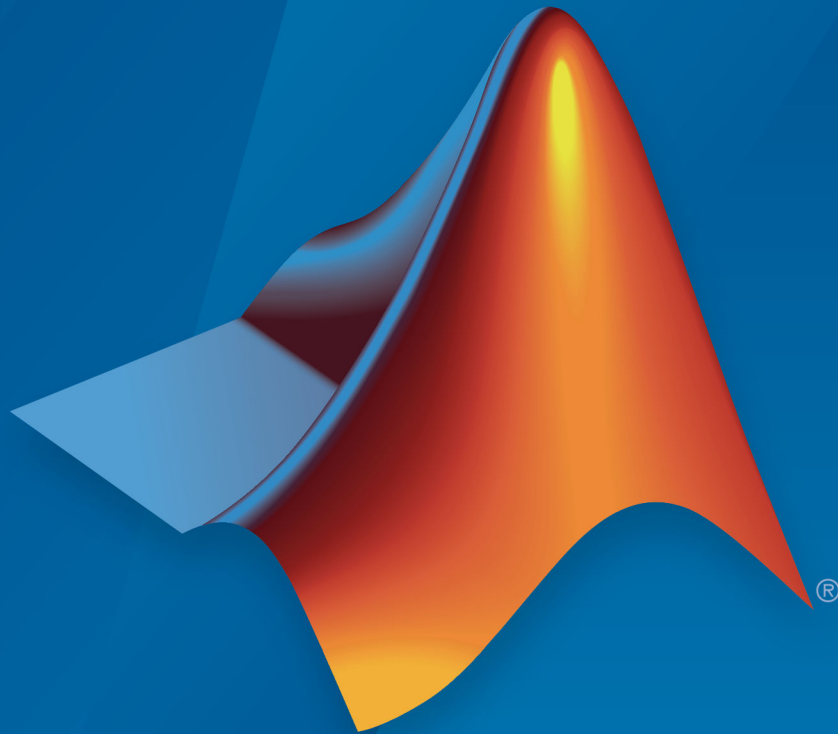


AUTOSAR Blockset

User's Guide



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Revision History

March 2019	Online only	New for Version 2.0 (Release 2019a)
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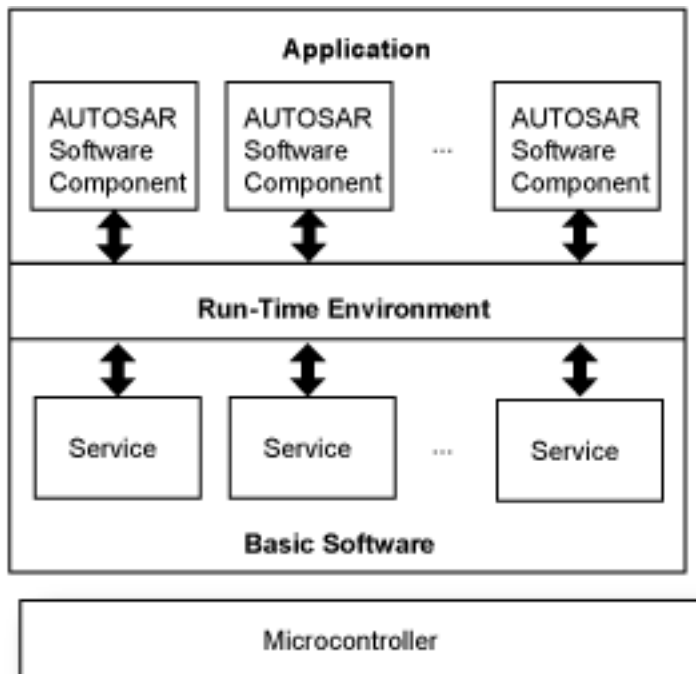
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Overview of AUTOSAR Support

- “AUTOSAR Standard” on page 1-2
- “Comparison of AUTOSAR Classic and Adaptive Platforms” on page 1-4
- “AUTOSAR Software Components and Compositions” on page 1-11
- “Workflows for AUTOSAR” on page 1-13
- “AUTOSAR Workflow Samples” on page 1-16
- “Develop AUTOSAR Software Component Model” on page 1-18
- “Create Algorithmic Model Content That Represents AUTOSAR Software Component Behavior” on page 1-20
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- “Optional: Generate AUTOSAR Adaptive Software Component Code (Requires Embedded Coder)” on page 1-47

AUTOSAR Standard

Simulink® software supports *AUTomotive Open System ARchitecture* (AUTOSAR), an open and standardized automotive software architecture consisting of three layers of software: Application, Run-Time Environment (RTE), and Basic Software.



Automobile manufacturers, suppliers, and tool developers jointly develop components of the Application layer. The standard refers to the components as AUTOSAR software components. They interact with the Run-Time Environment layer. The Run-Time Environment layer enables communication between:

- Components of the Application layer
- The Basic Software layer and components of the Application layer

The Basic Software layer provides shared common system services that components of the Application layer use.

The AUTOSAR standard addresses:

- **Architecture**—A layered software architecture decouples application software from the execution platform. Standard interfaces between AUTOSAR software components and the run-time environment allow reuse or relocation of components within the Electronic Control Unit (ECU) topology of a vehicle.

The standard defines variations of the software architecture called AUTOSAR platforms: Classic Platform and Adaptive Platform. For more information, see “Comparison of AUTOSAR Classic and Adaptive Platforms” on page 1-4.

- **Methodology**—Configuration description files define system information that ECUs share, system information that is unique to specific ECUs, and basic software information specific to an ECU.
- **Foundation**—Requirements and specifications shared between AUTOSAR platforms that support platform interoperability.
- **Application Interfaces**—Provide a standardized exchange format by specifying interfaces for typical automotive applications and specifying interfaces between the layers of software.

See Also

More About

- <https://www.autosar.org>
- “Comparison of AUTOSAR Classic and Adaptive Platforms” on page 1-4
- “Modeling Patterns”
- “Workflows for AUTOSAR” on page 1-13
- <https://www.mathworks.com/automotive/standards/autosar.html>

Comparison of AUTOSAR Classic and Adaptive Platforms

The AUTOSAR standard defines variations of the software architecture called AUTOSAR platforms: Classic Platform (CP) and Adaptive Platform (AP).

When you choose which platform to use for designing and implementing an AUTOSAR software component, review the information in this table for guidance.

AUTOSAR Platform Comparison

Goal or Feature	Classic Platform	Adaptive Platform
Use cases	Embedded systems	High performance computing, communication with external resources, and flexible deployment
Programming language	C	C++
Operating system	Bareboard	POSIX
Real-time requirements	Hard	Soft
Computing power	Low	High
Communication	Signal-based	Event-based, service-oriented
Safety and security	Supported	Supported
Dynamic updating	Not available	Incremental deployment and run-time configuration changes
Level of standardization	High—detailed specifications	Low—APIs and semantics
Agile development	No	Yes

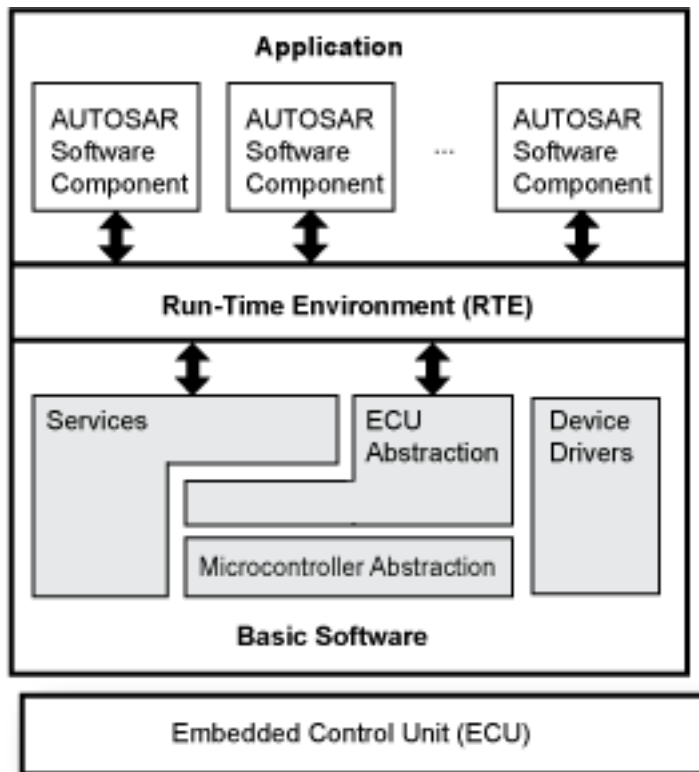
Classic Platform

The Classic Platform addresses requirements of deeply embedded electronic control units (ECUs) that control electrical output signals based on input signals and information from other ECUs connected to a vehicle network. Typically, you design and implement the control software for a specific type of vehicle, which does not change during the lifetime of the vehicle.

The Run-Time Environment (RTE) layer of the software architecture handles communication between AUTOSAR software components in the Application layer and

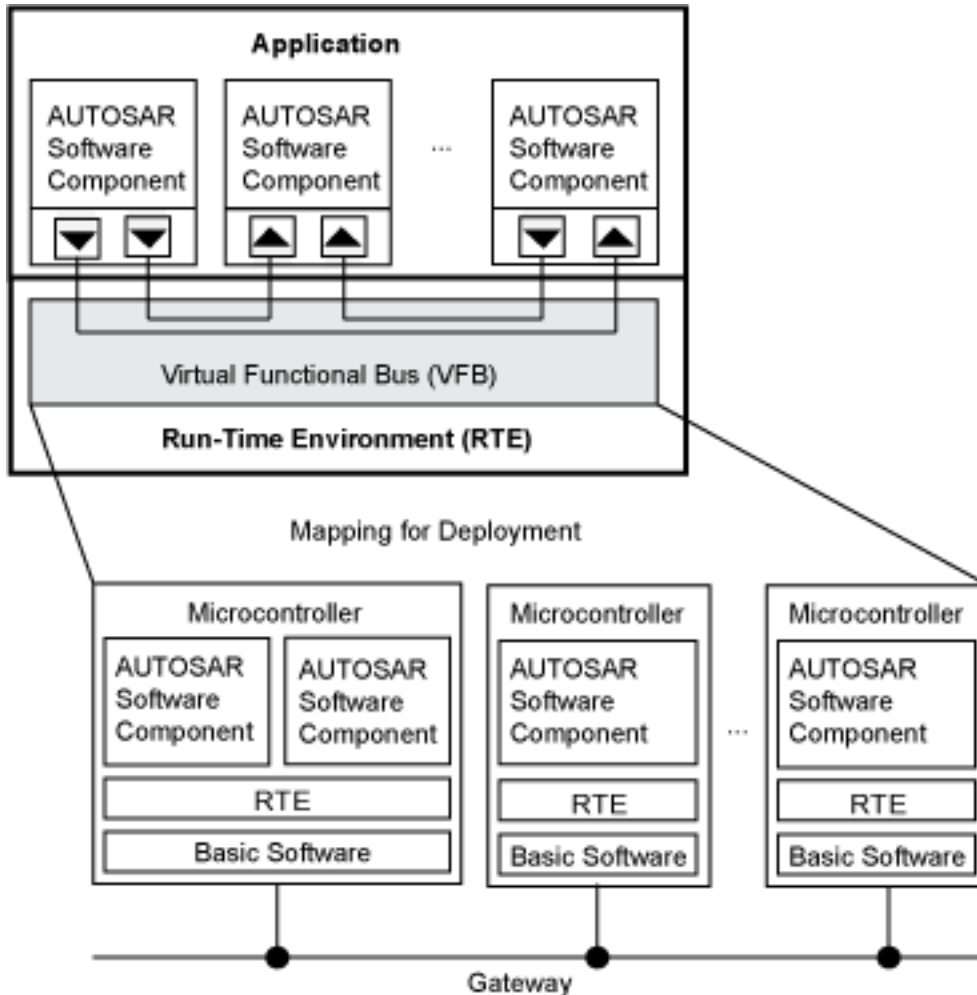
between AUTOSAR software components and services provided by the Basic Software layer. The Basic Software layer consists of:

- Services, such as system, memory, and communication services
- Device drivers
- ECU abstraction
- Microcontroller abstraction



The Classic Platform uses a virtual functional bus (VFB) to support hardware-independent development and usage of AUTOSAR application software. The bus consists of abstract representations of RTEs for specific ECUs, decoupling AUTOSAR software components in the Application layer of the architecture from the architecture infrastructure. AUTOSAR software components and the bus communicate by using dedicated ports. You configure

an application by mapping component ports to the RTE representations of the system ECUs.



Adaptive Platform

The Adaptive Platform is a distributed computing and service-oriented architecture (SOA). The platform provides high-performance computing, message-based communication mechanisms, and flexible software configuration for supporting

applications, such as automated driving and infotainment systems. Software based on this platform can:

- Meet strict integrity and security requirements
- Address environment perception and behavioral response planning
- Integrate a vehicle into the back end or infrastructure of an external system
- Address changes to external systems because you can update the software during the lifetime of a vehicle

The RTE layer of the software architecture includes the C++ standard library. It supports communication between AUTOSAR software components in the Application layer and between AUTOSAR software components and software provided by the Basic Software layer. The Basic Software layer consists of system foundation software and services. AUTOSAR software components in the Application layer communicate with each other, with nonplatform services, and with foundation software and services by responding to event-driven messages. Software components interact with software in the Basic Software layer by using C++ application programming interfaces (APIs).

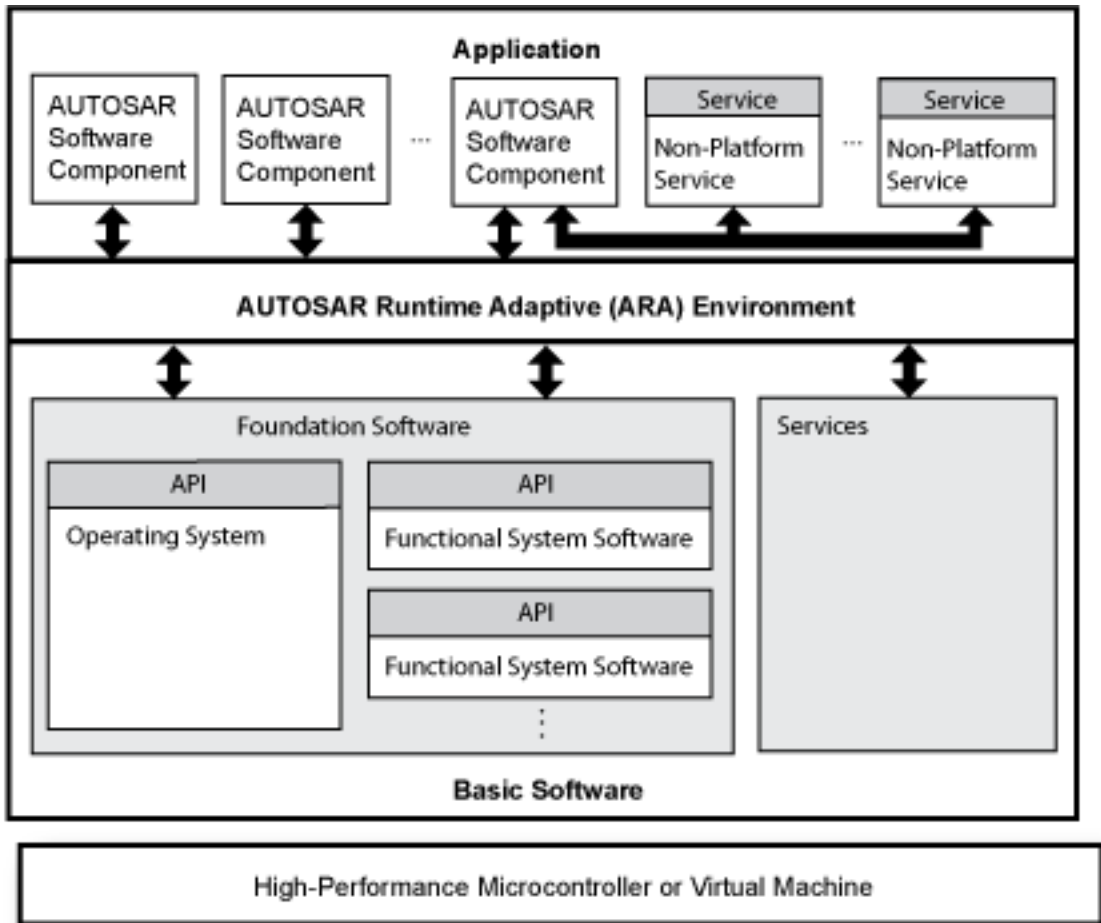
Foundation software includes the POSIX operating system and software for system management tasks, such as:

- Execution management
- Communication management
- Time synchronization
- Identity access management
- Logging and tracing

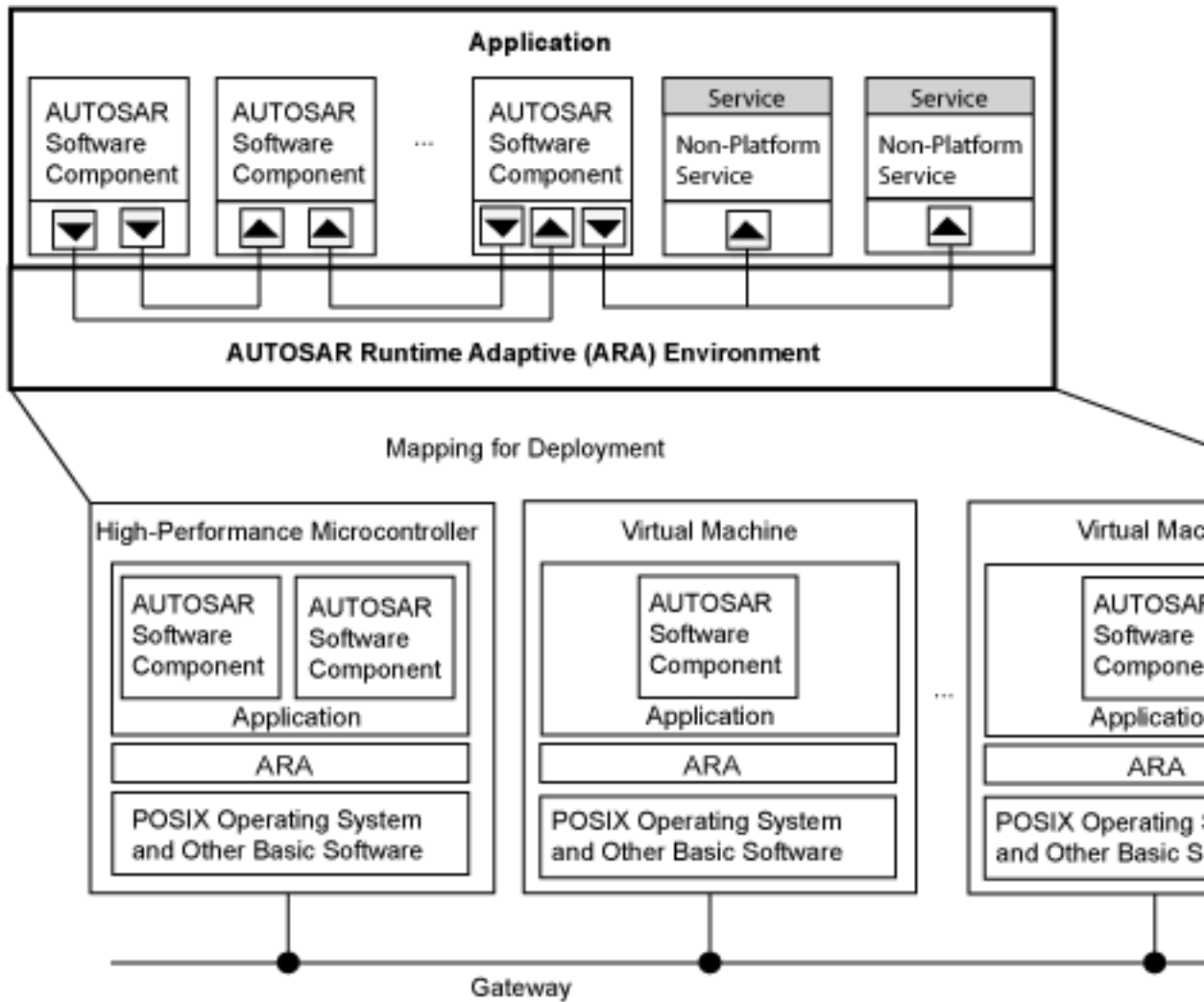
Examples of services include:

- Update and configuration management
- Diagnostics
- Signal-to-service mapping
- Network management

ECU hardware on which a single instance of an Adaptive Platform application runs is a machine. A machine might be one or more chips or a virtual hardware component. The hardware can be a single chip that hosts one or more machines or multiple chips that host a single machine.



The Adaptive Platform supports hardware-independent development and usage of AUTOSAR application software. Abstract representations of RTEs for specific ECUs (microcontrollers, high-performance microcontrollers, and virtual machines) decouple AUTOSAR software components in the Application layer of the architecture from the architecture infrastructure. AUTOSAR software components and foundation software and services communicate by using dedicated ports. You configure an application by mapping component ports to the RTE representations of the system ECUs.



See Also

More About

- <https://www.autosar.org>

AUTOSAR Software Components and Compositions

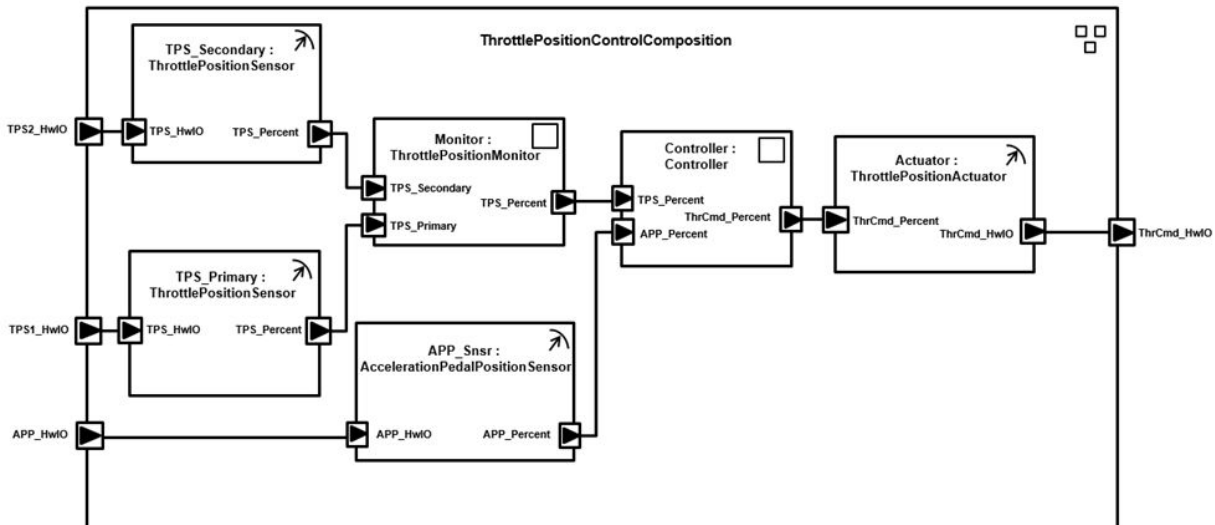
AUTOSAR software components are reusable building blocks of AUTOSAR software. An AUTOSAR software component encapsulates one or more algorithms and communicates with its environment through well-defined ports. For example, a throttle application might include AUTOSAR software components that represent sensors for throttle and acceleration pedal sensors, a throttle position monitor, a controller, and an actuator.

An AUTOSAR software component connects to an AUTOSAR runtime environment for communicating with other software components and software in the Basic Software layer of the AUTOSAR software architecture. You can reuse and relocate software components between ECUs.

In Simulink, you represent AUTOSAR software components with Simulink model components, such as Model, subsystem, and Simulink Function blocks.

AUTOSAR compositions are AUTOSAR software components that aggregate groups of software components that have related functionality. A composition is a system abstraction that facilitates scalability and helps to manage complexity when designing the logical representation of a software application.

This figure shows a composition for throttle position control.



The composition consists of software components that represent:

- Two throttle position sensors
- Throttle position monitor
- Acceleration pedal position sensor
- Controller
- Throttle position actuator

If you are using the AUTOSAR Classic Platform, you can model an AUTOSAR software composition by importing an arxml description of a composition into Simulink or by using an AUTOSAR architecture model to author a software composition (requires System Composer™).

See Also

More About

- <https://www.autosar.org>
- “Develop AUTOSAR Software Component Model” on page 1-18
- “Develop AUTOSAR Adaptive Software Component Model” on page 1-34
- “Model AUTOSAR Software Components” on page 2-3
- “Model AUTOSAR Adaptive Software Components” on page 6-2
- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Adaptive Software Descriptions” on page 6-15
- “Create AUTOSAR Software Component in Simulink” on page 3-2
- “Import AUTOSAR Composition to Simulink” on page 7-2
- “Import AUTOSAR Software Composition with Atomic Software Components (Classic Platform)” on page 3-30
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38

Workflows for AUTOSAR

To develop AUTOSAR software components in Simulink, you create a Simulink representation of an AUTOSAR software component. AUTOSAR component creation can start from an existing Simulink design or from an AUTOSAR XML (arxml) component description created in another development environment.

In a Simulink originated (*bottom-up*) workflow, you take an existing Simulink design or algorithm and map it into an AUTOSAR software component model.

In a *round-trip* workflow, you import an AUTOSAR component description created by an authoring tool in another development environment. Importing the component specification into Simulink creates an AUTOSAR software component model.

In this section...
“Simulink Originated (Bottom-Up) Workflow” on page 1-13
“Round-Trip Workflow” on page 1-13

Simulink Originated (Bottom-Up) Workflow

In a Simulink originated, or *bottom-up*, workflow, you take a design or algorithm that originated in Simulink and configure it into an AUTOSAR software component model. To get started, use the AUTOSAR Component Quick Start or AUTOSAR model templates on the Simulink Start Page. For more information, see “Create AUTOSAR Software Component in Simulink” on page 3-2.

You develop the component design and behavior in Simulink. For example, you configure AUTOSAR software component elements, map Simulink model elements to AUTOSAR software component elements, develop component behavior algorithms, and simulate the component behavior.

Using Simulink Coder™ and Embedded Coder®, you can generate AUTOSAR-compliant XML descriptions and C or C++ code from the component model. You can test the code in Simulink or integrate the descriptions and code in an AUTOSAR run-time environment.

Round-Trip Workflow

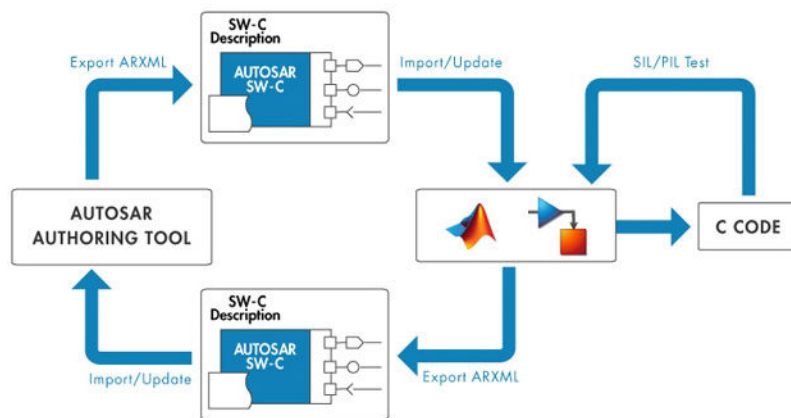
In a *round-trip* workflow, you import an AUTOSAR software component description created in another development environment into Simulink. Simulink can import

AUTOSAR-compliant XML descriptions exported by common AUTOSAR authoring tools (AATs). Importing the XML description of an AUTOSAR software component creates a Simulink model representation of the component. For more information, see “Import AUTOSAR Software Component” on page 3-19 or “Import AUTOSAR Adaptive Software Descriptions” on page 6-15.

As with a Simulink originated design, you develop the component design and behavior in Simulink. For example, you configure AUTOSAR software component elements, map Simulink model elements to AUTOSAR software component elements, develop component behavior algorithms, and simulate the component behavior.

Using Simulink Coder and Embedded Coder, you can generate AUTOSAR-compliant XML descriptions and C or C++ code from the component model for testing or integration.

In a round-trip workflow, you deliver the generated description files and code back to the originating AAT. Using the AAT, merge your Simulink design work with other components and systems. If you further modify the component in the other development environment, use the AAT to export updated XML specifications. In your Simulink environment, import the new descriptions and update your component model to reflect the changes. For more information, see “Import AUTOSAR Software Component Updates” on page 3-31.



To support the round trip of AUTOSAR elements between an AAT and Simulink, a `rxml` import preserves imported AUTOSAR XML file structure and content for `arxml` export. For more information, see “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.

See Also

Related Examples

- “Create AUTOSAR Software Component in Simulink” on page 3-2
- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Software Component Updates” on page 3-31
- “Import AUTOSAR Adaptive Software Descriptions” on page 6-15
- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38

AUTOSAR Workflow Samples

Example	How to ...
"Create and Configure AUTOSAR Software Component" on page 3-9	Create an AUTOSAR software component model from an algorithm model.
"Import AUTOSAR Component to Simulink" on page 3-24	Create Simulink model from XML description of AUTOSAR software component.
"Design and Simulate AUTOSAR Components and Generate Code" on page 4-103	Develop AUTOSAR components by implementing behavior algorithms, simulating components and compositions, and generating component code.
"Modeling Patterns for AUTOSAR Runnables" on page 2-13	Use Simulink models, subsystems, and functions to model AUTOSAR atomic software components and their runnable entities (runnables).
"Create and Configure AUTOSAR Adaptive Software Component" on page 6-7	Create an AUTOSAR adaptive software component model from an algorithm model.
"Import AUTOSAR Adaptive Components to Simulink" on page 6-17	Create Simulink models from XML descriptions of AUTOSAR adaptive software components.
"Simulate AUTOSAR Basic Software Services and Run-Time Environment" on page 7-34	Simulate AUTOSAR component calls to Basic Software memory and diagnostic services using reference implementations.
"Generate AUTOSAR C Code and XML Descriptions" on page 5-2	With Embedded Coder software, generate AUTOSAR-compliant C code and export AUTOSAR XML (arxml) descriptions from AUTOSAR component model.
"Generate AUTOSAR Adaptive C++ Code and XML Descriptions" on page 6-65	With Embedded Coder software, generate AUTOSAR-compliant C++ code and export AUTOSAR XML (arxml) descriptions from AUTOSAR adaptive component model.
"Author AUTOSAR Compositions and Components in Architecture Model" on page 8-38	With System Composer software, use an architecture model to develop AUTOSAR compositions and components for the Classic Platform.

Example	How to ...
"AUTOSAR Property and Map Function Examples" on page 4-340	Programmatically add AUTOSAR elements to a model, configure AUTOSAR properties, and map Simulink elements to AUTOSAR elements.

See Also

More About

- "Workflows for AUTOSAR" on page 1-13
- <https://www.autosar.org>

Develop AUTOSAR Software Component Model

Prerequisites

This tutorial assumes that you are familiar with the basics of the AUTOSAR standard and Simulink. The code generation portion of this tutorial assumes that you have knowledge of Embedded Coder basics.

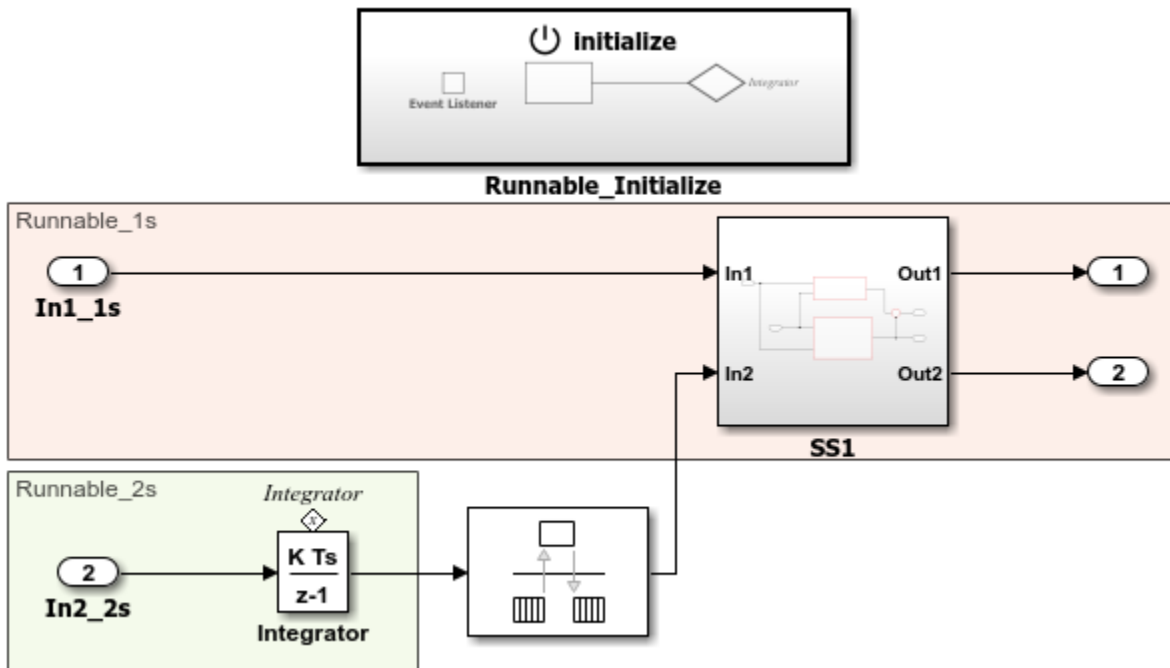
To complete this tutorial, you must have:

- MATLAB®
- Simulink

An optional part of the tutorial requires Simulink Coder and Embedded Coder software.

Example Model

The tutorial uses example models `swc` and `autosar_swc`.



What You Will Learn

You will learn how to:

- 1 Create algorithmic model content that represents AUTOSAR software component behavior.
- 2 Configure elements of an AUTOSAR software component for the Simulink modeling environment.
- 3 Simulate the AUTOSAR software component.
- 4 Optionally, generate AUTOSAR software component code.

To start the tutorial, see “Create Algorithmic Model Content That Represents AUTOSAR Software Component Behavior” on page 1-20.

Create Algorithmic Model Content That Represents AUTOSAR Software Component Behavior

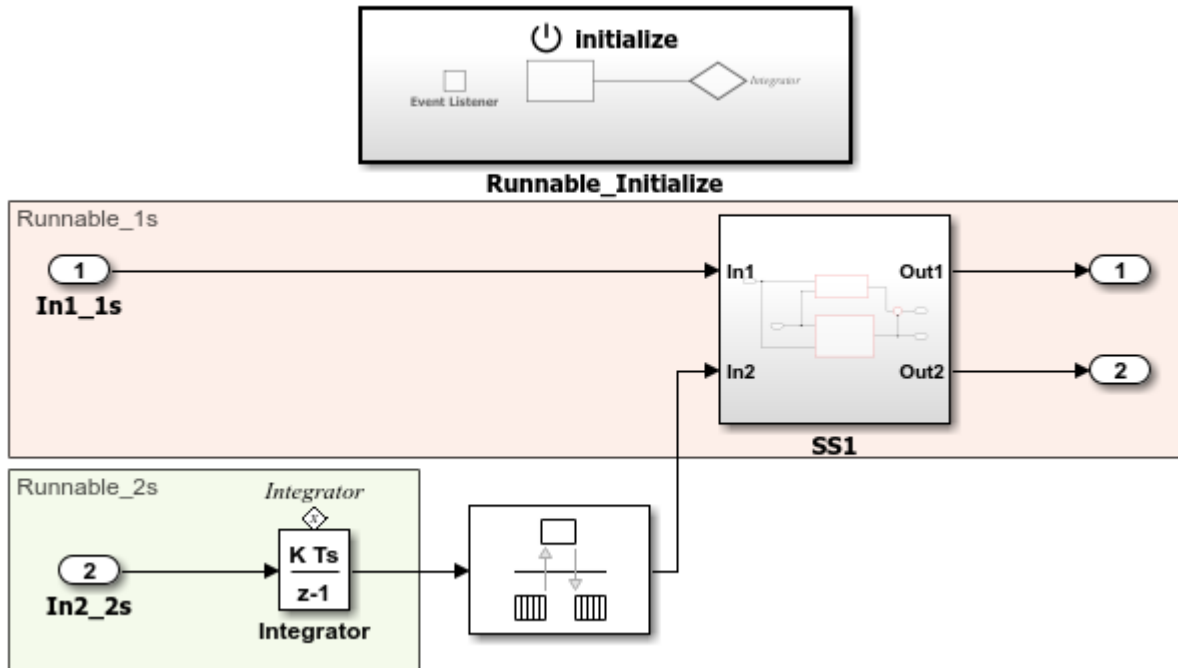
AUTOSAR Blockset software supports AUTOSAR software component modeling for the AUTOSAR Classic Platform. To develop an AUTOSAR software component in Simulink, create a Simulink model that represents the AUTOSAR software component. Initiate the model creation in one of these ways:

- Import an existing AUTOSAR XML (`arxml`) component description into the Simulink environment as a model. You import a component description by using the AUTOSAR `arxml` importer.
- Rework an existing Simulink model into a representation of the AUTOSAR software component.
- Starting from an AUTOSAR Blockset model template, create a Simulink model.

After creating an initial model design, refine the algorithmic content.

This tutorial uses example model `autosar_sw_c` to show a sample model representation of an AUTOSAR software component.

- 1** Open model `autosar_sw_c`.



2 Explore the model components. The model consists of:

- Periodic runnable `Runnable_1s`, which is configured with a sample rate of 1 second (`In1_1s`).
- Periodic runnable `Runnable_2s`, which is configured with a sample rate of 2 seconds (`In2_2s`).
- Initialize Function block, `Runnable_Initialize`, which initializes the integrator in `Runnable_2s` to a value of 1.

3 Explore the model configuration.

Model configuration parameter **System target file** is set to `autosar.tlc`. That system target file setting enables use of AUTOSAR Blockset software.

To maximize execution efficiency, the model is configured for multitasking mode. Solver settings are:

- **Type** is set to Fixed-step.

- **Solver** is set to discrete (no continuous states).
- **Fixed-step size (fundamental sample time)** is set to auto.
- **Treat each discrete rate as a separate task** is selected.

In the Simulink Editor, you can enable sample time color-code by selecting the **Debug** tab and selecting **Diagnostics > Information Overlays > Colors**. A sample time legend shows the implicit rate grouping. Red represents the fastest discrete rate. Green represents the second fastest discrete rate. Yellow represents a mixture of the two rates.

Because the model has multiple rates and the **Solver** parameter **Treat each discrete rate as a separate task** is selected, the model simulates in multitasking mode. The model handles the rate transition for In2_2s explicitly by using the Rate Transition block.

The Rate Transition block parameter **Ensure deterministic data transfer** is cleared to facilitate integration into an AUTOSAR run-time environment.

Generated code for the model schedules subrates in the model. For this model, the rate for Inport block In2_2s, the green rate, is a subrate. The generated code properly transfers data between tasks that run at different rates.

Next, configure elements of the AUTOSAR software component for use in the Simulink modeling environment.

See Also

Related Examples

- “Modeling Patterns”

Configure Elements of AUTOSAR Software Component for Simulink Modeling Environment

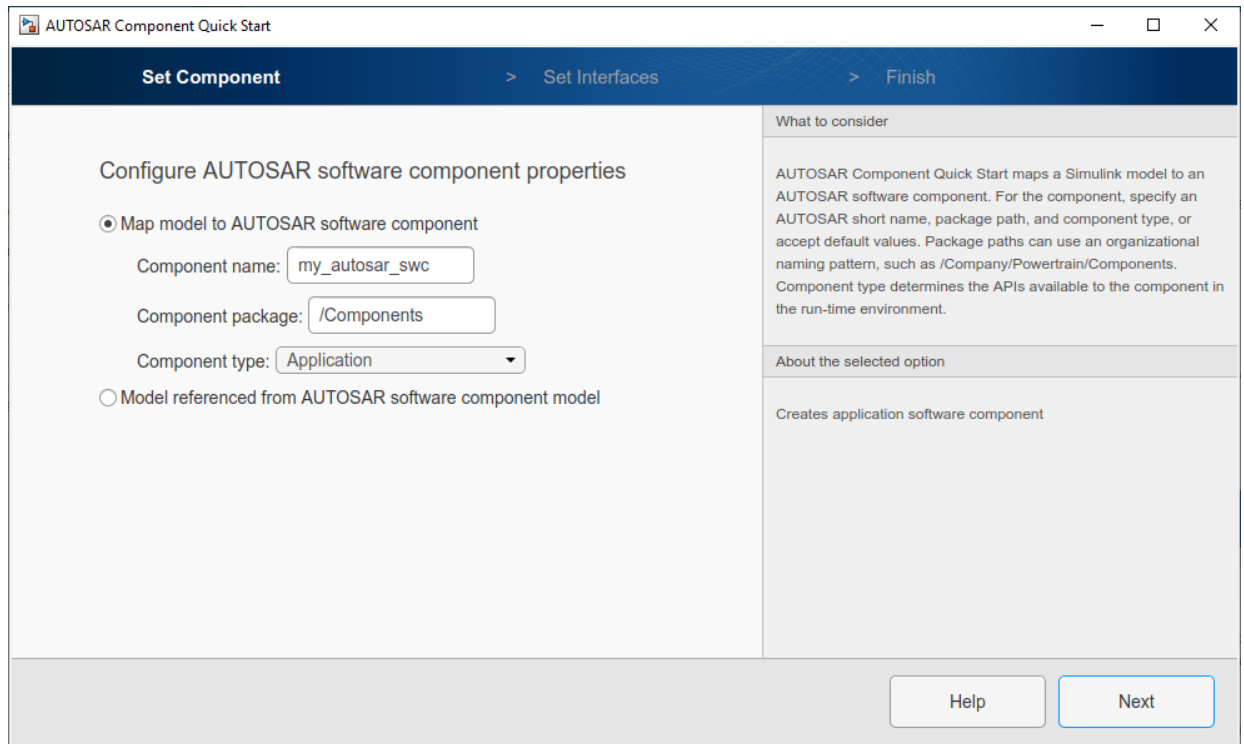
After you create a representation of the AUTOSAR software component in the Simulink Editor, configure elements of the software component for use in Simulink. The configuration maps AUTOSAR software component elements to Simulink modeling elements.

AUTOSAR Blockset software reduces the effort of setting up a configuration by providing an AUTOSAR Component Quick Start tool. If necessary, you can modify the initial configuration by using the Code Mappings editor and the AUTOSAR Dictionary.

Set Up Initial Component Configuration

Set up an initial configuration of an AUTOSAR software component by using the AUTOSAR Component Quick Start tool.

- 1 Open example model `swc`, an unconfigured version of `autosar_swc`.
- 2 Save a copy of the example model to a writable folder on your current MATLAB search path. Name the file `my_autosar_swc.slx`.
- 3 Set model configuration parameter **System target file** to `autosar.tlc`.
- 4 Run the AUTOSAR Component Quick Start tool. From the **Apps** tab, open the AUTOSAR Component Designer app. When you open the app for an unmapped model that is configured with an AUTOSAR system target file, the AUTOSAR Component Quick Start tool runs.



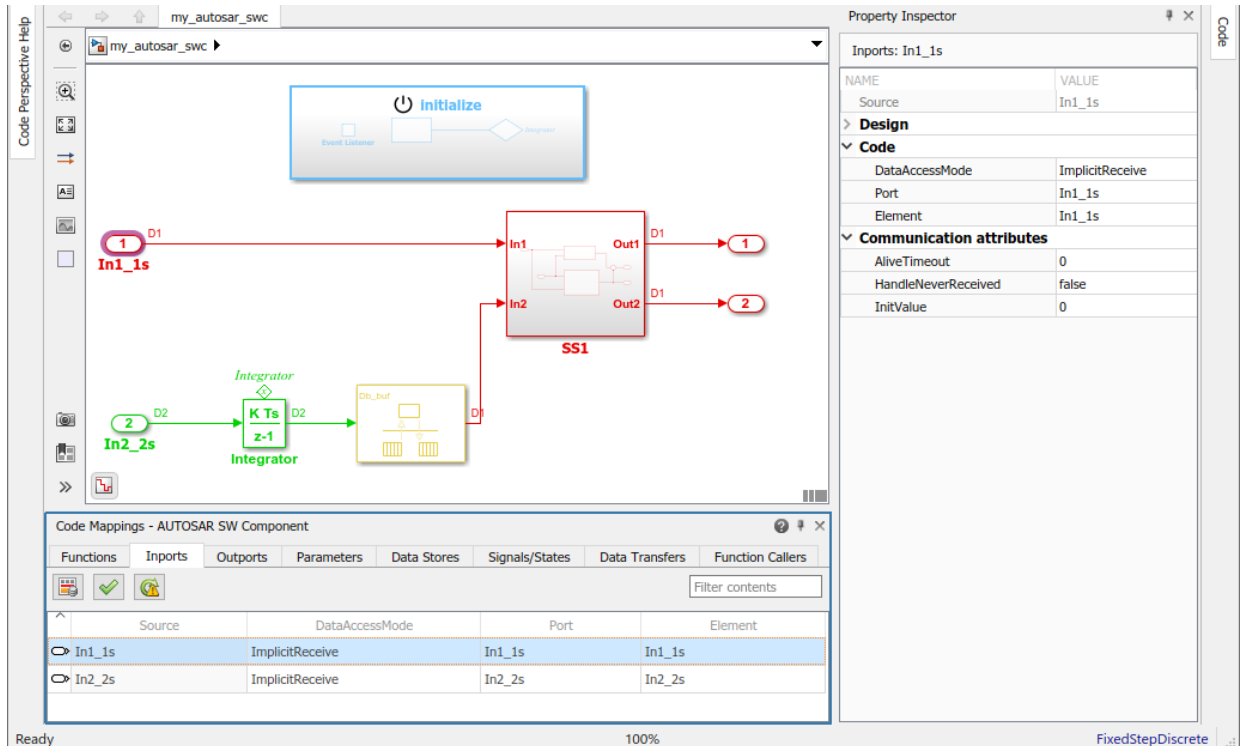
- 5 Advance through the steps of the AUTOSAR Component Quick Start tool. Each step prompts you for input that the tool uses to configure your AUTOSAR software component for the Simulink environment.
- The name, package, and type of the AUTOSAR software component that you are configuring.
 - Whether you want to use default properties based on the model or import AUTOSAR software component properties from an `arxml` file.

For this tutorial, use the defaults.

After you click **Finish**, the tool:

- Creates a mapping between elements of the AUTOSAR software component and Simulink model elements.

- Opens the model in the Simulink Editor AUTOSAR Code perspective. The AUTOSAR Code perspective displays a help panel, a Property Inspector panel, and, directly below the model, the Code Mappings editor.
- Displays the AUTOSAR software component mappings in the Code Mappings editor, which you can use to customize the configuration.



6 Save the model.

Customize Component Configuration

The AUTOSAR Component Quick Start tool sets up an initial configuration for an AUTOSAR software component. To refine or make changes to an existing component configuration, use the Code Mappings editor and the AUTOSAR Dictionary.

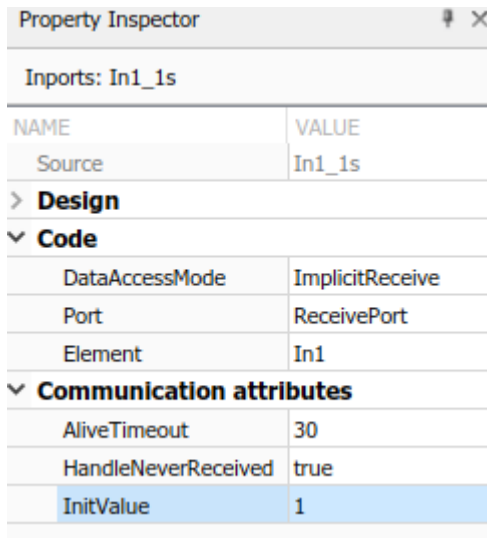
In a tabbed table format, the Code Mappings editor displays Simulink model elements, such as entry-point functions, inports, outports, and data transfers. Use the editor to map

Simulink model elements to AUTOSAR software component elements. AUTOSAR software component elements are defined in the AUTOSAR standard. They include runnable entities, ports, and inter-runnable variables (IRVs).

- 1 If not already open, open model `my_autosar_swc`.
- 2 In the Code Mappings editor, select the **Inports** tab.
- 3 Select model inport `In1_1s`. Selecting the inport highlights the corresponding element in the model. The inport is mapped to AUTOSAR port `In1_1s` and data element `In1_1s` with data access mode `ImplicitReceive`. Attributes of the inport appear in the Property Inspector panel.

In each Code Mappings editor tab, you can select model elements and modify their AUTOSAR mapping and attributes. Modifications are reflected in generated `arxml` descriptions and C code.

- 4 Modify attribute settings for a mapped model element. For this tutorial, modify communication attributes for inport `In1_1s`. In the Property Inspector, expand the list of communication attributes and change:
 - **AliveTimeout** from 0 to 30
 - **HandleNeverReceived** from `false` to `true`
 - **InitValue** from 0 to 1




NAME	VALUE
Source	In1_1s
> Design	
▼ Code	
DataAccessMode	ImplicitReceive
Port	ReceivePort
Element	In1
▼ Communication attributes	
AliveTimeout	30
HandleNeverReceived	true
InitValue	1

- 5 Save the model.

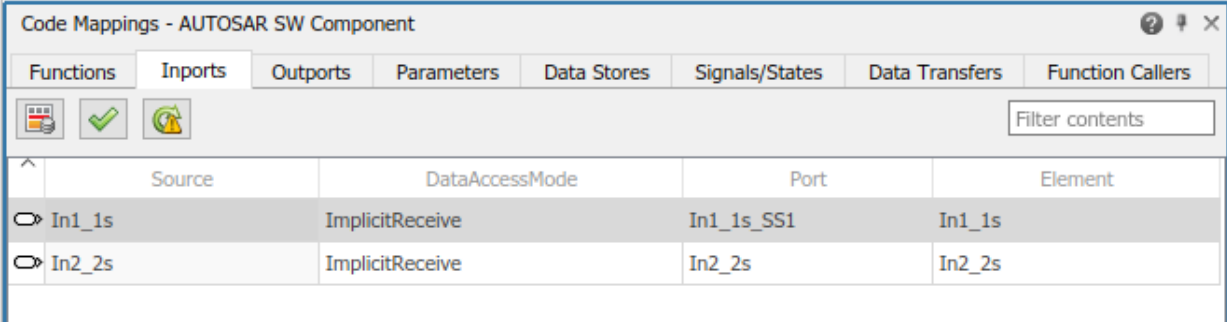
Configure AUTOSAR Software Component Elements from AUTOSAR Standard Perspective

Configure AUTOSAR software component elements from the perspective of the AUTOSAR standard by using the AUTOSAR Dictionary.

- 1 If not already open, open model `my_autosar_sw.c`.
- 2 Open the AUTOSAR Dictionary. In the Code Mappings editor, click the AUTOSAR Dictionary button . The AUTOSAR Dictionary opens in the AUTOSAR view that corresponds to the Simulink element that you last selected and mapped in the Code Mappings editor. If you selected and mapped a Simulink inport, the dictionary opens in ReceiverPorts view and displays the AUTOSAR port that you mapped the inport to.


In a tree format, the AUTOSAR Dictionary displays the mapped AUTOSAR software component and its elements, communication interfaces, computation methods, software address methods, and XML options.

- 3 Use the AUTOSAR Dictionary to further customize component configurations. In the ReceiverPorts view, select port `In1_1s`, the AUTOSAR receiver port to which the Simulink inport was mapped. An attributes panel appears, showing the attributes settings for that element.
- 4 In the AUTOSAR Dictionary, rename the AUTOSAR receiver port `In1_1s` to `In1_1s_SS1`. To initiate the edit, double-click the **Name** value field. The Code Mappings editor reflects the name change.



The screenshot shows the 'Code Mappings - AUTOSAR SW Component' window with the 'Inports' tab selected. The table below represents the data shown in the window:

Source	DataAccessMode	Port	Element
In1_1s	ImplicitReceive	In1_1s_SS1	In1_1s
In2_2s	ImplicitReceive	In2_2s	In2_2s

If the Update Code Mappings button appears with a warning symbol , click the button to update the Code Mappings to include the latest model data.

- 5 Save the model.

Next, simulate the AUTOSAR software component.


See Also

Related Examples

- “AUTOSAR Component Configuration” on page 4-3
- “Configure AUTOSAR Elements and Properties” on page 4-8

Simulate AUTOSAR Software Component

After you configure the AUTOSAR software component model for use in the Simulink environment, simulate model `my_autosar_swc`, which you configured in “Configure Elements of AUTOSAR Software Component for Simulink Modeling Environment” on page 1-23.

- 1 If not already open, open your configured version of model `my_autosar_swc`.
- 2 In the Simulink Editor, click the Simulate button .

If you have access to Simulink Coder and Embedded Coder software, next, generate code for the AUTOSAR model.

See Also

Related Examples

- “Simulate Model and View Results” (Simulink)

Optional: Generate AUTOSAR Software Component Code (Requires Embedded Coder)

If you have access to Simulink Coder and Embedded Coder software, you can build an AUTOSAR model. When you build an AUTOSAR model, the code generator produces C code that complies with the AUTOSAR standard and arxml descriptions.

- 1** If not already open, open your configured version of model `my_autosar_swc`.
- 2** Initiate code generation by pressing **Ctrl+B**. The code generator produces C code and arxml files. The generated code complies with the AUTOSAR standard so that you can schedule the code with the AUTOSAR run-time environment.

The code generator also produces and displays a code generation report.

- 3** In the code generation report, review the generated code. In your current MATLAB folder, the `my_autosar_swc_autosar_rtw` folder contains the primary files listed in this table.

Generated Code Files

Files	Description
<code>my_autosar_sw.c</code>	Contains entry points for the code that implements the model algorithm. This file includes rate scheduling code.
<code>my_autosar_sw.h</code>	Declares model data structures and a public interface to the model entry points and data structures.
<code>rtwtypes.h</code>	Defines data types, structures, and macros that the generated code requires.
<code>my_autosar_sw_component.arxml</code> <code>my_autosar_sw_datatype.arxml</code> <code>my_autosar_sw_implementation.arxml</code> <code>my_autosar_sw_interface.arxml</code>	Contain elements and objects that represent AUTOSAR software components, ports, interfaces, data types, and packages. You integrate arxml files into an AUTOSAR run-time environment. You can import arxml files into the Simulink environment by using the AUTOSAR arxml importer tool.

- 4 Open and review the Code Interface Report. This information is captured in the arxml files. The run-time environment generator uses the arxml descriptions to interface the code into an AUTOSAR run-time environment.

Entry-point functions:

- Initialization entry-point function — `void my_autosar_sw_Init(void)`. At startup, call this function once.
- Output and update entry-point function — `void my_autosar_sw_Step(void)`. Call this function periodically at the fastest rate in the model. For this model, call the function every second. To achieve real-time execution, attach this function to a timer.
- Output and update entry-point function — `void my_autosar_sw_Step1(void)`. Call this function periodically at the second fastest rate in the model. For this model, call the function every 2 seconds. To achieve real-time execution, attach this function to a timer.

The entry-point functions are also accessible in the Code Mappings editor, on the **Functions** tab. You call these generated functions from external code or from a version of a generated main function that you modify. If required, you can change the name of a function. For the base-rate step function of a rate-based model and for step functions for export function models, you can customize the function name and arguments.

Input ports:

- Block In1_1s — Require port, interface: sender-receiver of type real-T of 1 dimension
- Block In2_2s — Require port, interface: sender-receiver of type real-T of 1 dimension

Output ports:

- Block Out1 — Provide port, interface: sender-receiver of type real-T of 1 dimension
 - Block Out2 — Provide port, interface: sender-receiver of type real-T of 1 dimension
- 5 Check whether the configuration changes that you made appear in the generated code by using the Code panel in the Code perspective. To open the Code panel, on the AUTOSAR tab, select **View Code**. The Code panel opens to the right of the model. In the search field, type `In1_1s_SS1`, the new name for AUTOSAR software component port `In1_1s`. Then, click the arrow button to advance to instances of the name in the arxml file `my_autosar_swc_component.arxml`. Verify that the settings of communication attributes that you modified for the AUTOSAR software component port appear correctly.

```

<PORTS>
  <R-PORT-PROTOTYPE UUID="7b644055-8cb0-500d-612e-c39
    <SHORT-NAME>In1_1s_SS1</SHORT-NAME>
    <REQUIRED-COM-SPECS>
      <NONQUEUED-RECEIVER-COM-SPEC>
        <DATA-ELEMENT-REF DEST="VARIABLE-DATA-F
        <HANDLE-OUT-OF-RANGE>NONE</HANDLE-OUT-C
        <USES-END-TO-END-PROTECTION>false</USES
        <ALIVE-TIMEOUT>30</ALIVE-TIMEOUT>
        <ENABLE-UPDATE>false</ENABLE-UPDATE>
        <HANDLE-NEVER-RECEIVED>true</HANDLE-NEV
        <HANDLE-TIMEOUT-TYPE>NONE</HANDLE-TIMEC
        <INIT-VALUE>
          <NUMERICAL-VALUE-SPECIFICATION>
            <SHORT-LABEL>DefaultInitValue_D
            <VALUE>1</VALUE>

```

- 6 Use the Code perspective Code panel to explore other aspects of the generated code. For example, if you select file `my_autosar_sw.c`, and then click in the search field, a list of links to code elements, including the entry-point functions, appears. Use the links to quickly navigate to key areas of the generated C code.

See Also

Related Examples

- “Configure AUTOSAR Code Generation” on page 5-8

Develop AUTOSAR Adaptive Software Component Model

Prerequisites

This tutorial assumes that you are familiar with the basics of the AUTOSAR standard and Simulink. The code generation portion of this tutorial assumes that you have knowledge of Embedded Coder basics.

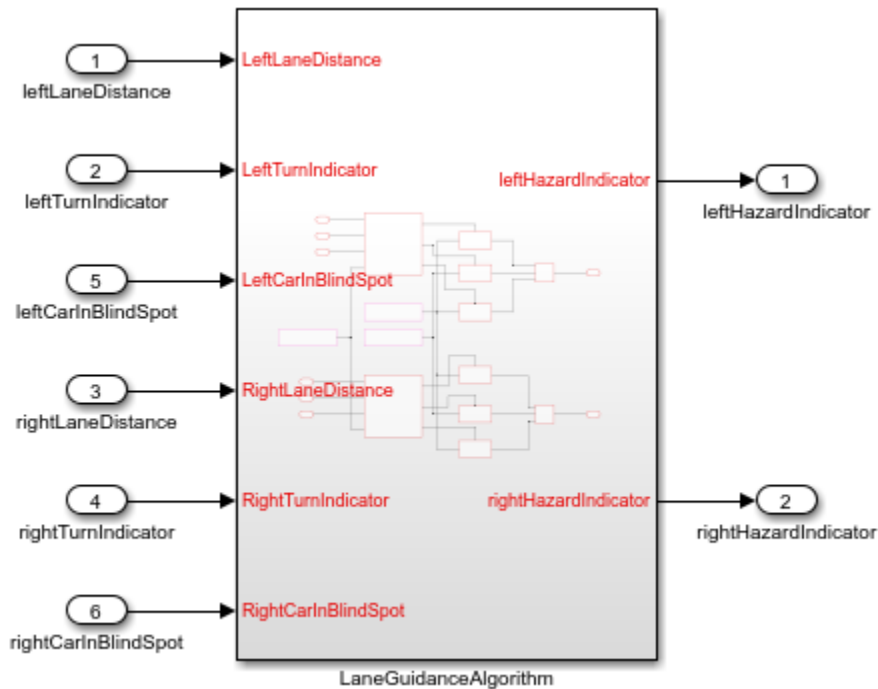
To complete this tutorial, you must have:

- MATLAB
- Simulink

An optional part of the tutorial requires Simulink Coder and Embedded Coder software.

Example Model

The tutorial uses example models LaneGuidance and autosar_LaneGuidance.



What You Will Learn

You will learn how to:

- 1 Create algorithmic model content that represents AUTOSAR adaptive software component behavior.
- 2 Configure elements of an AUTOSAR adaptive software component for the Simulink modeling environment.
- 3 Simulate the AUTOSAR adaptive software component.
- 4 Optionally, generate AUTOSAR adaptive software component code.

To start the tutorial, see “Create Algorithmic Model Content That Represents AUTOSAR Adaptive Software Component Behavior” on page 1-36.

Create Algorithmic Model Content That Represents AUTOSAR Adaptive Software Component Behavior

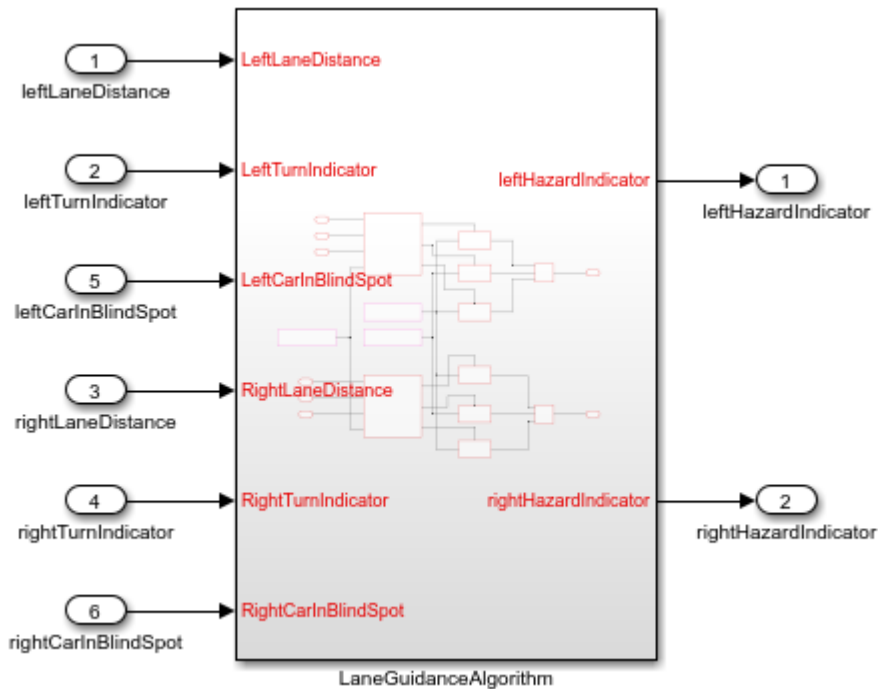
AUTOSAR Blockset software supports AUTOSAR software component modeling for the AUTOSAR Adaptive Platform. To develop an AUTOSAR adaptive software component in Simulink, create a Simulink model that represents the AUTOSAR adaptive software component. Initiate the model creation in one of these ways:

- Import an existing AUTOSAR XML (`arxml`) component description into the Simulink environment as a model. You import a component description by using the AUTOSAR `arxml` importer.
- Rework an existing Simulink model into a representation of the AUTOSAR adaptive software component.
- Starting from an AUTOSAR Blockset model template, create a Simulink model.

After creating an initial model design, refine the algorithmic content.

This tutorial shows a sample model representation of an AUTOSAR adaptive software component.

- 1** Open model `LaneGuidance`.



- 2 Explore the model. It consists of a subsystem, LaneGuidanceAlgorithm. The subsystem has six inports, which represent required ports of the AUTOSAR adaptive software component: leftLaneDistance, leftTurnIndicator, leftCarInBlindSpot, rightLaneDistance, rightTurnIndicator, and rightCarInBlindSpot. Two outports represent provider ports: leftHazardIndicator and rightHazardIndicator.
- 3 Set model configuration parameter **System target file** to `autosar_adaptive.tlc`. That system target file setting enables use of AUTOSAR Blockset software and affects other model configuration parameter settings. For example:
 - **Language** is set to C++.
 - **Generate code only** is selected.
 - **Toolchain** is set to AUTOSAR Adaptive | CMake.
 - **Code interface packaging** is set to C++ class.

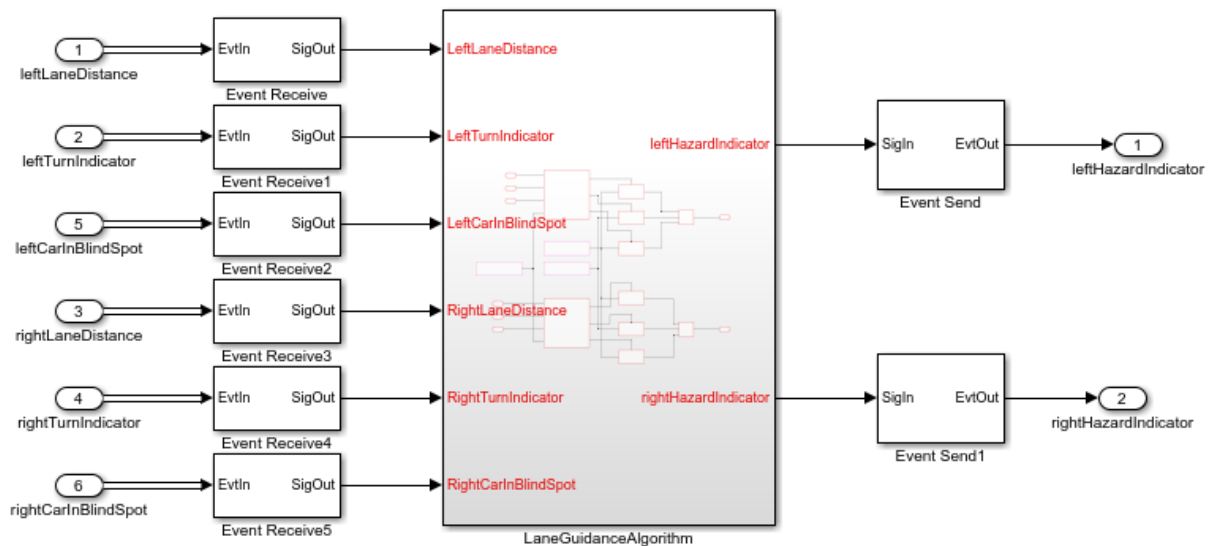
- 4 At the top level of the model, set up event-based communication. An AUTOSAR adaptive software component provides and consumes services. Each component contains:

- An algorithm that performs tasks in response to received events
- Required and provided ports, each associated with a service interface
- Service interfaces, with associated events and associated namespaces

AUTOSAR Blockset provides Event Receive and Event Send blocks to make the necessary event and signal connections.

- After each root inport, add an Event Receive block, which converts an input event to a signal while preserving the signal values and data type.
- Before each root outport, add an Event Send block, which converts an input signal to an event while preserving the signal values and data type.

To expedite the block insertion, you can copy the event blocks from the completed version of the example model `autosar_LaneGuidance`.



- 5 Explore the model configuration. Solver settings are:

- **Type** is set to Fixed-step.

- **Solver** is set to auto (Automatic solver selection).
- **Fixed-step size (fundamental sample time)** is set to 1/10.
- **Periodic same time constraint** is set to Unconstrained.

In the Simulink Editor, you can enable sample time color-code by selecting the **Debug** tab and selecting **Diagnostics > Information Overlays > Colors**. A sample time legend shows the implicit rate grouping. The legend for this model shows that the model uses a single rate of 0.1 second. The model simulates in single-tasking mode.

- 6 Save the model to a writable folder on your current MATLAB search path. Name the file `my_autosar_LaneGuidance.slx`.

Next, configure elements of the AUTOSAR adaptive software component for use in the Simulink modeling environment.

See Also

Related Examples

- “Modeling Patterns”

Configure Elements of AUTOSAR Adaptive Software Component for Simulink Modeling Environment

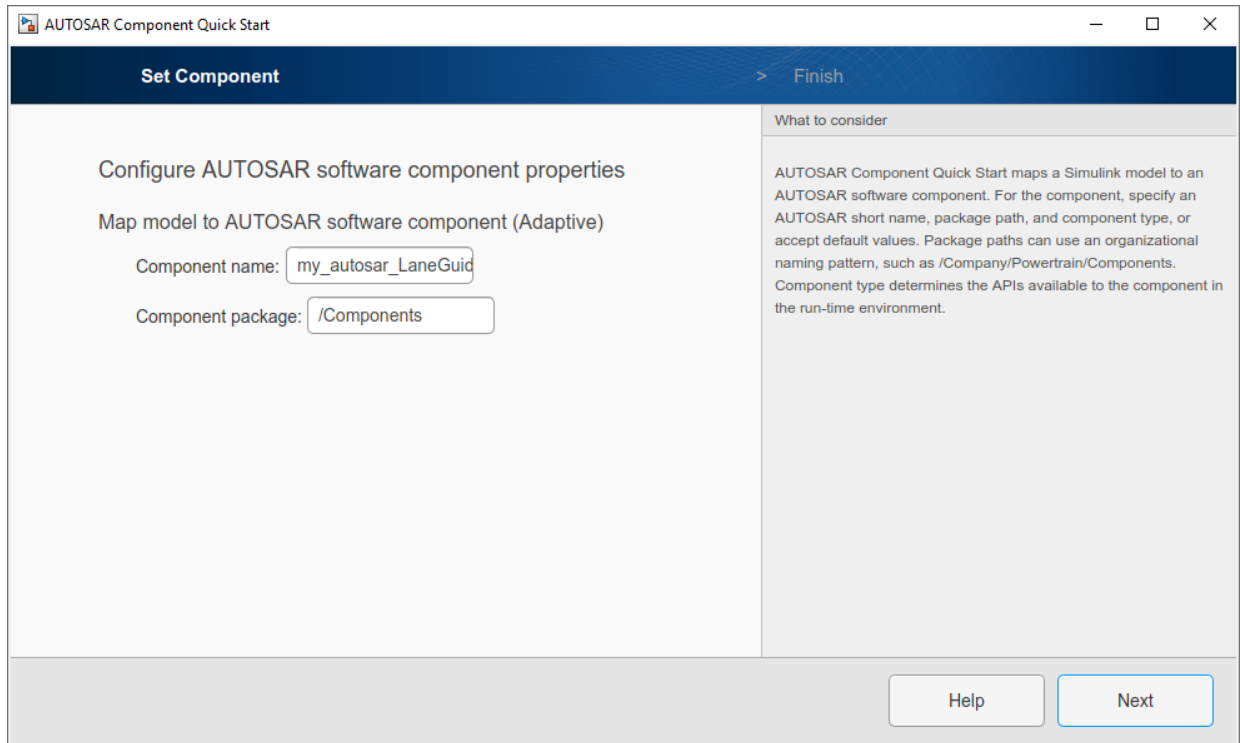
After you create a representation of the AUTOSAR adaptive software component in the Simulink Editor, configure elements of the software component for use in Simulink. The configuration maps AUTOSAR adaptive software component elements to Simulink modeling elements.

AUTOSAR Blockset software reduces the effort of setting up a configuration by providing an AUTOSAR Component Quick Start tool. If necessary, you can modify the initial configuration by using the Code Mappings editor and the AUTOSAR Dictionary.

Set Up an Initial Component Configuration

Set up an initial configuration of an AUTOSAR adaptive software component by using the AUTOSAR Component Quick Start tool.

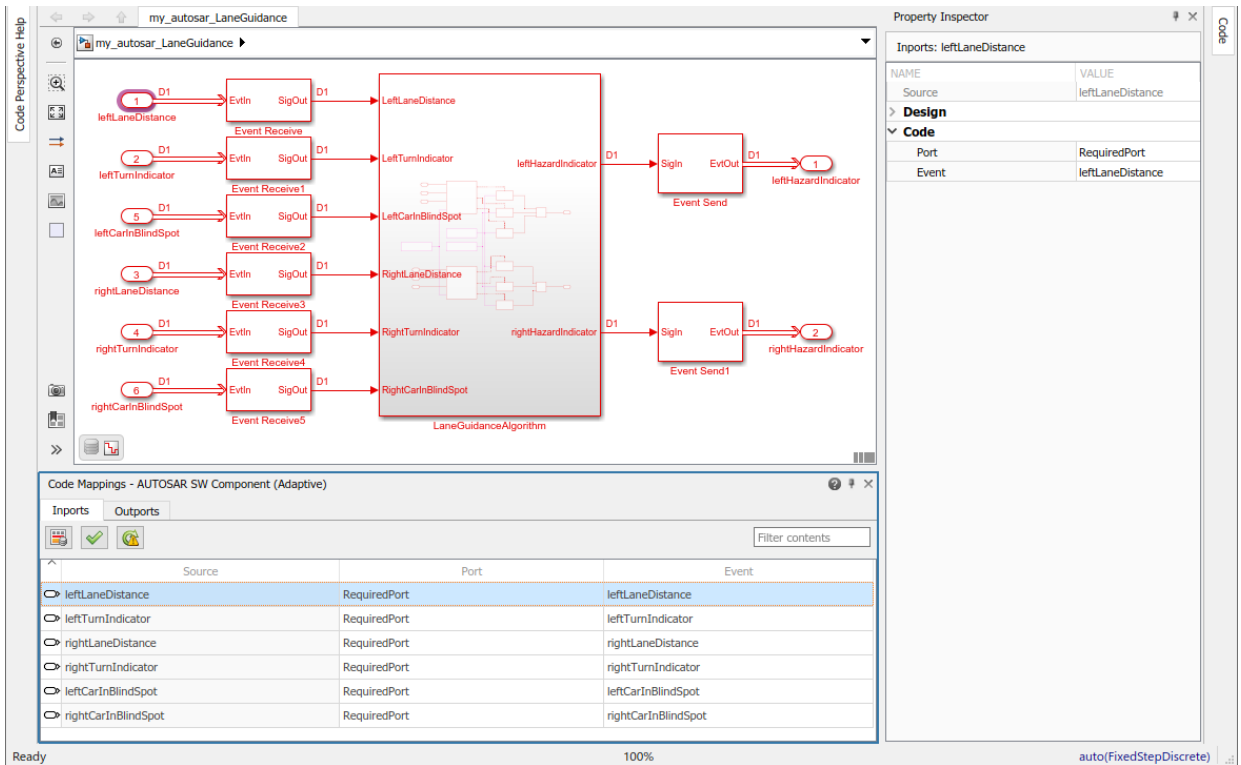
- 1 Open your saved version of the example model `my_autosar_LaneGuidance`.
- 2 Run the AUTOSAR Component Quick Start tool. From the **Apps** tab, open the AUTOSAR Component Designer app. When you open the app for an unmapped model that is configured with an AUTOSAR system target file, the AUTOSAR Component Quick Start tool runs.



- 3 Advance through the steps of the AUTOSAR Component Quick Start tool. Each step prompts you for input that the tool uses to configure your AUTOSAR software component for the Simulink environment. For this tutorial, use the defaults.

After you click **Finish**, the tool:

- Creates a mapping between elements of the AUTOSAR adaptive software component and Simulink model elements.
- Opens the model in the Simulink Editor AUTOSAR Code perspective. The AUTOSAR Code perspective displays a help panel, a Property Inspector panel, and directly below the model, the Code Mappings editor.
- Displays the AUTOSAR software component mappings in the Code Mappings editor, which you can use to customize the configuration.



4 Save the model.

Customize Component Configuration

The AUTOSAR Component Quick Start tool sets up an initial configuration for an AUTOSAR adaptive software component. To refine or make changes to an existing component configuration, use the Code Mappings editor and the AUTOSAR Dictionary.


In a tabbed table format, the Code Mappings editor displays Simulink model inports and outports. Map Simulink inports and outports to AUTOSAR adaptive software component ports in the editor. AUTOSAR adaptive software component ports are defined in the AUTOSAR standard.

- 1 If not already open, open model `my_autosar_LaneGuidance`.
- 2 In the Model Data Editor, check whether you need to reconfigure data types or other attributes of model data. For example, verify that event data is configured correctly

for the design. To view data in the Model Data Editor, on the **AUTOSAR** tab, select **Settings > Model Data Editor**. For this tutorial, make no changes.


- 3 To exit the Model Data Editor, remove the check mark next to the **Settings > Model Data Editor** menu item. Open the Code Mappings editor.
- 4 In the Code Mappings editor, examine the mapping of Simulink inports and outputs to AUTOSAR ports and events. In each tab, you can select model elements and modify their AUTOSAR mapping and attributes. Modifications are reflected in generated arxml descriptions and C code.

Select the **Inports** tab. For each Simulink inport, the editor lists the corresponding AUTOSAR port type and event. For example, Simulink inport `leftLaneDistance` is mapped to an AUTOSAR required port and event `leftLaneDistance`. For this tutorial, make no changes.

If the Update Code Mappings button appears with a warning symbol , click the button to update the Code Mappings to include the latest model data.

Configure AUTOSAR Adaptive Software Component Elements from AUTOSAR Standard Perspective

Configure AUTOSAR software component elements from the perspective of the AUTOSAR standard perspective by using the AUTOSAR Dictionary.

- 1 If not already open, open model `my_autosar_LaneGuidance`.
- 2 Open the AUTOSAR Dictionary. In the Code Mappings editor, click the AUTOSAR Dictionary button . The AUTOSAR Dictionary opens in the AUTOSAR view, which corresponds to the Simulink element that you last selected and mapped in the Code Mappings editor. If you selected and mapped a Simulink inport, the dictionary opens in RequiredPorts view and displays the AUTOSAR port that you mapped the inport to.

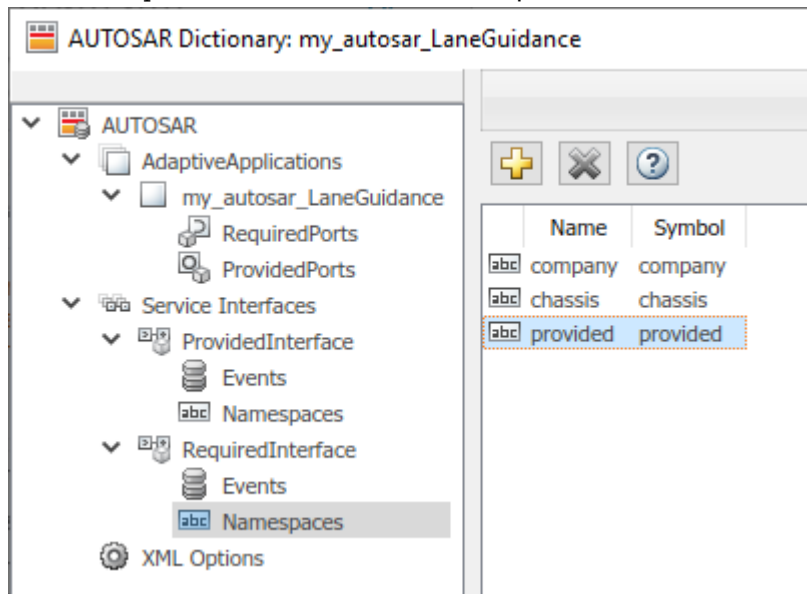
In a tree format, the AUTOSAR Dictionary displays the mapped AUTOSAR software component and its elements, service interfaces, and XML options.

- 3 Use the AUTOSAR Dictionary to further customize component configurations. For example, you can use the dictionary to:
 - Expand service interface nodes to examine AUTOSAR events created during the default component mapping.


- Define a unique namespace for each service interface. The code generator uses the defined namespaces when producing C++ code for the model.
- Configure characteristics of exported AUTOSAR XML.

In the left pane of the dictionary, expand the tree nodes and explore what is defined for the model.

- 4 For this tutorial, add namespaces for service interfaces **ProvidedInterface** and **RequiredInterface**.
 - a In the left pane of the dictionary, expand the **Service Interfaces** and **ProvidedInterface** nodes.
 - b Select **Namespaces**.
 - c In the right pane, click the plus sign.
 - d Set **Name** and **Symbol** to company.
 - e Add namespace entries for chassis and provided.



- f Add company, chassis, and required namespace entries for the **RequiredInterface** node.
- 5 Close the dictionary.

- 6 After making configuration changes, in the Code Mappings editor, the Update Code Mappings button appears with a warning symbol , click the button to update the Code Mappings to include the latest model data.
- 7 Save the model.

Next, simulate the AUTOSAR software component.


See Also

Related Examples

- “Create AUTOSAR Software Component in Simulink” on page 3-2
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27

Simulate AUTOSAR Adaptive Software Component

After you configure the AUTOSAR adaptive software component model for use in the Simulink environment, simulate model `my_autosar_LaneGuidance`, which you configured in “Configure Elements of AUTOSAR Adaptive Software Component for Simulink Modeling Environment” on page 1-40.

- 1 If not already open, open your configured version of model `my_autosar_LaneGuidance`.
- 2 In the Simulink Coder Editor, click the Simulate button .

If you have access to Simulink Coder and Embedded Coder software, next, generate code for the AUTOSAR model.

See Also

Related Examples

- “Simulate Model and View Results” (Simulink)

Optional: Generate AUTOSAR Adaptive Software Component Code (Requires Embedded Coder)

If you have access to Simulink Coder and Embedded Coder software, you can build an AUTOSAR adaptive model. When you build an AUTOSAR adaptive model, the code generator produces C++ code that complies with the AUTOSAR standard for the Adaptive Platform and arxml descriptions.

- 1 If not already open, open your configured version of model `my_autosar_LaneGuidance`.
- 2 Initiate code generation by pressing **Ctrl+B**. The code generator produces C++ code and arxml files. The generated code complies with the AUTOSAR standard so that you can schedule the code with the AUTOSAR run-time environment.

The code generator also produces and displays a code generation report.

- 3 In the code generation report, review the generated code. In your current MATLAB folder, the `my_autosar_LaneGuidance_autosar_adaptive` folder contains the primary files listed in this table.

Generated Code Files

Files	Description
<code>my_autosar_LaneGuidance.cpp</code>	Contains entry points for the code that implements the model algorithm. This file includes the rate scheduling code.
<code>my_autosar_LaneGuidance.h</code>	Declares model data structures and a public interface to the model entry points and data structures.
<code>rtwtypes.h</code>	Defines data types, structures, and macros that the generated code requires.
<code>my_autosar_LaneGuidance_component.arxml</code> <code>my_autosar_LaneGuidance_datatype.arxml</code> <code>my_autosar_LaneGuidance_interface.arxml</code>	Contain elements and objects that represent AUTOSAR software components, ports, interfaces, data types, and packages. You integrate arxml files into an AUTOSAR run-time environment. You can import arxml files into the Simulink environment by using the AUTOSAR arxml importer tool.
<code>main.cpp</code> <code>MainUtils.hpp</code>	Provide a framework for running adaptive software component service code.

- 4 Open and review the Code Interface Report. This information is captured in the arxml files. The run-time environment generator uses the arxml descriptions to interface the code into an AUTOSAR run-time environment.

Entry-point functions

- Initialization entry-point function — `void my_autosar_LaneGuidanceModelClass::initialize()`. At startup, call this function once.
- Output entry-point function — `void my_autosar_LaneGuidanceModelClass::step()`. Call this function periodically, every 0.1 seconds.

- Termination entry-point function — `void my_autosar_LaneGuidanceModelClass::terminate()`. At shutdown, call this function once.

Input ports:

- Block `leftLaneDistance` — Require port, interface: sender-receiver of type `real-T` of 1 dimension
- Block `leftTurnIndicator` — Require port, interface: sender-receiver of type `real-T` of 1 dimension
- Block `rightLaneDistance` — Require port, interface: sender-receiver of type `real-T` of 1 dimension
- Block `rightTurnIndicator` — Require port, interface: sender-receiver of type `real-T` of 1 dimension
- Block `leftCarInBlindSpot` — Require port, interface: sender-receiver of type `real-T` of 1 dimension
- Block `rightCarInBlindSpot` — Require port, interface: sender-receiver of type `real-T` of 1 dimension

Output ports:

- Block `leftHazardIndicator` — Port defined externally of type `real-T` of 1 dimension
 - Block `rightHazardIndicator` — Port defined externally of type `real-T` of 1 dimension
- 5** Check whether the configuration changes that you made appear in the generated code by using the Code panel in the Code perspective. To open the Code panel, on the AUTOSAR tab, select **View Code**. The Code panel opens to the right of the model.

With file `my_autosar_LaneGuidance.cpp` selected, in the search field, type `company` (one of the namespace values that you defined for the service interfaces). The Code view highlights instances of `company`, showing how the namespace symbols are applied in the code.



```
← → my_autosar_LaneGuidance.cpp (9) 🔍 company
Highlighting: company 1 / 27 < >
35 // Model step function
36 void my_autosar_LaneGuidanceModelClass::step()
37 {
38     const ara::com::SampleContainer< ara::com::SamplePtr< const company::chassis::
39         provided::proxy::events::leftLaneDistance::SampleType > > *sampleContainer;
40     const ara::com::SampleContainer< ara::com::SamplePtr< const company::chassis::
41         provided::proxy::events::leftTurnIndicator::SampleType > >
42         *sampleContainer_0;
43     const ara::com::SampleContainer< ara::com::SamplePtr< const company::chassis::
44         provided::proxy::events::leftCarInBlindSpot::SampleType > >
45         *sampleContainer_1;
46     const ara::com::SampleContainer< ara::com::SamplePtr< const company::chassis::
47         provided::proxy::events::rightLaneDistance::SampleType > >
48         *sampleContainer_2;
49     const ara::com::SampleContainer< ara::com::SamplePtr< const company::chassis::
50         provided::proxy::events::rightTurnIndicator::SampleType > >
51         *sampleContainer_3;
52     const ara::com::SampleContainer< ara::com::SamplePtr< const company::chassis::
53         provided::proxy::events::rightCarInBlindSpot::SampleType > >
54         *sampleContainer_4;
```

- 6 Use the Code perspective Code panel to explore other aspects of the generated code. For example, if you select file `my_autosar_LaneGuidance.cpp`, and then click in the search field, a list of links to code elements appear. Use the links to quickly navigate to key areas of the generated code.

See Also

Related Examples

- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

Modeling Patterns for AUTOSAR Components

- “Simulink Modeling Patterns for AUTOSAR” on page 2-2
- “Model AUTOSAR Software Components” on page 2-3
- “Modeling Patterns for AUTOSAR Runnables” on page 2-13
- “Model AUTOSAR Runnables Using Exported Functions” on page 2-23
- “Model AUTOSAR Communication” on page 2-28
- “Model AUTOSAR Component Behavior” on page 2-39
- “Model AUTOSAR Variants” on page 2-45
- “Model AUTOSAR Calibration Parameters and Lookup Tables” on page 2-49
- “Model AUTOSAR Data Types” on page 2-53

Simulink Modeling Patterns for AUTOSAR

The following topics present Simulink modeling patterns for common AUTOSAR elements. You can use these modeling patterns when developing models for the AUTOSAR Classic Platform.

- “Model AUTOSAR Software Components” on page 2-3
- “Modeling Patterns for AUTOSAR Runnables” on page 2-13
- “Model AUTOSAR Runnables Using Exported Functions” on page 2-23
- “Model AUTOSAR Communication” on page 2-28
- “Model AUTOSAR Component Behavior” on page 2-39
- “Model AUTOSAR Variants” on page 2-45
- “Model AUTOSAR Calibration Parameters and Lookup Tables” on page 2-49
- “Model AUTOSAR Data Types” on page 2-53

Model AUTOSAR Software Components

In Simulink, you can flexibly model the structure and behavior of software components for the AUTOSAR Classic Platform. Components can contain one or multiple runnable entities, and can be single-instance or multi-instance. To design the internal behavior of components, you can use Simulink modeling styles, such as rate-based and function-call based.

In this section...

“About AUTOSAR Software Components” on page 2-3

“Implementation Considerations” on page 2-4

“Rate-Based Components” on page 2-7

“Function-Call Based Components” on page 2-9

“Multi-Instance Components” on page 2-11

“Startup, Reset, and Shutdown” on page 2-11

About AUTOSAR Software Components

An AUTOSAR application is made up of interconnected *software components* (SWCs). Each software component encapsulates a functional implementation of automotive behavior, with well-defined connection points to the outside world.

In Simulink, you can model:

- *Atomic* software components — An atomic software component cannot be split into smaller software components, and runs on exactly one automotive electronic control unit (ECU).
- *Parameter* software components — A parameter software component represents memory containing AUTOSAR calibration parameters, and provides parameter data to connected atomic software components.

The main focus of AUTOSAR modeling in Simulink is atomic software components. For information about parameter software components, see “Model AUTOSAR Calibration Parameters and Lookup Tables” on page 2-49.

Note Do not confuse *atomic* in this context with the Simulink concept of atomic subsystems.

An AUTOSAR atomic software component interacts with other AUTOSAR software components or system services via well-defined connection points called *ports*. One or more *runnable entities* (runnables) implement the behavior of the component.

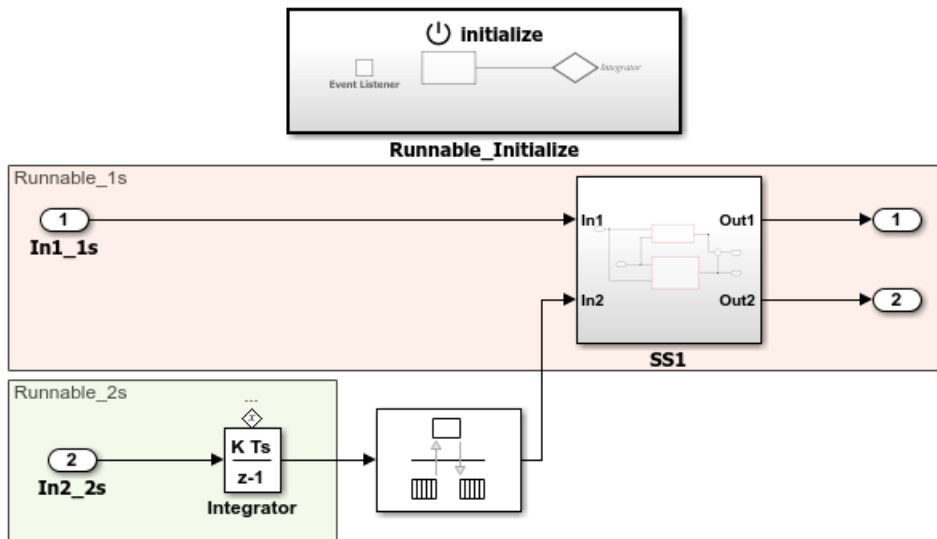
Implementation Considerations

To develop an AUTOSAR atomic software component in Simulink, you create an initial Simulink representation of an AUTOSAR component, as described in “Component Creation”. You can either import an AUTOSAR component description from a `arxml` files or, in an existing model, build a default AUTOSAR component based on the model content. The resulting representation includes:

- Simulink blocks, connections, and data that model AUTOSAR elements such as ports, runnables, inter-runnable variables, and parameters.
- Stored properties, defined in the AUTOSAR standard, for AUTOSAR elements in the software component.
- A mapping of Simulink elements to AUTOSAR elements.

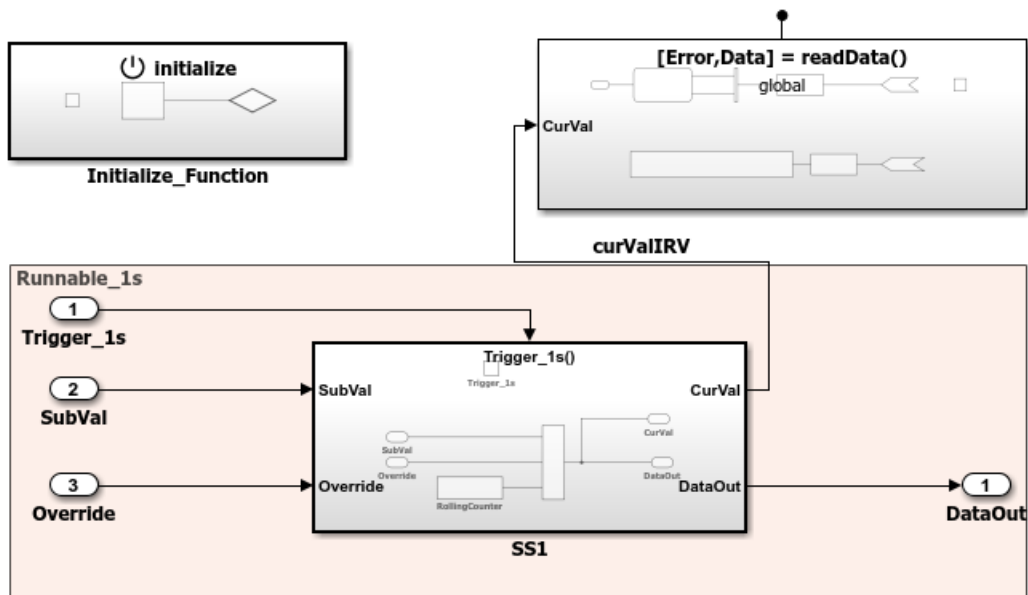
Usually, the Simulink representation of an AUTOSAR component is a rate-based model, in which periodic runnables are modeled as atomic subsystems with periodic rates.

Consider AUTOSAR example model `autosar_swc`. This model shows a rate-based implementation of an AUTOSAR atomic software component. The model implements periodic runnables using multiple rates. An Initialize Function block initializes the component.



However, if your component design requires server functions or periodic function calls, the Simulink representation can be a function-call based model. The model can contain Simulink Function blocks or function-call subsystems with periodic rates.

Consider AUTOSAR example model `autosar_swc_slfcns`. This model shows a function-call based implementation of an AUTOSAR atomic software component. The model uses a Simulink Function block and a periodic function-call subsystem at root level. An Initialize Function block initializes the component.



If your AUTOSAR software component design contains periodic runnables, you must decide whether your component requires a rate-based or function-call based modeling approach. Before you create an initial Simulink representation of your AUTOSAR component, designate how to model periodic runnables:

- If you are importing an AUTOSAR component description from arxml files using `arxml.importer` object function `createComponentAsModel`, specify the property `ModelPeriodicRunnablesAs` as `AtomicSubsystem` (default) for rate-based or `FunctionCallsSubsystem` for function-call based.
- If you are building a default AUTOSAR component in an existing model, populate the model with rate-based or function-call based content.
 - For rate-based modeling, create model content with one or more periodic rates. To model an AUTOSAR inter-runnable variable, use a Rate Transition block that handles data transfers between blocks operating at different rates. The resulting component has N periodic step runnables, where N is the number of discrete rates in the model. Events that represent rate-based interrupts initiate execution of the periodic step runnables, using rate monotonic scheduling.
 - For function-call based modeling, at the top level of a model, create function-call subsystems — or (for client-server modeling) Simulink Function blocks. Add root

model inports and outports. To model an AUTOSAR inter-runnable variable, use a signal line to connect function-call subsystems. The resulting component has N exported-function or server runnables. N is the number of function-call subsystems or Simulink Function blocks at the top level of the model. Events that represent function calls initiate execution of the function-based runnables.

Select rate-based modeling, the default, unless your design requires function-call based modeling.

Sometimes, conditions in your AUTOSAR software component can prevent use of rate-based modeling. For example:

- The AUTOSAR software component contains a server runnable.
- The AUTOSAR software component contains an inter-runnable variable (IRV) that multiple runnables read or write.
- The AUTOSAR software component contains a periodic runnable with a rate that is not a multiple of the fastest rate.
- The AUTOSAR software component contains multiple runnables that access the same read or write data at different rates.
- The AUTOSAR software component contains a periodic runnable that other events also trigger.
- The AUTOSAR software component contains multiple periodic runnables that are triggered at the same period.

If your AUTOSAR software component supports multiple instantiation (that is, `SwcInternalBehavior` attribute `supportsMultipleInstantiation` is set to true), you cannot model periodic runnables as function-call subsystems. Either use rate-based modeling and model periodic runnables as atomic subsystems, or set `supportsMultipleInstantiation` to false.

For examples of different ways to model AUTOSAR software components, see “Rate-Based Components” on page 2-7, “Function-Call Based Components” on page 2-9, and “Modeling Patterns for AUTOSAR Runnables” on page 2-13.

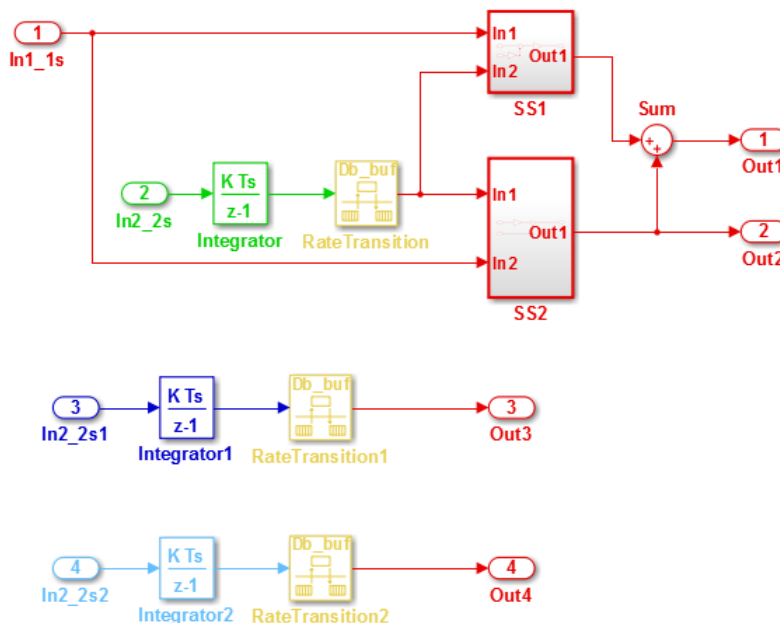
Rate-Based Components

You can model AUTOSAR multi-runnables using Simulink rate-based, multitasking modeling. First you create or import model content with multiple periodic rates. You can:

- Create a software component with multiple periodic runnables in Simulink.
- Import a software component with multiple periodic runnables from arxml files into Simulink. Use `arxml.importer` object function `createComponentAsModel` with property `ModelPeriodicRunnablesAs` set to `AtomicSubsystem`.
- Migrate an existing rate-based, multitasking Simulink model to the AUTOSAR target.

Root model inports and outports represent AUTOSAR ports, and Rate Transition blocks represent AUTOSAR inter-runnable variables (IRVs).

Here is an example of a rate-based, multitasking model that is suitable for simulation and AUTOSAR code generation. (This example uses the model `matlabroot/help/toolbox/autosar/examples/mMultitasking_4rates.slx`.) The model represents an AUTOSAR software component. The four colors displayed when you update the model (if **Display > Sample Time > Colors** is selected) represent the different periodic rates present. The Rate Transition blocks represent three AUTOSAR IRVs.

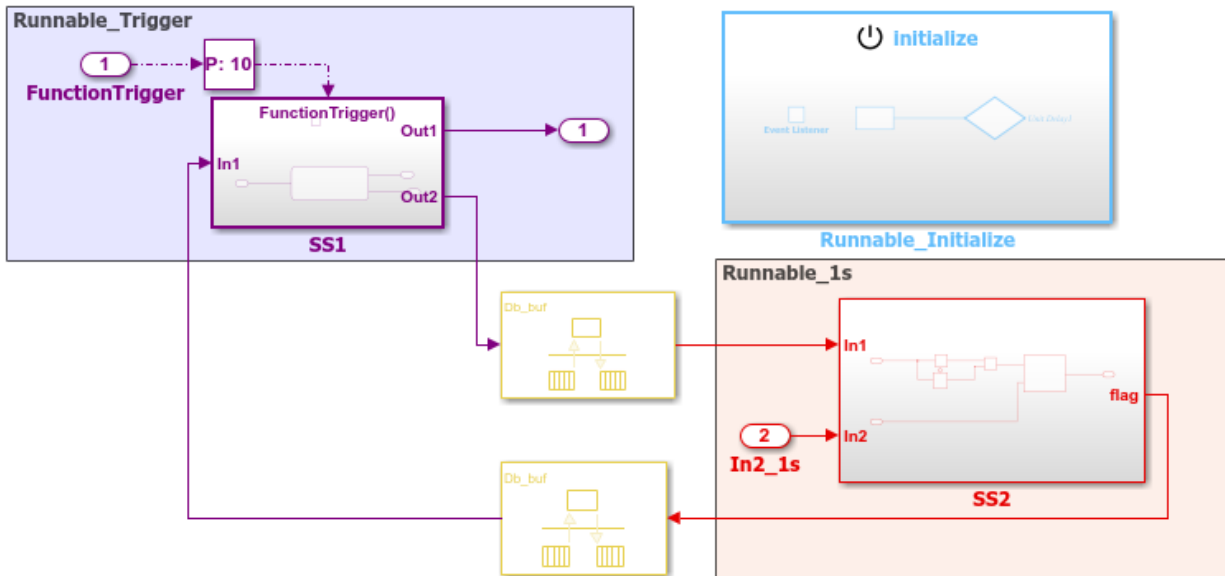


When you generate code, the model C code contains rate-grouped model step functions corresponding to AUTOSAR runnables, one for each discrete rate in the model. (The

periodic step functions must be called in the manner of a rate-monotonic scheduler.) For more information, see “Modeling Patterns for AUTOSAR Runnables” on page 2-13.

A rate-based AUTOSAR software component can include both periodic and asynchronous runnables. For example, in the JMAAB type beta architecture, an asynchronous trigger runnable interacts with periodic rate-based runnables.

Consider AUTOSAR example model `autosar_swc_fcncalls`. This model shows a rate-based implementation of an AUTOSAR atomic software component that includes an asynchronous (triggered) function-call subsystem at root level. An Initialize Function block initializes the component.



For more information, see “Add Top-Level Asynchronous Trigger to Periodic Rate-Based System” on page 4-239.

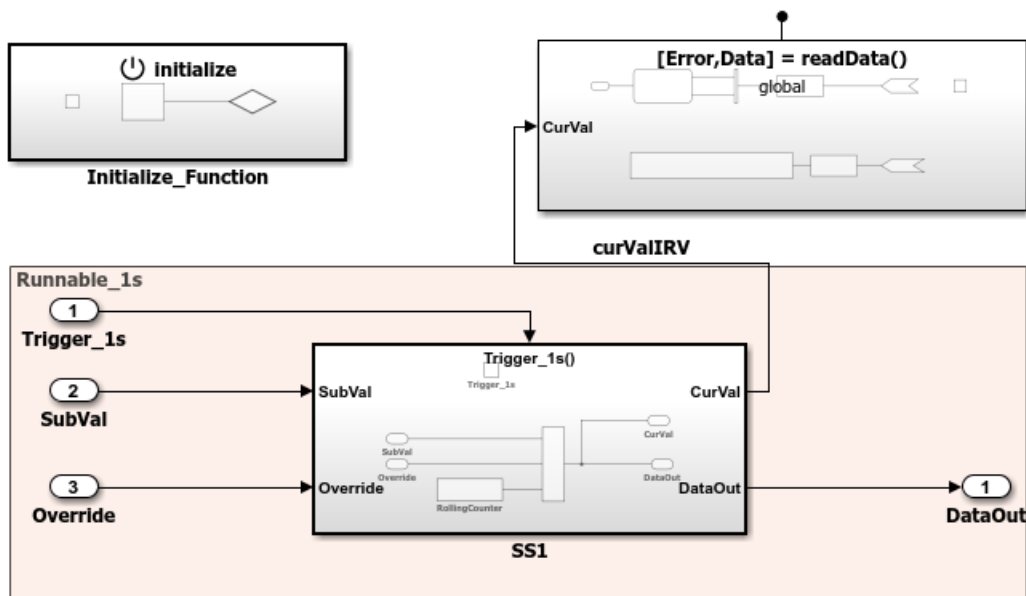
Function-Call Based Components

You can model AUTOSAR multi-runnables using Simulink function-call subsystems — or (for client-server modeling) Simulink Function blocks — at the top level of a model. First you create or import model content with multiple functions. You can:

- Create a software component with multiple runnables modeled as function-call subsystems or Simulink Function blocks in Simulink.
- Import a software component with multiple runnables from arxml files into Simulink. Use `arxml.importer` object function `createComponentAsModel` with property `ModelPeriodicRunnablesAs` set to `FunctionCallSubsystem`.
- Migrate an existing function-based Simulink model to the AUTOSAR target.

Root model inports and outports represent AUTOSAR ports, and signal lines connecting function-call subsystems represent AUTOSAR inter-runnable variables (IRVs).

Here is an example of a function-call-based model, with multiple runnable entities, that is suitable for simulation and AUTOSAR code generation. (This example uses AUTOSAR example model `autosar_swc_slfcns`.) The model represents an AUTOSAR software component. The function-call subsystem labeled `SS1` and the Simulink Function block `readData` represent runnables that implement its behavior. An Initialize Function block initializes the component. The signal line `curValIRV` represents an AUTOSAR IRV.



When you generate code, the model C code includes callable model entry-point functions corresponding to AUTOSAR runnables, one for each top-model function-call subsystem or

Simulink Function block. For more information, see “Modeling Patterns for AUTOSAR Runnables” on page 2-13.

Multi-Instance Components

You can model multi-instance AUTOSAR SWCs in Simulink. For example, you can:

- Map and configure a Simulink model as a multi-instance AUTOSAR SWC, and validate the configuration. Use the `Reusable` function setting of the model parameter **Code interface packaging** (Simulink Coder).
- Generate C code with reentrant runnable functions and multi-instance RTE API calls. You can access external I/O, calibration parameters, and per-instance memory, and use reusable subsystems in multi-instance mode.
- Verify AUTOSAR multi-instance C code with SIL and PIL simulations.
- Import and export multi-instance AUTOSAR SWC description XML files.

Note Configuring a model as a multi-instance AUTOSAR SWC is not supported when the model contains either of the following blocks:

- Simulink Function
 - Model-level Inport configured to output a periodic function-call
-

Startup, Reset, and Shutdown

AUTOSAR applications sometimes require complex logic to execute during system initialization, reset, and termination sequences. To model startup, reset, and shutdown processing in an AUTOSAR software component, use the Simulink blocks Initialize Function and Terminate Function.

The Initialize Function and Terminate Function blocks can control execution of a component in response to initialize, reset, or terminate events. You can place the blocks at any level of a model hierarchy. Each nonvirtual subsystem can have its own set of initialize, reset, and terminate functions. In a lower-level model, Simulink aggregates the content of the functions with corresponding instances in the parent model.

The Initialize Function and Terminate Function blocks contain an Event Listener block. To specify the event type of the function — `Initialize`, `Reset`, or `Terminate` — use the

Event type parameter of the Event Listener block. In addition, the function block reads or writes the state of conditions for other blocks. By default, Initialize Function block initializes block state with the State Writer block. Similarly, the Terminate Function block saves block state with the State Reader block. When the function is triggered, the value of the state variable is written to or read from the specified block.

AUTOSAR models can use the blocks to model potentially complex AUTOSAR startup, reset, and shutdown sequences. The subsystems work with any AUTOSAR component modeling style. (However, software-in-the-loop simulation of AUTOSAR initialize, reset, or terminate runnables works only with exported function modeling.)

In an AUTOSAR model, you map each Simulink initialize, reset, or terminate entry-point function to an AUTOSAR runnable. For each runnable, configure the AUTOSAR event that activates the runnable. In general, you can select any AUTOSAR event type except `TimingEvent`.

For more information, see “Configure AUTOSAR Initialize, Reset, or Terminate Runnables” on page 4-232.

See Also

Event Listener | Initialize Function | Rate Transition | Simulink Function | State Reader | State Writer | Terminate Function

Related Examples

- “Import AUTOSAR Software Component” on page 3-19
- “Modeling Patterns for AUTOSAR Runnables” on page 2-13
- “Configure AUTOSAR Runnables and Events” on page 4-224
- “Configure AUTOSAR Initialize, Reset, or Terminate Runnables” on page 4-232
- “Add Top-Level Asynchronous Trigger to Periodic Rate-Based System” on page 4-239
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “AUTOSAR Component Configuration” on page 4-3

Modeling Patterns for AUTOSAR Runnables

Use Simulink® models, subsystems, and functions to model AUTOSAR atomic software components and their runnable entities (runnables).

Multiple Periodic Runnables Configured for Multitasking

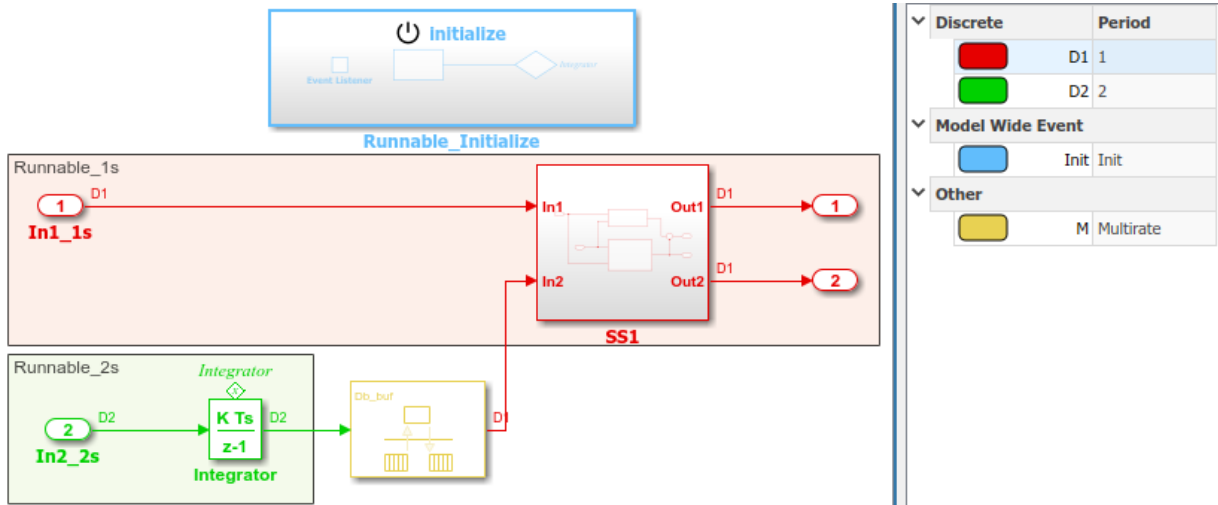
Open the example model `autosar_swc.slx`.

```
open_system('autosar_swc')
```

The model shows the implementation of an AUTOSAR atomic software component (ASWC). Two periodic runnables, `Runnable_1s` and `Runnable_2s`, are modeled with multiple sample rates: 1 second (`In1_1s`) and 2 seconds (`In2_2s`). To maximize execution efficiency, the model is configured for multitasking.

The model includes an Initialize Function block, which initializes the integrator in `Runnable_2s` to a value of 1.

To display color-coded sample rates with annotations and a legend, on the **Debug** tab, select **Diagnostics > Information Overlays > Colors**.



Relevant Model Configuration Parameter Settings

- **Solver > Type** set to Fixed-step.
- **Solver > Solver** set to discrete (no continuous states).
- **Solver > Fixed-step size (fundamental sample time)** set to auto.
- **Solver > Treat each discrete rate as a separate task** selected.

Scheduling

In the model window, enable sample time color-coding by selecting the **Debug** tab and selecting **Diagnostics > Information Overlays > Colors**. The sample time legend shows the implicit rate grouping. Red represents the fastest discrete rate. Green represents the second fastest discrete rate. Yellow represents the mixture of the two rates.

Because the model has multiple rates and the **Solver** parameter **Treat each discrete rate as a separate task** is selected, the model simulates in multitasking mode. The model handles the rate transition for In2_2s explicitly with the Rate Transition block.

The Rate Transition block parameter **Ensure deterministic data transfer** is cleared to facilitate integration into an AUTOSAR run-time environment.

The generated code for the model schedules subrates in the model. In this example, the rate for Inport block In2_2s, the green rate, is a subrate. The generated code properly transfers data between tasks that run at the different rates.

Generate Code and Report (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, generate code and a code generation report. The example model generates a report.

Generated code complies with AUTOSAR so that you can schedule the code with the AUTOSAR run-time environment.

Review Generated Code

In the code generation report, review the generated code.

- `autosar_sw.c` contains entry points for the code that implements the model algorithm. This file includes the rate scheduling code.
- `autosar_sw.h` declares model data structures and a public interface to the model entry points and data structures.

- `autosar_swc_private.h` contains local `define` constants and local data required by the model and subsystems.
- `autosar_swc_types.h` provides forward declarations for the real-time model data structure and the parameters data structure.
- `rtwtypes.h` defines data types, structures, and macros that the generated code requires.
- `autosar_swc_component.arxml`, `autosar_swc_datatype.arxml`, `autosar_swc_implementation.arxml`, and `autosar_swc_interface.arxml` contain elements and objects that represent AUTOSAR software components, ports, interfaces, data types, and packages. You integrate `arxml` files into an AUTOSAR run-time environment. You can import `arxml` files into the Simulink environment by using the AUTOSAR `arxml` importer tool.
- `Compiler.h`, `Platform_Types.h`, `Rte_ASWC.h`, `Rte_Type.h`, and `Std_Types.h` contain stub implementations of AUTOSAR run-time environment functions. Use these files to test the generated code in Simulink, for example, in software-in-the-loop (SIL) or processor-in-the-loop (PIL) simulations of the component under test.

Code Interface

Open and review the Code Interface Report. This information is captured in the `arxml` files. The run-time environment generator uses the `arxml` descriptions to interface the code into an AUTOSAR run-time environment.

Input ports:

- Require port, interface: sender-receiver of type `real -T` of 1 dimension
- Require port, interface: sender-receiver of type `real -T` of 1 dimension

Entry-point functions:

- Initialization entry-point function, `void Runnable_Initialize(void)`. At startup, call this function once.
- Output and update entry-point function, `void Runnable_1s(void)`. Call this function periodically at the fastest rate in the model. For this model, call the function every second. To achieve real-time execution, attach this function to a timer.
- Output and update entry-point function, `void Runnable_2s(void)`. Call this function periodically at the second fastest rate in the model. For this model, call the function every 2 seconds. To achieve real-time execution, attach this function to a timer.

Output ports:

- Provide port, interface: sender-receiver of type `real-T` of 1 dimension
- Provide port, interface: sender-receiver of type `real-T` of 1 dimension

Multiple Runnables Configured as Periodic-Rate Runnable and Asynchronous Function-Call Runnable

Open the example model `autosar_swc_fcncalls.slx`.

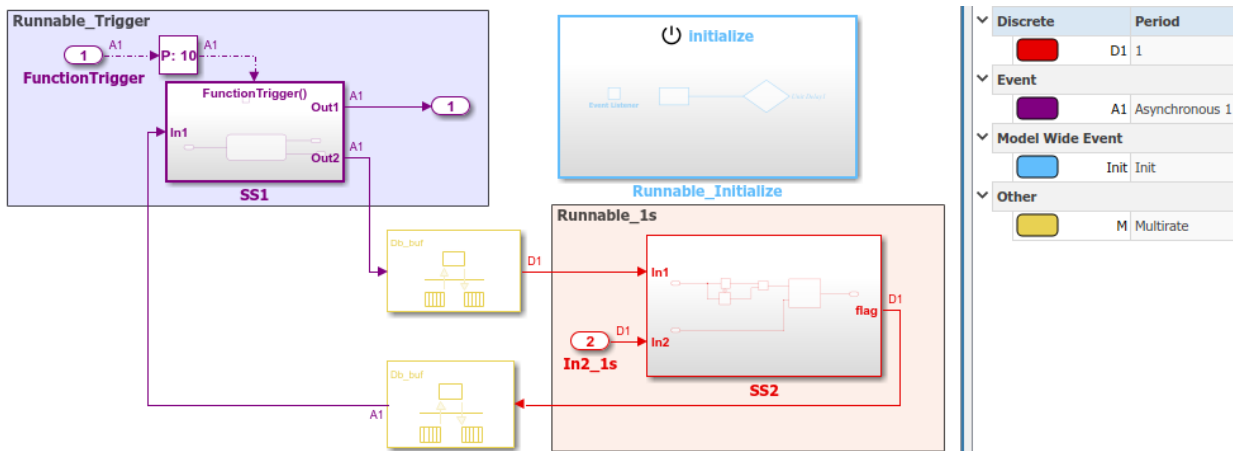
```
open_system('autosar_swc_fcncalls')
```

The model shows the implementation of an AUTOSAR atomic software component (ASWC). The model uses an asynchronous function-call runnable, `Runnable_Trigger`, which is triggered by an external event. The model also includes a periodic rate-based runnable, `Runnable_1s`. The Rate Transition blocks represent inter-runnable variables (IRVs).

Use this approach to model the JMAAB complex control model type beta architecture. In JMAAB type beta modeling, at the top level of a control model, you place function layers above scheduling layers.

The model includes an Initialize Function block, which initializes the unit delay in `Runnable_1s` to a value of 0.

To display color-coded sample rates with annotations and a legend, on the **Debug** tab, select **Diagnostics > Information Overlays > Colors**.



Relevant Model Configuration Parameter Settings

- **Solver > Type** set to Fixed-step.
- **Solver > Solver** set to discrete (no continuous states).
- **Solver > Fixed-step size (fundamental sample time)** set to 1.
- **Solver > Treat each discrete rate as a separate task** cleared.

Scheduling

In the model window, enable sample time color-coding by selecting the **Debug** tab and selecting **Diagnostics > Information Overlays > Colors**. The sample time legend shows the implicit rate grouping. Red represents the discrete rate. Magenta represents the asynchronous function trigger. Yellow represents the mixture of two rates.

The asynchronous trigger runnable runs at asynchronous rates (the **Sample time type** parameter of the function-call subsystem Trigger block is set to |triggered|) while the periodic rate runnable runs at the specified discrete rate. The generated code manages the rates by using single-tasking assumptions. For models with one discrete rate, the code generator does not produce scheduling code because there is only a single rate to execute. Use this technique for a single-rate application when you have one periodic runnable.

The model handles transitions between the asynchronous and discrete rates of the connected runnables with the two Rate Transition blocks. The Rate Transition block parameter **Ensure deterministic data transfer** is cleared to facilitate integration into an AUTOSAR run-time environment.

Generate Code and Report (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, generate code and a code generation report. The example model generates a report.

Generated code complies with AUTOSAR so that you can schedule the code with the AUTOSAR run-time environment.

Review Generated Code

In the code generation report, review the generated code.

- `autosar_swc_fcncalls.c` contains entry points for the code that implements the model algorithm. This file includes the rate scheduling code.

- `autosar_swc_fcncalls.h` declares model data structures and a public interface to the model entry points and data structures.
- `autosar_swc_fcncalls_private.h` contains local `define` constants and local data required by the model and subsystems.
- `autosar_swc_fcncalls_types.h` provides forward declarations for the real-time model data structure and the parameters data structure.
- `rtwtypes.h` defines data types, structures, and macros that the generated code requires.
- `autosar_swc_fcncalls_component.arxml`, `autosar_swc_fcncalls_datatype.arxml`, `autosar_swc_fcncalls_implementation.arxml`, and `autosar_swc_fcncalls_interface.arxml` contain elements and objects that represent AUTOSAR software components, ports, interfaces, data types, and packages. You integrate `arxml` files into an AUTOSAR run-time environment. You can import `arxml` files into the Simulink environment by using the AUTOSAR `arxml` importer tool.
- `Compiler.h`, `Platform_Types.h`, `Rte_ASWC.h`, `Rte_Type.h`, and `Std_Types.h` contain stub implementations of AUTOSAR run-time environment functions. Use these files to test the generated code in Simulink, for example, in software-in-the-loop (SIL) or processor-in-the-loop (PIL) simulations of the component under test.

Code Interface

Open and review the Code Interface Report. This information is captured in the `arxml` files. The run-time environment generator uses the `arxml` descriptions to interface the code into an AUTOSAR run-time environment.

Input port:

- Require port, interface: sender-receiver of type `real-T` of 1 dimension

Entry-point functions:

- Initialization entry-point function, `void Runnable_Initialize(void)`. At startup, call this function once.
- Simulink function, `void Runnable_1s(void)`. Call this function periodically at the fastest rate in the model. For this model, call the function every second. To achieve real-time execution, attach this function to a timer.
- Exported function, `void Runnable_Trigger(void)`. Call this function at any time from an external trigger.

Output port:

- Provide port, interface: sender-receiver of type `real-T` of 1 dimension

Multiple Runnables Configured As Function-Call Subsystem and Simulink Function

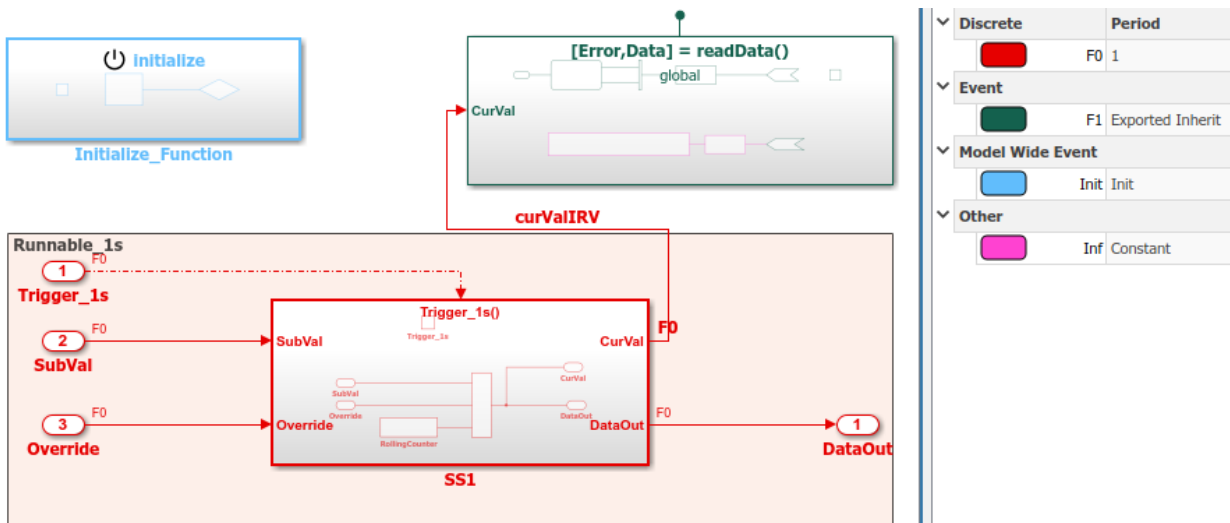
Open the example model `autosar_swc_slfcns.slx`.

```
open_system('autosar_swc_slfcns')
```

The model shows the implementation of an AUTOSAR atomic software component (ASWC). The model includes one periodic rate runnable, `Runnable_1s`, that uses a function-call subsystem, `SS1`. The model also includes a Simulink function, `readData`, to provide a value (`CurVal`) to clients that request it.

The model includes an Initialize Function block, which initializes the unit delay in subsystem `RollingCounter` to a value of 0.

To display color-coded sample rates with annotations and a legend, on the **Debug** tab, select **Diagnostics > Information Overlays > Colors**.



Use function-call subsystems:

- When it is difficult or not possible to specify system events in a Simulink model.
- To achieve complex multirate scheduling of runnables. Model each rate as a separate function-call subsystem.

Relevant Model Configuration Parameter Settings

- **Solver > Type** set to Fixed-step.
- **Solver > Solver** set to discrete (no continuous states).
- **Solver > Fixed-step size (fundamental sample time)** set to 1.
- **Solver > Treat each discrete rate as a separate task** selected.

Scheduling

In the model window, enable sample time color-coding by selecting the **Debug** tab and selecting **Diagnostics > Information Overlays > Colors**. The sample time legend shows the implicit rate grouping. Red identifies the discrete rate. Magenta identifies rates inherited from exported functions, indicating their execution is outside the context of Simulink scheduling.

Your execution framework must schedule the generated function code and handle data transfers between functions.

Generate Code and Report (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, generate code and a code generation report. The example model generates a report.

The code generator:

- Produces an AUTOSAR runnable for the function-call subsystem at the root level of the model.
- Implements signal connections between runnables as AUTOSAR inter-runnable variables (IRVs).

Generated code complies with AUTOSAR so that you can schedule the code with the AUTOSAR run-time environment.

Review Generated Code

In the code generation report, review the generated code.

- `autosar_swc_slfcns.c` contains entry points for the code that implements the model algorithm. This file includes the rate scheduling code.
- `autosar_swc_slfcns.h` declares model data structures and a public interface to the model entry points and data structures.
- `autosar_swc_slfcns_private.h` contains local `define` constants and local data required by the model and subsystems.
- `autosar_swc_slfcns_types.h` provides forward declarations for the real-time model data structure and the parameters data structure.
- `readData.c` contains code for the Simulink function.
- `readData_private.h` contains local `define` constants and local data required by the function.
- `readData.h` declares data structures and a public interface for calling the function.
- `rtwtypes.h` defines data types, structures, and macros that the generated code requires.
- `autosar_swc_slfcns_component.arxml`, `autosar_swc_slfcns_datatype.arxml`, `autosar_swc_slfcns_implementation.arxml`, and `autosar_swc_slfcns_interface.arxml` contain elements and objects that represent AUTOSAR software components, ports, interfaces, data types, and packages. You integrate `arxml` files into an AUTOSAR run-time environment. You can import `arxml` files into the Simulink environment by using the AUTOSAR `arxml` importer tool.
- `Compiler.h`, `Platform_Types.h`, `Rte_ASWC.h`, `Rte_Type.h`, and `Std_Types.h` contain stub implementations of AUTOSAR run-time environment functions. Use these files to test the generated code in Simulink, for example, in software-in-the-loop (SIL) or processor-in-the-loop (PIL) simulations of the component under test.

Code Interface

Open and review the Code Interface Report. This information is captured in the `arxml` files. The run-time environment generator uses the `arxml` descriptions to interface the code into an AUTOSAR run-time environment.

Input ports:

- Require port, interface: sender-receiver of type `uint16-T` of 1 dimension
 - Require port, interface: sender-receiver of type `real-T` of 1 dimension
- Entry-point functions:

Entry-point functions:

- Initialization entry-point function, `void Runnable_Init(void)`. At startup, call this function once.
- Exported function, `void Runnable_1s(void)`. Call this function periodically, every second.
- Simulink function, `Std_ReturnType readData(real_T Data[2])`. Call this function at any time.

Output ports:

- Provide port, interface: sender-receiver of type `uint16-T` of 1 dimension

Related Links

- “Model AUTOSAR Software Components” on page 2-3
- “Component Creation”
- “Code Generation”

Model AUTOSAR Runnables Using Exported Functions

Use Simulink® exported functions to model AUTOSAR runnables.

Multiple Periodic Runnables Configured for Function Export

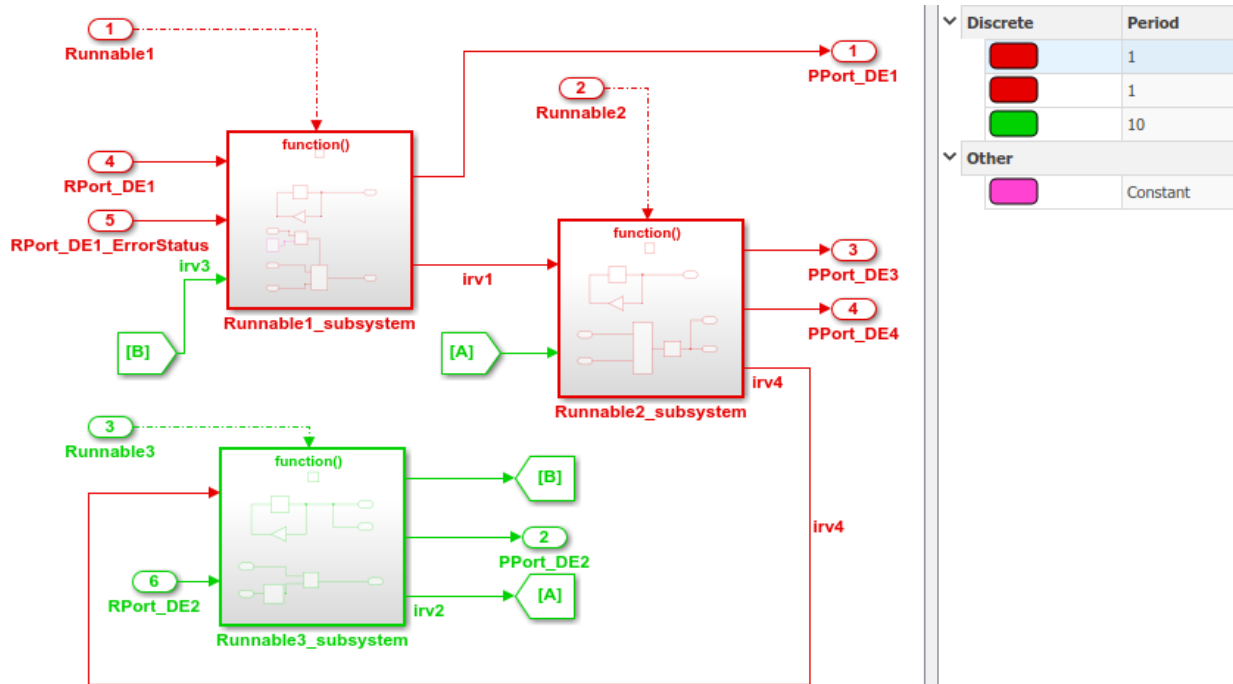
Open the example model `autosar_swc_expfcns.slx`.

```
open_system('autosar_swc_expfcns')
```

The model shows the implementation of an AUTOSAR atomic software component (ASWC) using export-function modeling. Export-function models are Simulink models that generate code for independent functions. You can integrate the independent function code with an external environment and scheduler. Functions typically are defined using Function-Call Subsystem and Simulink Function blocks.

This model implements three AUTOSAR periodic runnables using Function-Call Subsystem blocks that have periodic rates. The runnables have sample rates of 1 second, 1 second, and 10 seconds, respectively. To display color coded sample rates with annotations and a legend, on the **Debug** tab, select **Diagnostics > Information Overlays > Colors**.

Simulink signal lines model AUTOSAR inter-runnable variables (IRVs), which connect the runnables.



Generate AUTOSAR Component Code and XML Descriptions (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, you can generate algorithmic C code and AUTOSAR XML (arxml) component descriptions. You can test the generated code in Simulink or integrate the code and descriptions into an AUTOSAR run-time environment.

For example, to build the `autosar_swc_expfncs` component model, open the model. Press `Ctrl+B` or enter the MATLAB command `rtwbuild('autosar_swc_expfncs')`. When the build completes, a code generation report opens.

In the code generation report, select the **Code Interface Report** section, and examine the **Entry-Point Functions** table.

Function: [Runnable1](#)

Prototype	void Runnable1(void)
Description	Exported function: <Root>/Runnable1
Timing	Must be called periodically, every 1 second
Arguments	None
Return value	None
Header file	

Function: [Runnable2](#)

Prototype	void Runnable2(void)
Description	Exported function: <Root>/Runnable2
Timing	Must be called periodically, every 1 second
Arguments	None
Return value	None
Header file	

Function: [Runnable3](#)

Prototype	void Runnable3(void)
Description	Exported function: <Root>/Runnable3
Timing	Must be called periodically, every 10 seconds
Arguments	None
Return value	None
Header file	

In the generated code, each root-level function-call Inport block generates a void-void function. From generated file `autosar_swc_expfcns.c`, here is the generated code for `Runnable1`.

```

78 /* Model step function for TID1 */
79 void Runnable1(void)          /* Explicit Task: Runnable1 */
80 {
81     /* RootInportFunctionCallGenerator: '<Root>/RootFcnCall_InsertedFor_Runnable1_at_outport_1' incorporates:
82      * SubSystem: '<Root>/Runnable1_subsystem'
83      */
84     /* Output: '<Root>/PPort_DE1' incorporates:
85      * UnitDelay: '<S1>/Delay'
86      */
87     Rte_IWrite_Runnable1_PPort_DE1(rtDWork.Delay_DSTATE_a);
88
89     /* Gain: '<S1>/Gain' incorporates:
90      * UnitDelay: '<S1>/Delay'
91      */
92     rtDWork.Delay_DSTATE_a = (sint8)-rtDWork.Delay_DSTATE_a;
93
94     /* Outputs for Enabled SubSystem: '<S1>/Subsystem' incorporates:
95      * EnablePort: '<S4>/Enable'
96      */
97     /* RelationalOperator: '<S1>/Data Valid' incorporates:
98      * Inport: '<Root>/RPort_DE1_ErrorStatus'
99      */
100    if (Rte_IStatus_Runnable1_RPort_DE1() == 0) {
101        /* Sum: '<S4>/Add' incorporates:
102         * Inport: '<Root>/RPort_DE1'
103         * SignalConversion: '<S1>/TmpSignal ConversionAtIn2Outport1'
104         * SignalConversion: '<S3>/TmpSignal ConversionAtTicToc_irvInport1'
105         */
106        rtB.Add = Rte_IRead_Runnable1_RPort_DE1() + (float64)
107            Rte_IrvIRead_Runnable1_IRV3();
108    }
109
110    /* End of RelationalOperator: '<S1>/Data Valid' */
111    /* End of Outputs for SubSystem: '<S1>/Subsystem' */
112
113    /* SignalConversion: '<S1>/TmpSignal ConversionAtAdderInport1' incorporates:
114     * SignalConversion: '<S1>/OutputBufferForAdder'
115     */
116    Rte_IrvIWrite_Runnable1_IRV1(rtB.Add);
117
118    /* End of Outputs for RootInportFunctionCallGenerator: '<Root>/RootFcnCall_InsertedFor_Runnable1_at_outport_1' */
119 }

```


Related Links

[“Export-Function Models Overview” \(Simulink\)](#)

Model AUTOSAR Communication

In Simulink, for the Classic Platform, you can model AUTOSAR sender-receiver (S-R), client-server (C-S), mode-switch (M-S), nonvolatile (NV) data, parameter, and trigger communication.

In this section...

“About AUTOSAR Communication” on page 2-28

“Sender-Receiver Interface” on page 2-29

“Client-Server Interface” on page 2-30

“Mode-Switch Interface” on page 2-32

“Nonvolatile Data Interface” on page 2-37

“Parameter Interface” on page 2-37

“Trigger Interface” on page 2-38

About AUTOSAR Communication

AUTOSAR software components provide well-defined connection points called *ports*. There are three types of AUTOSAR ports:

- **Require (In)**
- **Provide (Out)**
- **Combined Provide-Require (InOut — introduced in AUTOSAR schema version 4.1)**

AUTOSAR ports can reference the following kinds of interfaces:

- **Sender-Receiver**
- **Client-Server**
- **Mode-Switch**
- **Nonvolatile Data**
- **Parameter**
- **Trigger**

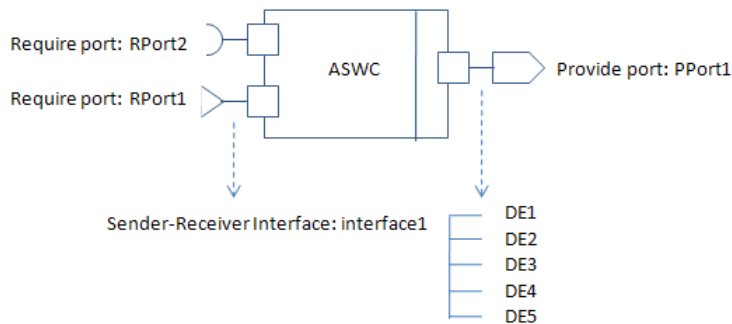
The following figure shows an AUTOSAR software component with four ports representing the port and interface combinations for Sender-Receiver and Client-Server interfaces.



A **Require** port that references a Mode-Switch interface is called a mode-receiver port.

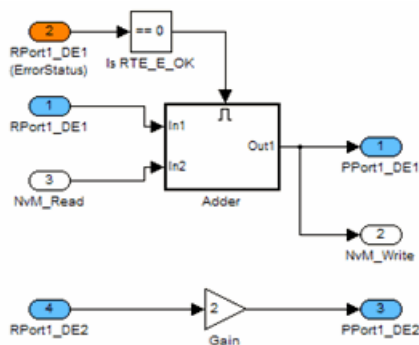
Sender-Receiver Interface

A Sender-Receiver Interface consists of one or more data elements. Although a **Require**, **Provide**, or **Provide-Require** port can reference a Sender-Receiver Interface, the AUTOSAR software component does not necessarily access all of the data elements. For example, consider the following figure.



The AUTOSAR software component has a **Require** and **Provide** port that references the same Sender-Receiver Interface, **Interface1**. Although this interface contains data elements **DE1**, **DE2**, **DE3**, **DE4**, and **DE5**, the component does not utilize all of the data elements.

The following figure is an example of how you model, in Simulink, an AUTOSAR software component that accesses data elements.



ASWC accesses data elements DE1 and DE2. You model data element access as follows:

- For Require ports, use Simulink inports. For example, RPort1_DE1 and RPort1_DE2.
- For Provide ports, use Simulink outports. For example, PPort1_DE1 and PPort1_DE2.
- For Provide-Require ports (schema 4.1 or higher), use a Simulink inport and outport pair with matching data type, dimension, and signal type. For more information, see “Configure AUTOSAR Provide-Require Port” on page 4-128.

ErrorStatus is a value that the AUTOSAR Runtime Environment (RTE) returns to indicate errors that the communication system detects for each data element. You can use a Simulink inport to model error status, for example, RPort1_DE1 (*ErrorStatus*).

Use the AUTOSAR Dictionary and the Code Mappings editor to specify the AUTOSAR settings for each inport and outport. For more information, see “Configure AUTOSAR Sender-Receiver Communication” on page 4-126.

Client-Server Interface

AUTOSAR allows client-server communication between:

- Application software components
- An application software component and Basic Software

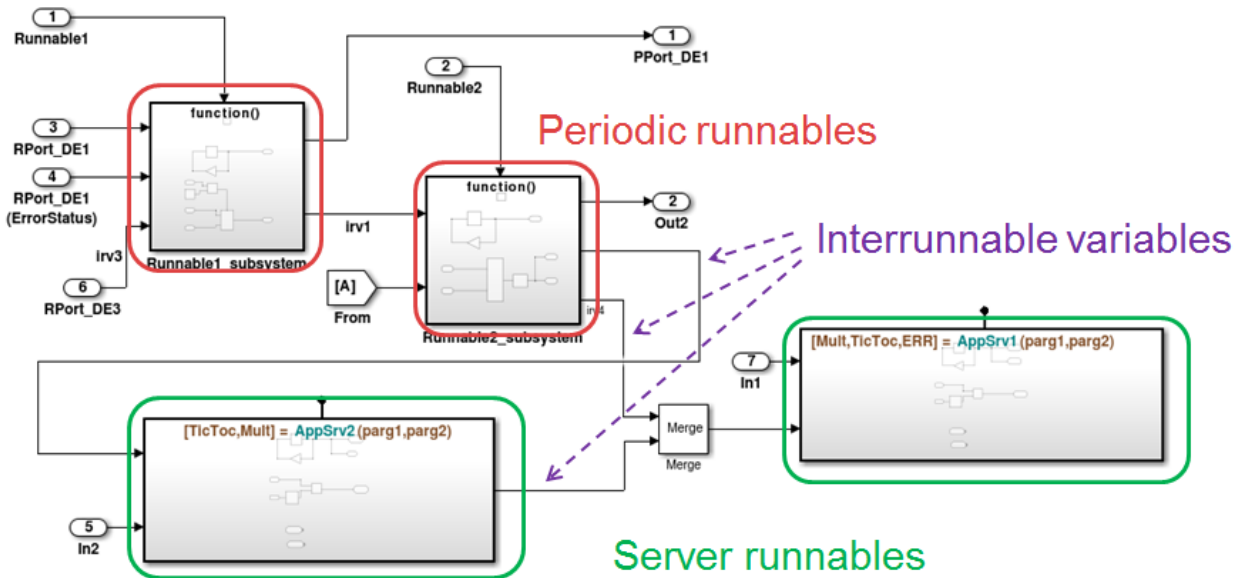
An AUTOSAR Client-Server Interface defines the interaction between a software component that *provides* the interface and a software component that *requires* the

interface. The component that provides the interface is the server. The component that requires the interface is the client.

To model AUTOSAR clients and servers in Simulink, for simulation and code generation:

- To model AUTOSAR servers, use Simulink Function blocks at the root level of a model.
- To model AUTOSAR client invocations, use Function Caller blocks.
- Use the function-call-based modeling style to create interconnected Simulink functions, function-calls, and root model inports and outports at the top level of a model.

This diagram illustrates a function-call framework in which Simulink Function blocks model AUTOSAR server runnables, Function Caller blocks model AUTOSAR client invocations, and Simulink data transfer lines model AUTOSAR inter-runnable variables (IRVs).



The high-level workflow for developing AUTOSAR clients and servers in Simulink is:

- 1 Model server functions and caller blocks in Simulink. For example, create Simulink Function blocks at the root level of a model, with corresponding Function Caller blocks that call the functions. Use the Simulink toolset to simulate and develop the blocks.

- 2 In the context of a model configured for AUTOSAR, map and configure the Simulink functions to AUTOSAR server runnables. Validate the configuration, simulate, and generate C and arxml code from the model.
- 3 In the context of another model configured for AUTOSAR, map and configure function caller blocks to AUTOSAR client ports and AUTOSAR operations. Validate the configuration, simulate, and generate C and arxml code from the model.
- 4 Integrate the generated C code into a test framework for testing, for example, with SIL simulation. (Ultimately, the generated C and arxml code are integrated into the AUTOSAR Runtime Environment (RTE).)

For more information, see “Configure AUTOSAR Client-Server Communication” on page 4-171.

Mode-Switch Interface

AUTOSAR mode-switch (M-S) communication relies on a mode manager and connected mode users. The mode manager is an authoritative source for software components to query the current mode and to receive notification when the mode changes. A mode manager can be provided by AUTOSAR Basic Software (BSW) or implemented as an AUTOSAR software component. A mode manager implemented as a software component is called an application mode manager. A software component that queries the mode manager and receives notifications of mode changes is a mode user.

- “Mode User” on page 2-32
- “Application Mode Manager” on page 2-35

Mode User

To model an AUTOSAR mode user software component in Simulink:

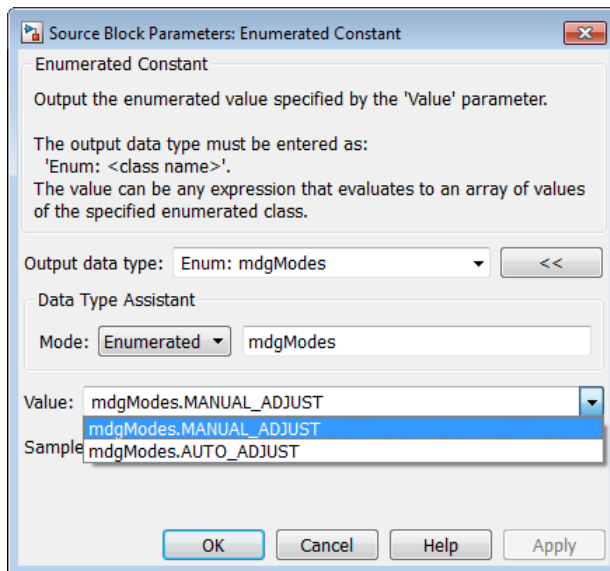
- Create an AUTOSAR mode-switch interface.
- Create an AUTOSAR mode receiver port and map it to a Simulink inport.
- For an initialization or other AUTOSAR runnable in the model, specify a mode-switch event to trigger the runnable.

To model an AUTOSAR software component mode-receiver port, general steps can include:

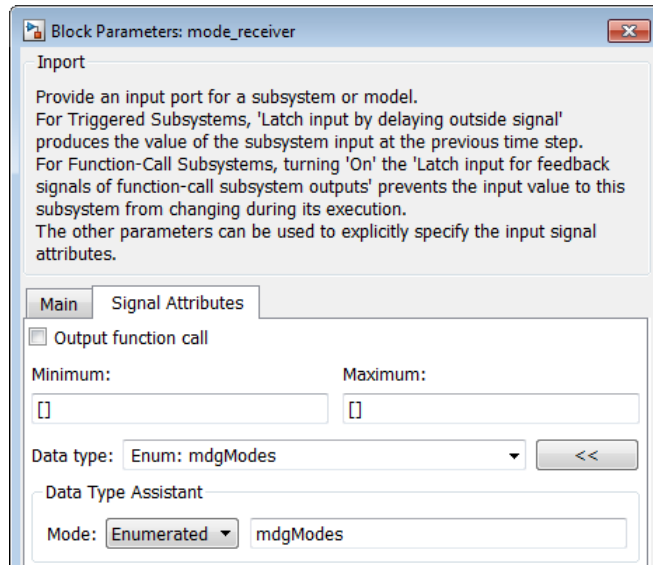
- 1 Declare a mode declaration group — a group of mode values — using Simulink enumeration. For example, you could create an enumerated type `mdgModes`, with

enumerated values `MANUAL_ADJUST` and `AUTO_ADJUST`. Specify the storage type as an unsigned integer.

```
Simulink.defineIntEnumType('mdgModes', ...
    {'MANUAL_ADJUST', 'AUTO_ADJUST'}, ...
    [18 28], ...
    'Description', 'Type definition of mdgModes.', ...
    'HeaderFile', 'Rte_Type.h', ...
    'DefaultValue', 'MANUAL_ADJUST', ...
    'AddClassNameToEnumNames', false,...
    'StorageType', 'uint16'...
);
```



- 2 Apply the enumeration data type to a Simulink inport that represents an AUTOSAR mode-receiver port. In this Inport block dialog box, enumerated type `mdgModes` is specified as the inport data type.



- 3 To specify the mapping of the Simulink inport to the AUTOSAR mode-receiver port, use the Code Mappings editor (or equivalent AUTOSAR map functions).

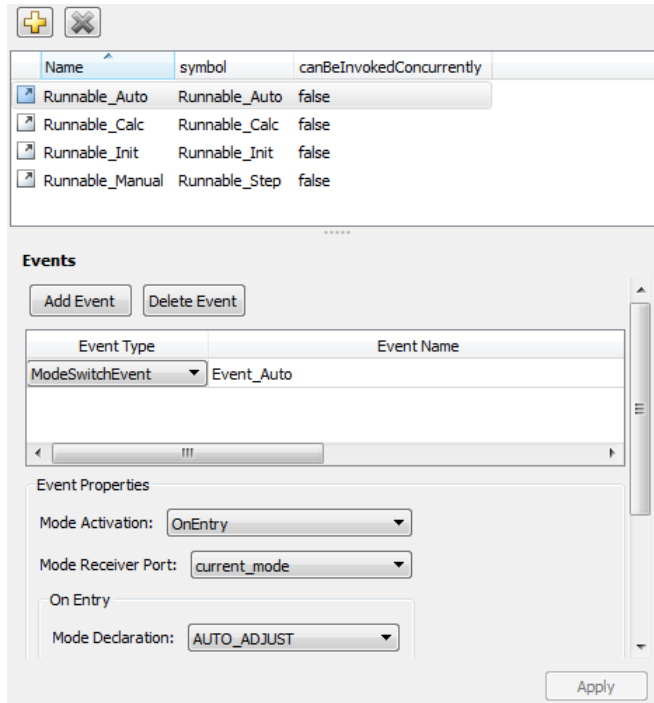
In the following example, in the **Inports** tab of the Code Mappings editor, Simulink inport `mode_receiver` is mapped to AUTOSAR mode-receiver port `current_mode` and AUTOSAR element `mgMirrorAdjust`.

Source	DataAccessMode	Port	Element
move_hor	ExplicitReceive	move_hor	move_hor_in
pos_hor	ExplicitReceive	pos_hor	pos_hor_in
move_ver	ExplicitReceive	move_ver	move_ver_in
pos_ver	ExplicitReceive	pos_ver	pos_ver_in
mode_receiver	ModeReceive	current_mode	mgMirrorAdjust

To specify a mode-switch event to trigger an initialize runnable or exported runnable, general steps can include:

- 1 To edit, add, or remove AUTOSAR mode-switch interfaces and mode-receiver ports, use the AUTOSAR Dictionary (or equivalent AUTOSAR property functions).
- 2 In your model, choose or add a runnable that you want a mode-switch event to activate.

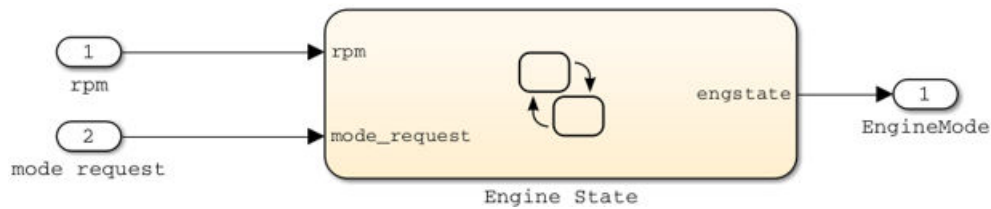
- 3 In the **Runnable**s view of the AUTOSAR Dictionary, select the runnable that you want a mode-switch event to activate. Configure the event. In the following example, a mode-switch event is added for `Runnable_Auto`, and configured to activate on entry (versus on exit or on transition). It is mapped to a previously configured mode-receiver port and a mode declaration value that is valid for the selected port.



For more information, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.

Application Mode Manager

To model an application mode manager software component in Simulink, use an AUTOSAR mode sender port (as defined in AUTOSAR Release 4). Mode sender ports output a mode switch to connected mode user components. For example, here is an application mode manager, modeled in Simulink, that uses a mode sender port to output the current value of `EngineMode`.



You model the mode sender port as a model root output, which is mapped to an AUTOSAR mode sender port and a mode-switch (M-S) interface. The output data type is an enumeration class with an unsigned integer storage type, representing an AUTOSAR mode declaration group.

In Simulink, you can:

- Import AUTOSAR mode-switch communication elements from a `arxml` code.
 - The software imports `ModeSwitchPoints`, `ModeSwitchInterfaces`, and `ModeDeclarationGroups`.
 - For each AUTOSAR provider port that references an M-S interface, the importer creates a root output with `ModeSend` data access and with an AUTOSAR mode declaration group enumeration class.
 - The importer maps the model output to an AUTOSAR mode sender port with an M-S interface.
- Create AUTOSAR mode-switch communication elements.
 - Create a model root output, and set the output data type to an enumeration class that represents an AUTOSAR mode declaration group.
 - Create an AUTOSAR mode sender port with an associated M-S interface.
 - In the Code Mappings editor, set the output data access mode to `ModeSend`, and map the output to the AUTOSAR mode sender port.
- Generate `arxml` and C code for AUTOSAR mode sender ports and related AUTOSAR M-S communication elements.
 - The `arxml` code includes referenced `ModeSwitchPoints`, `ModeSwitchInterfaces`, and `ModeDeclarationGroups`.
 - The C code includes `Rte_Switch` API calls to communicate mode switches to other software components.

For more information, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.

Nonvolatile Data Interface

AUTOSAR Release 4.0 introduced port-based nonvolatile (NV) data communication, in which an AUTOSAR software component reads and writes data to AUTOSAR nonvolatile components. To implement NV data communication, AUTOSAR software components define provide and require ports that send and receive NV data.

In Simulink, you can:

- Import AUTOSAR NV data interfaces and ports from a `rxml` code.
- Create AUTOSAR NV interfaces and ports, and map Simulink inports and outports to AUTOSAR NV ports.

You model AUTOSAR NV ports with Simulink inports and outports, in the same manner described in “Sender-Receiver Interface” on page 2-29.

- Generate C and a `rxml` code for AUTOSAR NV data interfaces and ports.

For more information, see “Configure AUTOSAR Nonvolatile Data Communication” on page 4-208.

Parameter Interface

AUTOSAR parameter communication relies on a parameter software component (`ParameterSwComponent`) and one or more atomic software components that require port-based access to parameter data. The parameter software component represents memory containing AUTOSAR parameters and provides parameter data to connected atomic software components.

In Simulink, you can model the receiver portion of AUTOSAR port-based parameter communication. In an AUTOSAR atomic software component, you create a parameter interface with data elements and a parameter receiver port.

For more information, see “Configure Receiver for AUTOSAR Parameter Communication” on page 4-211.

Trigger Interface

AUTOSAR Release 4.0 introduced external trigger event communication, in which an AUTOSAR software component or service signals an external trigger occurred event (`ExternalTriggerOccurredEvent`) to another component. The receiving component activates a runnable in response to the event.

In Simulink, you can model the receiver portion of AUTOSAR external trigger event communication. In a component that you want to react to an external trigger, you create a trigger interface, a trigger receiver port to receive an `ExternalTriggerOccurredEvent`, and a runnable that the event activates.

For more information, see “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214.

See Also

Related Examples

- “Configure AUTOSAR Provide-Require Port” on page 4-128
- “Configure AUTOSAR Client-Server Communication” on page 4-171
- “Configure AUTOSAR Mode-Switch Communication” on page 4-199
- “Configure AUTOSAR Nonvolatile Data Communication” on page 4-208
- “Configure Receiver for AUTOSAR Parameter Communication” on page 4-211
- “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214

More About

- “AUTOSAR Component Configuration” on page 4-3

Model AUTOSAR Component Behavior

In Simulink, you can model AUTOSAR component behavior, including behavior of runnables, events, and inter-runnable variables.

In this section...

“AUTOSAR Elements for Modeling Component Behavior” on page 2-39

“Runnables” on page 2-40

“Inter-Runnable Variables” on page 2-40

“System Constants” on page 2-41

“Per-Instance Memory” on page 2-42

“Static and Constant Memory” on page 2-43

“Shared and Per-Instance Parameters” on page 2-43

AUTOSAR Elements for Modeling Component Behavior

To model AUTOSAR component behavior, you model AUTOSAR elements that describe scheduling and resource sharing aspects of a component. The AUTOSAR elements that bear on component behavior include:

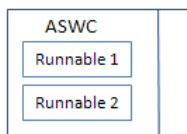
- Runnables and the events to which they respond
- Inter-runnable variables, used to communicate data between runnables in the same component
- System constants, used to specify system-level constant values that are available for reference in component algorithms
- Per-instance memory, used to specify instance-specific global memory within a component
- Static and constant memory, for access to global data and parameter values within a component
- Shared and per-instance memory, for access to component internal parameters.

This topic describes how to model the AUTOSAR elements that help you define component behavior.

Runnableables

AUTOSAR software components contain runnables that are directly or indirectly scheduled by the underlying AUTOSAR operating system.

This figure shows an AUTOSAR software component with two runnables, `Runnable 1` and `Runnable 2`. RTEEvents, events generated by the AUTOSAR Runtime Environment (RTE), trigger each runnable. For example, `TimingEvent` is an RTEEvent that is generated periodically.



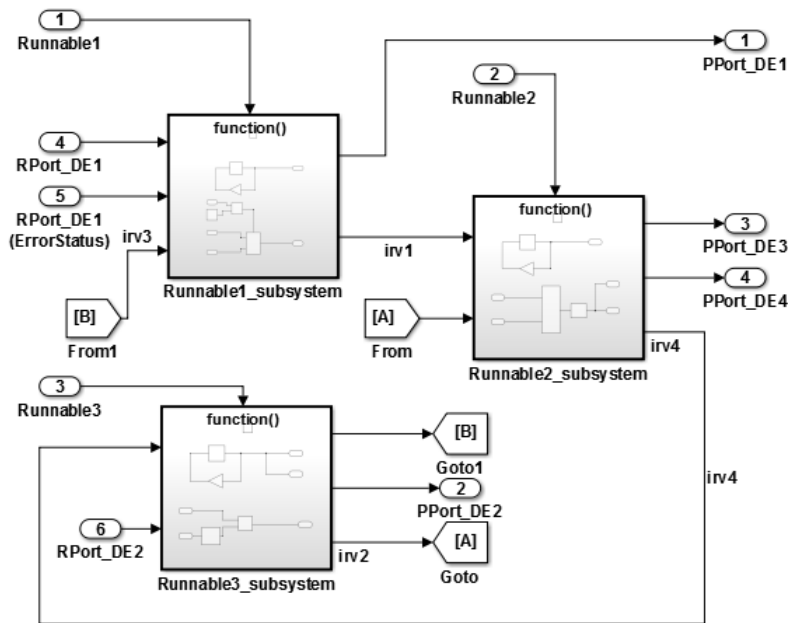
A component also can contain a single runnable, represented by a model, and can be single-rate or multirate.

Note The software generates an additional runnable for the initialization function regardless of the modeling pattern.

For more information, see “Configure AUTOSAR Runnables and Events” on page 4-224.

Inter-Runnable Variables

In AUTOSAR, *inter-runnable* variables are used to communicate data between runnables in the same component. You define these variables in a Simulink model by the signal lines that connect subsystems (runnables). For example, in the following figure, `irv1`, `irv2`, `irv3`, and `irv4` are inter-runnable variables.



You can specify the names and data access modes of the inter-runnable variables that you export.

System Constants

AUTOSAR system constants (SwSystemConstants) specify system-level constant values that are available for reference in component algorithms. To add AUTOSAR system constants to your model, you can:

- Import them from a xml files.
- Create them in Simulink, using AUTOSAR.Parameter objects with **Storage class** set to SystemConstant.

You can then reference the AUTOSAR system constants in Simulink algorithms. For example, you could reference a system constant in a Gain block, or in a condition formula inside a variant subsystem or model reference.

When you reference an AUTOSAR system constant in your model:

- Exported arxml code contains a corresponding SwSystemConstant and a corresponding AUTOSAR variation point proxy (VariationPointProxy) that references the SwSystemConstant. If you generate modular arxml files, the SwSystemConstant is located in *modelname_datatype.arxml* and the VariationPointProxy is located in *modelname_component.arxml*.
- Generated C code uses the generated VariationPointProxy in places where the model uses the SwSystemConstant.

For an example of an AUTOSAR system constant used to represent a conditional value associated with variant condition logic, see “Configure Variants for AUTOSAR Runnable Implementations” on page 4-269.

Per-Instance Memory

AUTOSAR supports per-instance memory, which allows you to specify instance-specific global memory within a software component. An AUTOSAR run-time environment generator allocates this memory and provides an API through which you access this memory.

Per-instance memory can be AUTOSAR-typed or C-typed. AUTOSAR-typed per-instance memory (arTypedPerInstanceMemory), introduced in AUTOSAR schema version 4.0, is described using AUTOSAR data types rather than C types. When exported in arxml code, arTypedPerInstanceMemory allows the use of measurement and calibration tools to monitor the global variable corresponding to per-instance memory.

AUTOSAR also allows you to use per-instance memory as a RAM mirror for data in nonvolatile RAM (NVRAM). You can access and use NVRAM in your AUTOSAR application.

To add AUTOSAR per-instance memory to your model, you can:

- Import per-instance memory definitions from arxml files.
- Create model content that represents per-instance memory.

To model arTypedPerInstanceMemory, you can use block signals, discrete states, or data stores in your AUTOSAR model:

- To use block signals and discrete states, use the Code Mappings editor, **Signals/States** tab, to select a signal or state and map it to arTypedPerInstanceMemory. The Property Inspector displays code and calibration attributes for the static memory, which you can modify.

- To use data stores, use the Code Mappings editor, **Data Stores** tab, to select a data store and map it to `arTypedPerInstanceMemory`. The Property Inspector displays code and calibration attributes for the static memory, which you can modify.

For more information, see “Configure AUTOSAR Per-Instance Memory” on page 4-246.

Static and Constant Memory

AUTOSAR supports static memory (`StaticMemory`) and constant memory (`ConstantMemory`) data, introduced in AUTOSAR schema version 4.0. Static memory corresponds to Simulink internal global signals. Constant memory corresponds to Simulink internal global parameters. In Simulink, you can import and export `arxml` descriptions of AUTOSAR static and constant memory. When exported in `arxml` code, static memory and constant memory allow the use of measurement and calibration tools to monitor the internal memory data.

To model AUTOSAR static memory in Simulink, use the Code Mappings editor, **Signals/States** or **Data Stores** tab. Select a signal, state, or data store and map it to `StaticMemory`. The Property Inspector displays code and calibration attributes for the static memory, which you can modify.

To model AUTOSAR constant memory in Simulink, use the Code Mappings editor, **Parameters** tab, to select a parameter and map it to `ConstantMemory`. The Property Inspector displays code and calibration attributes for the constant memory, which you can modify.

For more information, see “Configure AUTOSAR Static Memory” on page 4-251 and “Configure AUTOSAR Constant Memory” on page 4-256.

Shared and Per-Instance Parameters

AUTOSAR supports shared parameters (`SharedParameters`) and per-instance parameters (`PerInstanceParameters`) for use in software components that potentially are instantiated multiple times. Shared parameter values are shared among all instances of a component. Per-instance parameter values are unique and private to each component instance.

In Simulink, you can import and export `arxml` descriptions of AUTOSAR shared and per-instance parameters. When exported in `arxml` code, shared and per-instance parameters allow the use of measurement and calibration tools to monitor component parameters.

To model an AUTOSAR shared parameter in Simulink, configure a model workspace parameter that is not a model argument (that is, not unique to each instance of a multi-instance model). For example, in the Model Explorer view of the parameter, clear the **Argument** property. In the Code Mappings editor, **Parameters** tab, select the parameter and map it to parameter type `SharedParameter`. The Property Inspector displays code and calibration attributes for the shared parameter, which you can modify.

To model an AUTOSAR per-instance parameter in Simulink, configure a model workspace parameter that is a model argument (that is, unique to each instance of a multi-instance model). For example, in the Model Explorer view of the parameter, select the **Argument** property. In the Code Mappings editor, **Parameters** tab, select the parameter and map it to parameter `PerInstanceParameter`. The Property Inspector displays code and calibration attributes for the per-instance parameter, which you can modify.

For more information, see “Configure AUTOSAR Shared or Per-Instance Parameters” on page 4-259.

See Also

Data Store Memory

Related Examples

- “Configure AUTOSAR Runnables and Events” on page 4-224
- “Configure Variants for AUTOSAR Runnable Implementations” on page 4-269
- “Configure AUTOSAR Per-Instance Memory” on page 4-246
- “Configure AUTOSAR Static Memory” on page 4-251
- “Configure AUTOSAR Constant Memory” on page 4-256
- “Configure AUTOSAR Shared or Per-Instance Parameters” on page 4-259

More About

- “AUTOSAR Component Configuration” on page 4-3

Model AUTOSAR Variants

AUTOSAR software components use variants to enable or disable AUTOSAR interfaces or implementations in the execution path, based on defined conditions. Components:

- Enable or disable an AUTOSAR port or runnable.
- Vary the implementation of an AUTOSAR runnable.
- Vary the array size of an AUTOSAR port.
- Specify predefined variants and system constant value sets for controlling variants in the component.

In Simulink, you can:

- Import and export AUTOSAR ports and runnables with variants.
- Model AUTOSAR variants.
 - To enable or disable an AUTOSAR port or runnable, use Variant Sink and Variant Source blocks.
 - To vary the implementation of an AUTOSAR runnable, use Variant Subsystem blocks.
 - To vary the array size of an AUTOSAR port, use Simulink symbolic dimensions.
- Resolve modeled variants by using predefined variants and system constant value sets imported from a `rxml` files.

In this section...
“Variants for Ports and Runnables” on page 2-45
“Variants for Runnable Implementations” on page 2-46
“Variants for Array Sizes” on page 2-46
“Predefined Variants and System Constant Value Sets” on page 2-47

Variants for Ports and Runnables

AUTOSAR software components can use `VariationPoint` elements to enable or disable AUTOSAR elements, such as ports and runnables, based on defined conditions. In Simulink, you can:

- Import AUTOSAR ports and runnables with variation points.

The `arxml` importer creates the required model elements, including Variant Sink and Variant Source blocks to propagate variant conditions and `AUTOSAR.Parameter` data objects to represent system constants with condition values.

- Model AUTOSAR elements with variation points.
 - To define variant condition logic and propagate variant conditions, use Variant Sink and Variant Source blocks.
 - To model AUTOSAR system constants and define condition values, use `AUTOSAR.Parameter` data objects with storage class `SystemConstant`.
- Run validation on the AUTOSAR configuration. The validation software verifies that variant conditions on Simulink blocks match the designed behavior from the imported `arxml` code.
- Export AUTOSAR ports and runnables with variation points.

For more information, see “Configure Variants for AUTOSAR Ports and Runnables” on page 4-265.

Variants for Runnable Implementations

To vary the implementation of an AUTOSAR runnable, AUTOSAR software components can specify variant condition logic inside a runnable. In Simulink, to model variant condition logic inside a runnable:

- Use Variant Subsystem blocks to define variant implementations and their associated variant condition logic.
- Use `AUTOSAR.Parameter` data objects to model AUTOSAR system constants and define condition values.

For more information, see “Configure Variants for AUTOSAR Runnable Implementations” on page 4-269.

Variants for Array Sizes

AUTOSAR software components can flexibly specify the dimensions of an AUTOSAR element, such as a port, by using a symbolic reference to a system constant. The system constant defines the array size of the port data type. The code generator supports models that include AUTOSAR elements with variant (symbolic) array sizes.

In Simulink, you can:

- Import AUTOSAR elements with variant array sizes.
 - The `arxml` importer creates the required model elements, including `AUTOSAR.Parameter` data objects with storage class `SystemConstant`, to represent the array size values.
 - Each block that represents an AUTOSAR element with variant array sizes references `AUTOSAR.Parameter` data objects to define its dimensions.
- Model AUTOSAR elements with variant array sizes.
 - Create blocks that represent AUTOSAR elements.
 - To represent array size values, add `AUTOSAR.Parameter` data objects with storage class `SystemConstant`.
 - To specify array size for an AUTOSAR element, reference an `AUTOSAR.Parameter` data object.
- Modify array size values in system constants and simulate the model, without regenerating code for simulation.
- Generate C and `arxml` code with symbols corresponding to variant array sizes.

For more information, see “Configure Variants for AUTOSAR Array Sizes” on page 4-275.

Predefined Variants and System Constant Value Sets

To define the values that control variation points in an AUTOSAR software component, components use the following AUTOSAR elements:

- `SwSystemconst` — Defines a system constant that serves as an input to control a variation point.
- `SwSystemconstantValueSet` — Specifies a set of system constant values.
- `PredefinedVariant` — Describes a combination of system constant values, among potentially multiple valid combinations, to apply to an AUTOSAR software component.

Suppose that you have an `arxml` specification of an AUTOSAR software component. If the `arxml` files also define a `PredefinedVariant` or `SwSystemconstantValueSets` for controlling variation points in the component, you can resolve the variation points at model creation time. Specify a `PredefinedVariant` or `SwSystemconstantValueSets` with which the importer can initialize `SwSystemconst` data.

After model creation, you can run simulations and generate code based on the combination of variation point input values that you specified.

In Simulink, using the AUTOSAR property function `createSystemConstants`, you can redefine the `SwSystemconst` data that controls variation points without recreating the model. You can run simulations and generate code based on the revised combination of variation point input values.

Building the model exports previously imported `PredefinedVariants` and `SwSystemconstantValueSets` to arxml code.

For more information, see “Control AUTOSAR Variants with Predefined Value Combinations” on page 4-277.

See Also

Related Examples

- “Configure Variants for AUTOSAR Ports and Runnables” on page 4-265
- “Configure Variants for AUTOSAR Runnable Implementations” on page 4-269
- “Configure Variants for AUTOSAR Array Sizes” on page 4-275
- “Control AUTOSAR Variants with Predefined Value Combinations” on page 4-277

More About

- “Variant Systems” (Embedded Coder)
- “AUTOSAR Component Configuration” on page 4-3

Model AUTOSAR Calibration Parameters and Lookup Tables

In Simulink, you can model AUTOSAR calibration parameters and lookup tables, which support run-time tuning of the AUTOSAR application with measurement and calibration tools.

In this section...

“AUTOSAR Calibration Parameters” on page 2-49

“Calibration Parameters for STD_AXIS and COM_AXIS Lookup Tables” on page 2-49

AUTOSAR Calibration Parameters

A calibration parameter is a value in an Electronic Control Unit (ECU). You tune or modify these parameters using a calibration data management tool or an offline calibration tool.

The AUTOSAR standard specifies the following types of calibration parameters:

- Calibration parameters that belong to a *calibration component* (ParameterSwComponent), which AUTOSAR software components can access.
- Internal calibration parameters, which only one AUTOSAR software component defines and accesses.

To provide your Simulink model with access to calibration parameters, reference the calibration parameters in block parameters.

To map Simulink parameter objects in the model workspace to AUTOSAR calibration parameters, open the AUTOSAR code perspective and use the Code Mappings editor, **Parameters** tab. Use the Property Inspector to configure parameter code and calibration attributes. For more information, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.

Calibration Parameters for STD_AXIS and COM_AXIS Lookup Tables

You can model standard axis (STD_AXIS) and common axis (COM_AXIS) lookup tables for AUTOSAR applications. AUTOSAR applications can use lookup tables in either or both of two ways:

- Implement fast search operations.
- Support tuning of the application with measurement and calibration tools.

A lookup table uses an array of data to map input values to output values, approximating a mathematical function. An n -dimensional lookup table can approximate an n -dimensional function. A COM_AXIS lookup table is one in which tunable breakpoints (axis points) are shared among multiple table axes.

The AUTOSAR standard defines calibration parameter categories for STD_AXIS and COM_AXIS lookup table data:

- CURVE, MAP, and CUBOID parameters represent 1-D, 2-D, and 3-D table data, respectively.
- COM_AXIS parameters represent axis data.

In Simulink, you can:

- Import arxml files that contain AUTOSAR lookup tables in STD_AXIS and COM_AXIS configurations:
 - For a lookup table in a STD_AXIS configuration, the importer creates a lookup table block and initializes it with a Simulink.LookupTable object.
 - For a lookup table in a COM_AXIS configuration, the importer creates a prelookup block initialized with a Simulink.Breakpoint object and an interpolation-using-prelookup block initialized with a Simulink.LookupTable object.
 - The importer maps each created Simulink lookup table to AUTOSAR parameters with code and calibration attributes.
 - If the arxml code defines input variables that measure lookup table inputs, the importer creates corresponding model content. If the input variables are global variables, the importer connects static global signals to lookup table block inputs. If the input variables are root-level inputs, the importer connects root-level inputs to lookup table block inputs.
- Create STD_AXIS and COM_AXIS lookup tables and map them to AUTOSAR parameters. You map lookup table objects to AUTOSAR parameters by using the Code Mappings editor, **Parameters** tab.
 - To model an AUTOSAR lookup table in a STD_AXIS configuration, create an AUTOSAR Blockset Curve or Map block.

Open each lookup table block and configure it to generate a routine from the AUTOSAR 4.0 code replacement library (CRL). As you modify block settings, the block dialog box updates the name of the targeted AUTOSAR routine.

To store the data, create a single `Simulink.LookupTable` object in the model workspace. Use the object in the Curve or Map block.

Data appears in the generated C code as fields of a single structure. To control the characteristics of the structure type, such as its name, use the properties of the object.

- To model an AUTOSAR lookup table in a `COM_AXIS` configuration, create one or more AUTOSAR Blockset Prelookup blocks. Pair each Prelookup with an AUTOSAR Blockset Curve Using Prelookup or Map Using Prelookup block.

Open each lookup table block and configure it to generate a routine from the AUTOSAR 4.0 code replacement library (CRL). As you modify block settings, the block dialog box updates the name of the targeted AUTOSAR routine.

To store each set of table data, create a `Simulink.LookupTable` object in the model workspace. To store each breakpoint vector, create a `Simulink.Breakpoint` object in the model workspace. Use each `Simulink.LookupTable` object in a Curve Using Prelookup or Map Using Prelookup block and each `Simulink.Breakpoint` object in a Prelookup block. You can reduce memory consumption by sharing breakpoint data between lookup tables.

Each set of table data appears in the generated C code as a separate variable. If the table size is tunable, each breakpoint vector appears as a structure with one field to store the breakpoint data and, optionally, one field to store the length of the vector. The second field enables you to tune the effective size of the table. If the table size is not tunable, each breakpoint vector appears as an array.

- Add AUTOSAR operating points to the lookup tables. Connect root level inports to Curve, Map, or Prelookup blocks. Alternatively, configure input signals to Curve, Map, or Prelookup blocks with static global memory.
- To map Simulink lookup table objects in the model workspace to AUTOSAR calibration parameters, open the AUTOSAR code perspective and use the Code Mappings editor, **Parameters** tab. Use the Property Inspector to configure parameter code and calibration attributes. For more information, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74

- In the Simulink Configuration Parameters dialog box, **Interface** pane, select the AUTOSAR 4.0 code replacement library for C code generation.
- Generate arxml and C code with STD_AXIS and COM_AXIS lookup table content.

The generated C code contains required Ifl and Ifx lookup function calls and Rte data access function calls.

The generated arxml files contain information to support run-time calibration of the tunable lookup table parameters, including:

- Lookup table calibration parameters that reference the application data types — category CURVE, MAP, or CUBOID for table data, or category COM_AXIS for axis data.
- Application data types of category CURVE, MAP, CUBOID, and COM_AXIS, with the data calibration properties that you configured. The properties include **SwCalibrationAccess**, **DisplayFormat**, and **SwAddrMethod**.
- Software record layouts (SwRecordLayouts) referenced by the application data types of category CURVE, MAP, CUBOID, and COM_AXIS.

For more information, see “Configure Lookup Tables for AUTOSAR Measurement and Calibration” on page 4-298.

See Also

Curve | Curve Using Prelookup | Map | Map Using Prelookup | Prelookup | Simulink.Breakpoint | Simulink.LookupTable | getParameter | mapParameter

Related Examples

- “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74
- “Configure Lookup Tables for AUTOSAR Measurement and Calibration” on page 4-298

More About

- “Code Generation with AUTOSAR Code Replacement Library” on page 5-15

Model AUTOSAR Data Types

The AUTOSAR standard defines platform data types for use by AUTOSAR software components. In Simulink, you can model AUTOSAR data types used in elements such as data elements, operation arguments, calibration parameters, measurement variables, and inter-runnable variables. If you import an AUTOSAR component from a `arxml` file, Embedded Coder imports AUTOSAR data types and creates the required corresponding Simulink data types. During code generation, Embedded Coder exports a `arxml` description for data types used in the component model and generates AUTOSAR data types in C code.

In this section...

“About AUTOSAR Data Types” on page 2-53

“Enumerated Data Types” on page 2-55

“Structure Parameters” on page 2-56

“Release 2.x and 3.x Data Types” on page 2-56

“Release 4.x Data Types” on page 2-56

“CompuMethod Categories for Data Types” on page 2-60

About AUTOSAR Data Types

AUTOSAR specifies data types that apply to:

- Data elements of a sender-receiver Interface
- Operation arguments of a client-server Interface
- Calibration parameters
- Measurement variables
- Inter-runnable variables

The data types fall into two categories:

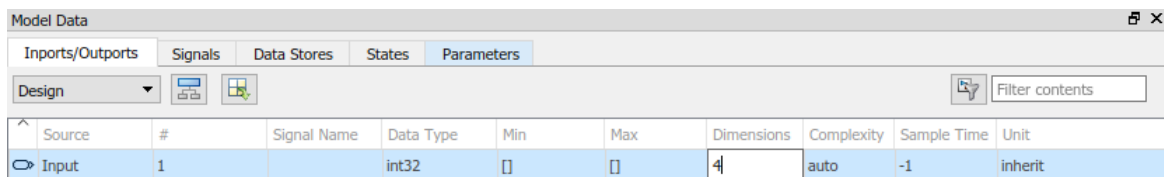
- Platform (primitive) data types, which allow a direct mapping to C intrinsic types.
- Composite data types, which map to C arrays and structures.

To model AUTOSAR data types, use corresponding Simulink data types.

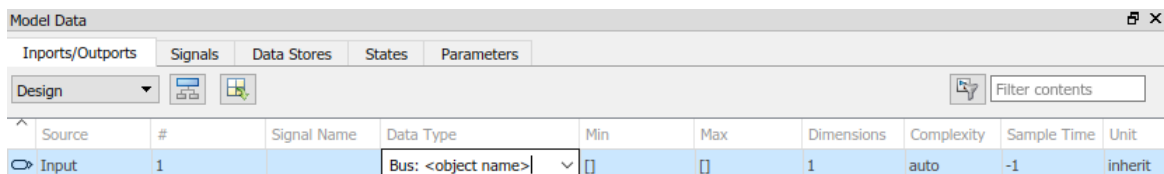
AUTOSAR Data Type		Simulink Data Type
R4.x Platform Type	R2.x/3.x Primitive Type	
boolean	Boolean	boolean
float32	Float	single
float64	Double	double
sint8	Sint8	int8
sint16	Sint16	int16
sint32	Sint32	int32
uint8	Uint8	uint8
uint16	Uint16	uint16
uint32	Uint32	uint32

AUTOSAR composite data types are arrays and records, which are represented in Simulink by wide signals and bus objects, respectively. To configure a wide signal or bus object through Inport or Outport blocks, use the Model Data Editor. On the **AUTOSAR** tab, select **Settings > Model Data Editor** and select the **Inports/Outports** tab. Select the **Design** view. From the list of inports and outports, select the source block to configure.

The following figure shows how to specify a wide signal, which corresponds to an AUTOSAR composite array.



The following figure shows how to specify a bus object, which corresponds to an AUTOSAR composite record.



To specify the data types of data elements and arguments of an operation prototype, use the drop-down list in the **Data Type** column. You can specify a Simulink built-in data type, such as `boolean`, `single`, or `int8`, or enter an (alias) expression for data type. For example, the following figure shows an alias `sint8`, corresponding to an AUTOSAR data type, in the **Data Type** column.

Source	#	Signal Name	Data Type	Min	Max	Dimensions	Complexity	Sample Time	Unit
Input	1		sint8			1	auto	-1	inherit

For more guidance in specifying the data type, you can use the **Data Type Assistant** on the **Signal Attributes** pane of the Inport or Outport Block Parameters dialog box or in the Property Inspector.

Enumerated Data Types

AUTOSAR supports enumerated data types. For the import process, if there is a corresponding Simulink enumerated data type, the software uses the data type. The software checks that the two data types are consistent. However, if a corresponding Simulink data type is not found, the software automatically creates the enumerated data type using the `Simulink.defineIntEnumType` class. This automatic creation of data types is useful when you want to import a large quantity of enumerated data types.

Consider the following example:

```
<SHORT-NAME>BasicColors</SHORT-NAME>
<COMPU-INTERNAL-TO-PHYS>
<COMPU-SCALES>
  <COMPU-SCALE>
    <LOWER-LIMIT>0</LOWER-LIMIT>
    <UPPER-LIMIT>0</UPPER-LIMIT>
  <COMPU-CONST>
    <VT>Red</VT>
```

The software creates an enumerated data type using:

```
Simulink.defineIntEnumType( 'BasicColors', ...
    {'Red', 'Green', 'Blue'}, ...
    [0;1;2], ...
    'Description', 'Type definition of BasicColors.', ...
    'HeaderFile', 'Rte_Type.h', ...
    'AddClassNameToEnumNames', false);
```

Structure Parameters

Before exporting an AUTOSAR software component, specify the data types of structure parameters to be `Simulink.Bus` objects. See “Control Field Data Types and Characteristics by Creating Parameter Object” (Simulink). Otherwise, the software displays the following behavior:

- When you validate the AUTOSAR configuration, the software issues a warning.
- When you build the model, the software defines each data type to be an anonymous `struct` and generates a random, nondescriptive name for the data type.

When importing an AUTOSAR software component, if a parameter structure has a data type name that corresponds to an anonymous `struct`, the software sets the data type to `struct`. However, if the component has data elements that reference this anonymous `struct` data type, the software generates an error.

Release 2.x and 3.x Data Types

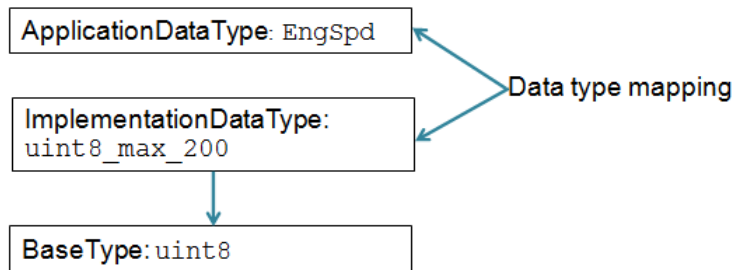
The following table shows how the software translates AUTOSAR R2.x and R3.x data types to Simulink data types. For information about Release 4.x data types, see “Release 4.x Data Types” on page 2-56.

AUTOSAR	Simulink
Primitive types (excluding fixed point), for example, <code>myInt16</code> Covers Boolean, integer, real	<pre>myInt16 = Simulink.AliasType; myInt16.BaseType = 'int16'; myInt16.HeaderFile = 'Rte_Type.h';</pre>
Primitive type (fixed point), for example, <code>myFixPt</code>	<pre>myFixPt = Simulink.NumericType; myFixPt.DataTypeMode = ...; myFixPt.IsAlias = true; myFixPt.HeaderFile = 'Rte_Type.h';</pre>
Enumerations, for example, <code>myEnum</code>	<pre>Simulink.defineIntEnumType('myEnum',... {'Red','Green','Blue'},... [1;2;3],...);</pre>
Record types, for example, <code>myRecord</code>	<pre>myRecord = Simulink.Bus;</pre>

Release 4.x Data Types

AUTOSAR Release 4.0 introduced a new approach to AUTOSAR data types, in which base data types are mapped to implementation data types and application data types.

Application and implementation data types separate application-level physical attributes, such as real-world range of values, data structure, and physical semantics, from implementation-level attributes, such as stored-integer minimum and maximum and specification of a primitive type (for example, integer, Boolean, or real).



The software supports AUTOSAR R4.x compliant data types in Simulink originated and round-trip workflows:

- For AUTOSAR components originated in Simulink, the software generates AUTOSAR application, implementation, and base types to preserve the information contained within Simulink data types.

In the AUTOSAR package structure created for Simulink originated components:

- You can specify separate packages to aggregate schema 4.x elements that relate to data types, including application data types, software base types, data type mapping sets, system constants, and units.
- Schema 4.x implementation data types are aggregated in the main data types package.

For more information, see “Configure AUTOSAR Packages” on page 4-111.

- For round-trip workflows involving AUTOSAR components originated outside MATLAB, the `arxml` importer and exporter preserve data type information and mapping for each imported AUTOSAR data type.

For information about mapping value constraints between AUTOSAR application data types and Simulink data types, see “Application Data Type Physical Constraint Mapping” on page 2-60.

For AUTOSAR R4.x data types originated in Simulink, you can control some aspects of data type export. For example, you can control when application data types are

generated, or specify the AUTOSAR package and short name exported for AUTOSAR data type mapping sets. For more information, see “Configure AUTOSAR Release 4.x Data Types” on page 4-326.

- “R4.x Data Types in Simulink Originated Workflow” on page 2-58
- “R4.x Data Types in Round-Trip Workflow” on page 2-59
- “Application Data Type Physical Constraint Mapping” on page 2-60

R4.x Data Types in Simulink Originated Workflow

In the Simulink originated (bottom-up) workflow, you create a Simulink model and export the model as an AUTOSAR software component.

The software generates the application and implementation data types and base types to preserve the information contained within the Simulink data types:

- For Simulink data types, the software generates implementation data types.
- For each fixed-point type, in addition to the implementation data type, the software generates an application data type with the COMPU-METHOD-REF element to preserve scale and bias information. This application data type is mapped to the implementation data type.

Note The software does not support application data types for code generated from referenced models.

Simulink Data Type	AUTOSAR XML	
	Implementation Type	Application Type
Primitive (excluding fixed point), for example, myInt16 Covers Boolean, integer, real <pre>myInt16 = Simulink.AliasType; myInt16.BaseType = 'int16';</pre>	<pre><IMPLEMENTATION-DATA-TYPE> <SHORT-NAME>myInt16</SHORT-NAME> <CATEGORY>VALUE</CATEGORY> ...</pre>	Not generated

Simulink Data Type	AUTOSAR XML	
	Implementation Type	Application Type
Primitive (fixed point), for example, myFixPt <pre>myFixPt = Simulink.NumericType; myFixPt.DataTypeMode = ...; myFixPt.IsAlias = true;</pre>	<pre><IMPLEMENTATION-DATA-TYPE> <SHORT-NAME>myFixPt</SHORT-NAME> <CATEGORY>VALUE</CATEGORY> ...</pre>	<pre><APPLICATION-PRIMITIVE-DATA-TYPE> <SHORT-NAME>myFixPt</SHORT-NAME> <COMPU-METHOD-REF>...</pre>
Enumeration, for example, myEnum <pre>Simulink.defineIntEnumType('myEnum', ... {'Red', 'Green', 'Blue'}, ... [1;2;3],...);</pre>	<pre><IMPLEMENTATION-DATA-TYPE> <SHORT-NAME>myEnum</SHORT-NAME> <CATEGORY>VALUE</CATEGORY> <COMPU-METHOD>...</pre>	Not generated
Record, for example, myRecord <pre>myRecord = Simulink.Bus;</pre>	<pre><IMPLEMENTATION-DATA-TYPE> <SHORT-NAME>myRecord</SHORT-NAME> <CATEGORY>STRUCT</CATEGORY> ...</pre>	Not generated

R4.x Data Types in Round-Trip Workflow

In the round-trip workflow, you first use the XML description generated by an AUTOSAR authoring tool to import on page 3-19 an AUTOSAR software component into a model. Later, you generate AUTOSAR C and XML code from the model.

If the data prototype references an application data type, the software stores application to implementation data type mapping within the model and uses the application data type name to define the Simulink data type.

For example, suppose that the authoring tool specifies an application data type:

```
ApplDT1
```

In this case, the software defines the following Simulink data type:

```
ImplDT1
```

AUTOSAR XML		Simulink Data Type
Application Type	Implementation Type	
<pre><APPLICATION-PRIMITIVE-DATA-TYPE> <SHORT-NAME>myFixPt</SHORT-NAME> <COMPU-METHOD-REF>...</pre>	<pre><IMPLEMENTATION-DATA-TYPE> <SHORT-NAME>myInt</SHORT-NAME> ...</pre>	<pre>myFixPt = Simulink.NumericType; myFixPt.DataTypeMode = ...; myFixPt.IsAlias = true;</pre>

If the data prototype references an implementation data type, the software does not store mapping information and uses the implementation data type name to define the Simulink data type.

The software uses the application data types in simulations and the implementation data types for code generation. When you re-export the AUTOSAR software component, the software uses the stored information to provide the same mapping between the exported application and implementation data types.

Application Data Type Physical Constraint Mapping

In models configured for AUTOSAR, the software maps minimum and maximum values for Simulink data to the corresponding physical constraint values for AUTOSAR application data types. Specifically:

- If you import arxml files, PhysConstr values on ApplicationDataTypes in the arxml files are imported to Min and Max values on the corresponding Simulink data objects and root-level I/O signals.
- When you export arxml code from a model, the Min and Max values specified on Simulink data objects and root-level I/O signals are exported to the corresponding ApplicationDataType PhysConstrs in the arxml files.

CompuMethod Categories for Data Types

AUTOSAR software components use computation methods (CompuMethods) to convert between the internal values and physical representation of AUTOSAR data. Common uses for CompuMethods are linear data scaling and measurement and calibration.

The category attribute of a CompuMethod represents a specialization of the CompuMethod, which can impose semantic constraints. The CompuMethod categories produced by the code generator include:

- BITFIELD_TEXTTABLE — Transform internal value into bitfield textual elements.
- IDENTICAL — Floating-point or integer function for which internal and physical values are identical and do not require conversion.
- LINEAR — Linear conversion of an internal value; for example, multiply the internal value with a factor, then add an offset.
- RAT_FUNC — Rational function; similar to linear conversion, but with conversion restrictions specific to rational functions.
- SCALE_LINEAR_AND_TEXTTABLE — Combination of LINEAR and TEXTTABLE scaling specifications.
- TEXTTABLE — Transform internal value into textual elements.

The arxml exporter generates CompuMethods for every primitive application type, allowing measurement and calibration tools to monitor and interact with the application data. The following table shows the CompuMethod categories that the code generator produces for data types in a model that is configured for AUTOSAR.

Data Type	CompuMethod Category	CompuMethod on Application Type	CompuMethod on Implementation Type
Bitfield	BITFIELD_TEXTTABLE	Yes	Yes
Boolean	TEXTTABLE	Yes	Yes
Enumerated without storage type	TEXTTABLE	Yes	Yes
Enumerated with storage type	TEXTTABLE	Yes	No
Fixed-point	LINEAR RAT_FUNC (limited to reciprocal scaling) SCALE_LINEAR_AND_TEXTTABLE	Yes	No
Floating-point	IDENTICAL SCALE_LINEAR_AND_TEXTTABLE	Yes	No
Integer	IDENTICAL SCALE_LINEAR_AND_TEXTTABLE	Yes	No

For floating-point and integer data types that do not require conversion between internal and physical values, the exporter generates a generic CompuMethod with category IDENTICAL and short-name Identcl.

For information about configuring CompuMethods for code generation, see “Configure AUTOSAR CompuMethods” on page 4-311.

See Also

Related Examples

- “Organize Data into Structures in Generated Code” (Embedded Coder)
- “Application Data Type Physical Constraint Mapping” on page 2-60

- “Configure AUTOSAR Release 4.x Data Types” on page 4-326
- “Automatic AUTOSAR Data Type Generation” on page 4-330
- “Configure AUTOSAR CompuMethods” on page 4-311

More About

- “AUTOSAR Data Types”

AUTOSAR Component Creation

- “Create AUTOSAR Software Component in Simulink” on page 3-2
- “Create and Configure AUTOSAR Software Component” on page 3-9
- “AUTOSAR arxml Importer” on page 3-17
- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Software Component with Multiple Runnables” on page 3-23
- “Import AUTOSAR Component to Simulink” on page 3-24
- “Import AUTOSAR Software Composition with Atomic Software Components (Classic Platform)” on page 3-30
- “Import AUTOSAR Software Component Updates” on page 3-31
- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38
- “Reuse AUTOSAR Element Descriptions” on page 3-41
- “Reuse AUTOSAR Elements in Component Model” on page 3-44
- “Limitations and Tips” on page 3-49

Create AUTOSAR Software Component in Simulink

To create a Simulink representation of an AUTOSAR software component, import an AUTOSAR XML component description into a new model or create a component in an existing model.

To create an AUTOSAR software component in an existing model, use one of these resources:

- AUTOSAR Component Quick Start — Creates a mapped AUTOSAR software component for your model and opens the model in the AUTOSAR code perspective.
- Simulink Start Page — Provides AUTOSAR Blockset model templates as a starting point for AUTOSAR software development.

Alternatively, if you have Simulink Coder and Embedded Coder software, you can use the Embedded Coder Quick Start. To create an AUTOSAR software component for your model, open Embedded Coder Quick Start from the Embedded Coder **C Code** tab or the AUTOSAR Blockset **AUTOSAR** tab. As you work through the quick-start procedure, in the Output window, select output option **C code compliant with AUTOSAR** or **C++ code compliant with AUTOSAR Adaptive Platform**.

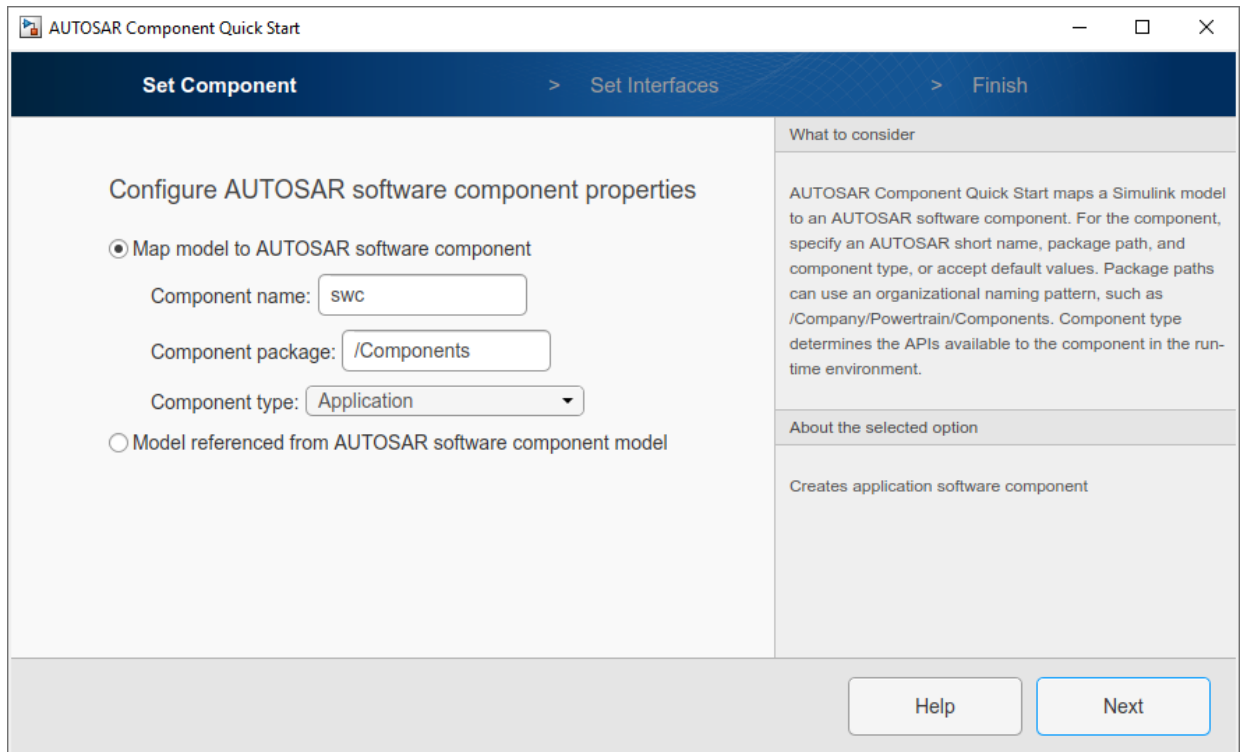
In this section...
“Create Mapped AUTOSAR Component with Quick Start” on page 3-2
“Create Mapped AUTOSAR Component with Simulink Start Page” on page 3-6

Create Mapped AUTOSAR Component with Quick Start

To create a mapped AUTOSAR software component using the AUTOSAR Component Quick Start:

- 1 Open a Simulink component model for which an AUTOSAR software component is not mapped. This example uses AUTOSAR example model `swc`. For adaptive component creation, you can use AUTOSAR example model `LaneGuidance`.
- 2 In the model window:
 - a Open the Configuration Parameters dialog box, **Code Generation** pane, and set the system target file to either `autosar.tlc` or `autosar_adaptive.tlc`. Click **OK**.

- b On the **Apps** tab, click **AUTOSAR Component Designer**. Because the model is unmapped, the AUTOSAR Component Quick Start opens.
- 3 To configure the model for AUTOSAR software component development, work through the quick-start procedure.



In the **Set Component** pane:

- For a Classic Platform software component, specify an AUTOSAR short name, package path, and component type, or accept default values.

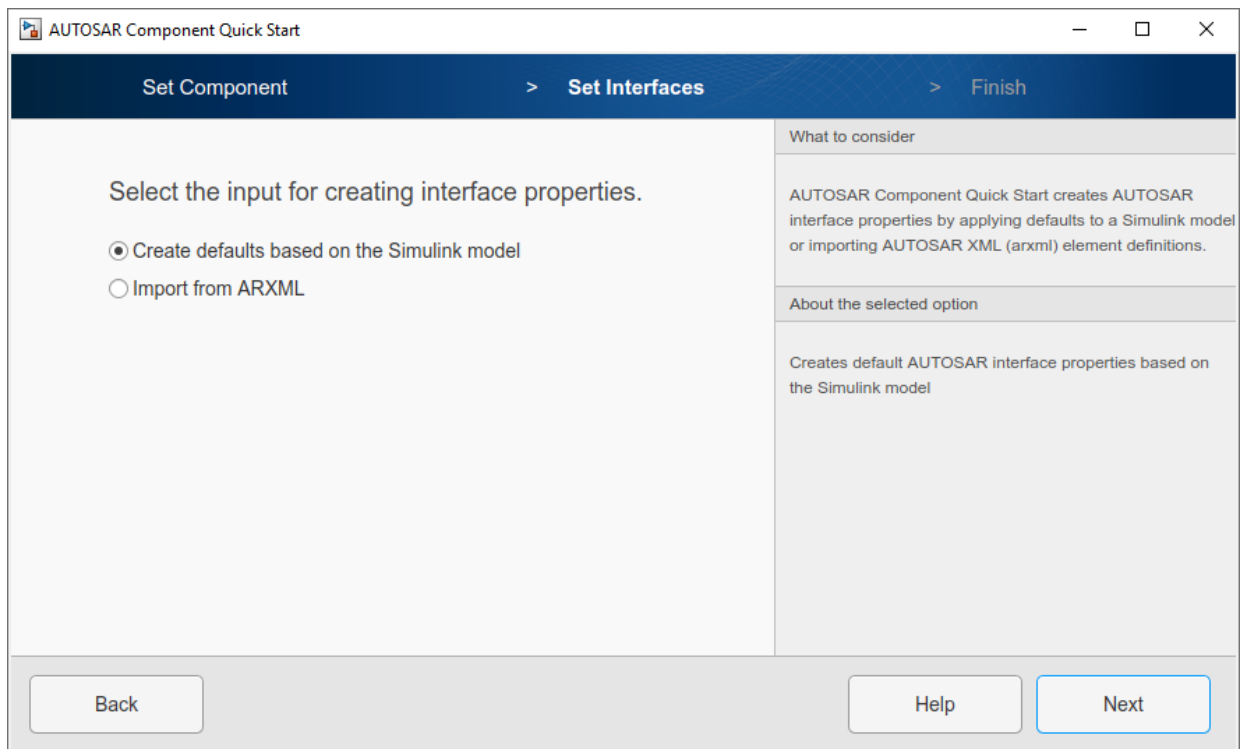
Component types include `Application`, `ComplexDeviceDriver`, `EcuAbstraction`, `SensorActuator`, and `ServiceProxy`. The most common types are `Application` and `SensorActuator`. For more information, see “Import AUTOSAR Software Composition with Atomic Software Components (Classic Platform)” on page 3-30.

- For an Adaptive Platform software component, specify an AUTOSAR short name and package path.

For the Classic Platform, you can also map a submodel referenced from an AUTOSAR software component model. For more information, see “Map Calibration Data for Submodels Referenced from AUTOSAR Component Models” on page 4-86.

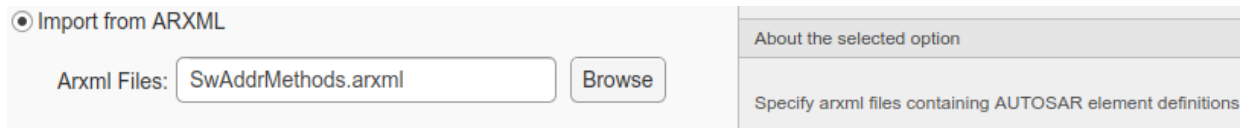
Click **Next**.

- 4 If you are creating a Classic Platform software component, a **Set Interfaces** pane opens.



In the **Set Interfaces** pane, select an option for creating component interface properties.

- If you select **Create defaults based on the Simulink model**, at the conclusion of the quick-start procedure, the software creates component interface properties by applying AUTOSAR defaults to the model.
- If you select **Import from ARXML**, an **Arxml Files** field opens. Specify one or more AUTOSAR XML files containing shared AUTOSAR element definitions (not AUTOSAR software component descriptions). For more information, see “Reuse AUTOSAR Element Descriptions” on page 3-41.



Import from ARXML

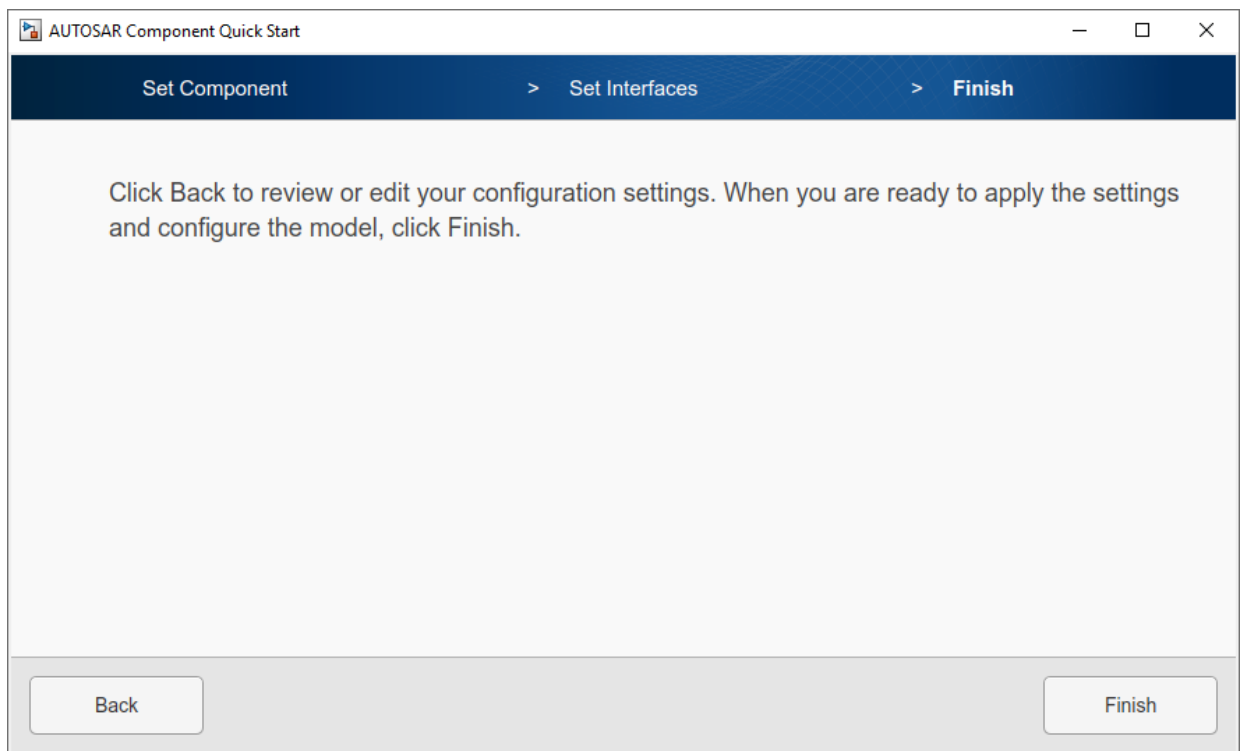
Arxml Files:

About the selected option

Specify arxml files containing AUTOSAR element definitions

Click **Next**.

- 5** The **Finish** pane opens.



AUTOSAR Component Quick Start

Set Component > Set Interfaces > **Finish**

Click Back to review or edit your configuration settings. When you are ready to apply the settings and configure the model, click Finish.

When you click **Finish**, your model opens in the AUTOSAR code perspective. To continue configuring the component model, see “AUTOSAR Component Configuration” on page 4-3.

Create Mapped AUTOSAR Component with Simulink Start Page

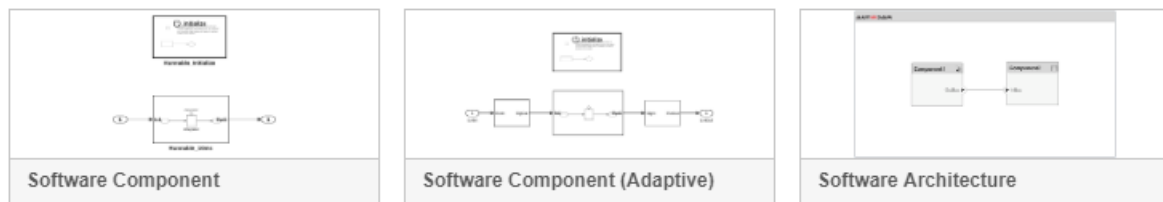
The Simulink Start Page provides AUTOSAR Blockset model templates as a starting point for AUTOSAR software component development. You can select either a Classic Platform or Adaptive Platform component template and click **Create Model**. (If you have System Composer software, you can also select an architecture model template. For more information, see “Create AUTOSAR Architecture Models” on page 8-2.)

The created model is preconfigured with AUTOSAR system target file and other code generation settings, but is not yet mapped to an AUTOSAR software component. After you examine and refine the template model, use the AUTOSAR Component Quick Start (or potentially the Embedded Coder Quick Start) to map the model to an AUTOSAR software component. For example:

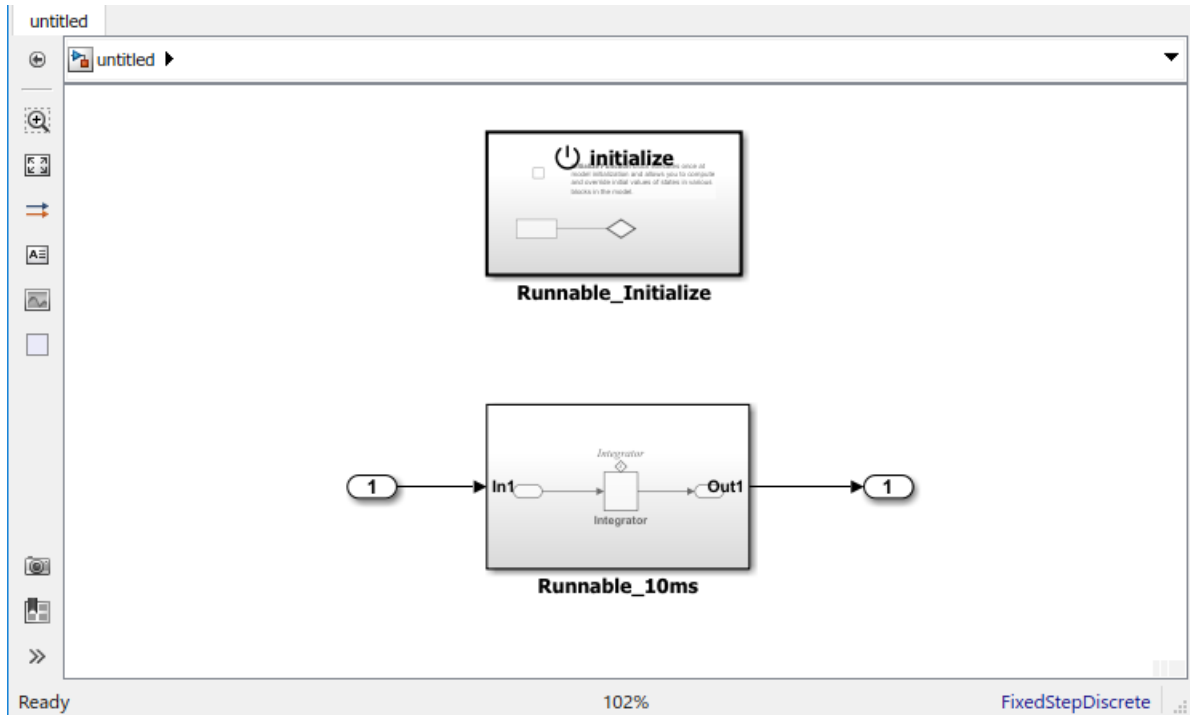
- 1 Open the Simulink Start Page. For example, enter the MATLAB command `simulink` or open a new model from the MATLAB or Simulink toolstrip.

The Start Page opens. On the **New** tab, scroll down to **AUTOSAR Blockset** and expand the product row.

▼ AUTOSAR Blockset

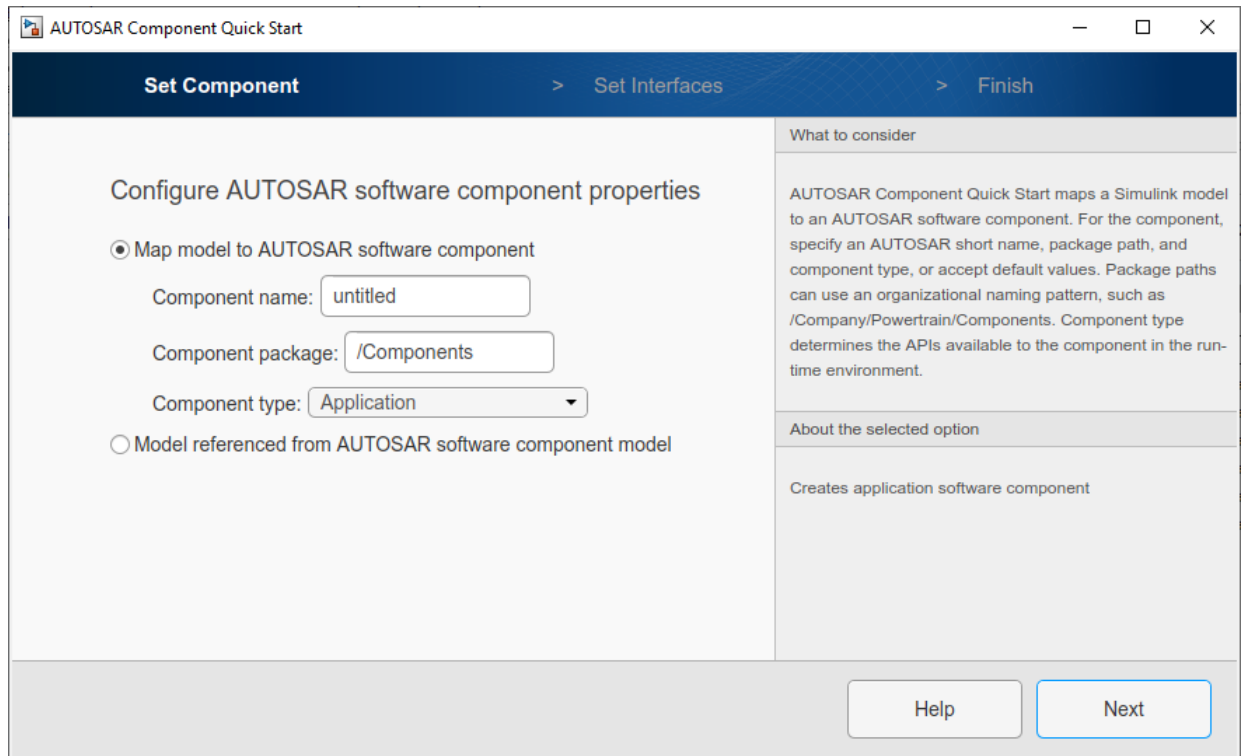


- 2 Place your cursor over the template you want to use and click **Create Model**. A model based on the template opens. (The Simulink Start Page closes.)



In this example, the created model is a starting point for developing a software component for the AUTOSAR Classic Platform.

- 3 Explore the model and refine the configuration according to your requirements. Optionally, you can develop the component behavior. To map the model to an AUTOSAR software component, use the AUTOSAR Component Quick Start. On the **Apps** tab, click **AUTOSAR Component Designer**. Because the model is unmapped, the AUTOSAR Component Quick Start opens.



- 4 Work through the quick-start procedure. If necessary, refer to “Create Mapped AUTOSAR Component with Quick Start” on page 3-2. When you click **Finish**, your model opens in the AUTOSAR code perspective. To continue configuring the component model, see “AUTOSAR Component Configuration” on page 4-3

See Also

Related Examples

- “AUTOSAR Component Configuration” on page 4-3
- “Create and Configure AUTOSAR Software Component” on page 3-9
- “Create and Configure AUTOSAR Adaptive Software Component” on page 6-7

Create and Configure AUTOSAR Software Component

Create an AUTOSAR software component model from an algorithm model.

AUTOSAR Blockset software supports AUTomotive Open System ARchitecture (AUTOSAR), an open and standardized automotive software architecture. Automobile manufacturers, suppliers, and tool developers jointly develop AUTOSAR components. To develop AUTOSAR components in Simulink, follow this general workflow:

- 1 Create a Simulink representation of an AUTOSAR component.
- 2 Develop the component by refining the AUTOSAR configuration and creating algorithmic model content.
- 3 Generate arxml descriptions and algorithmic C code for testing in Simulink or integration into an AUTOSAR run-time environment. (AUTOSAR code generation requires Simulink Coder and Embedded Coder.)

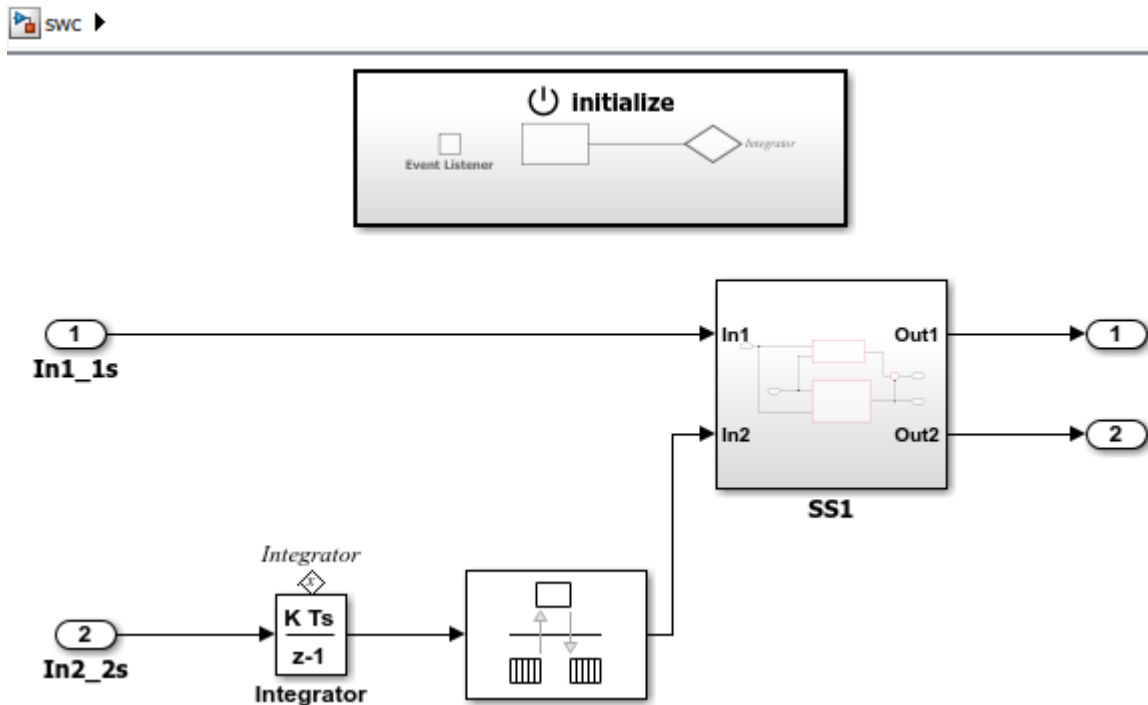
Create AUTOSAR Software Component in Simulink

To create an initial Simulink representation of an AUTOSAR software component, you take one of these actions:

- Create an AUTOSAR software component using an existing Simulink model.
- Import an AUTOSAR software component description from arxml files into a new Simulink model. (See example “Import AUTOSAR Component to Simulink” on page 3-24.)

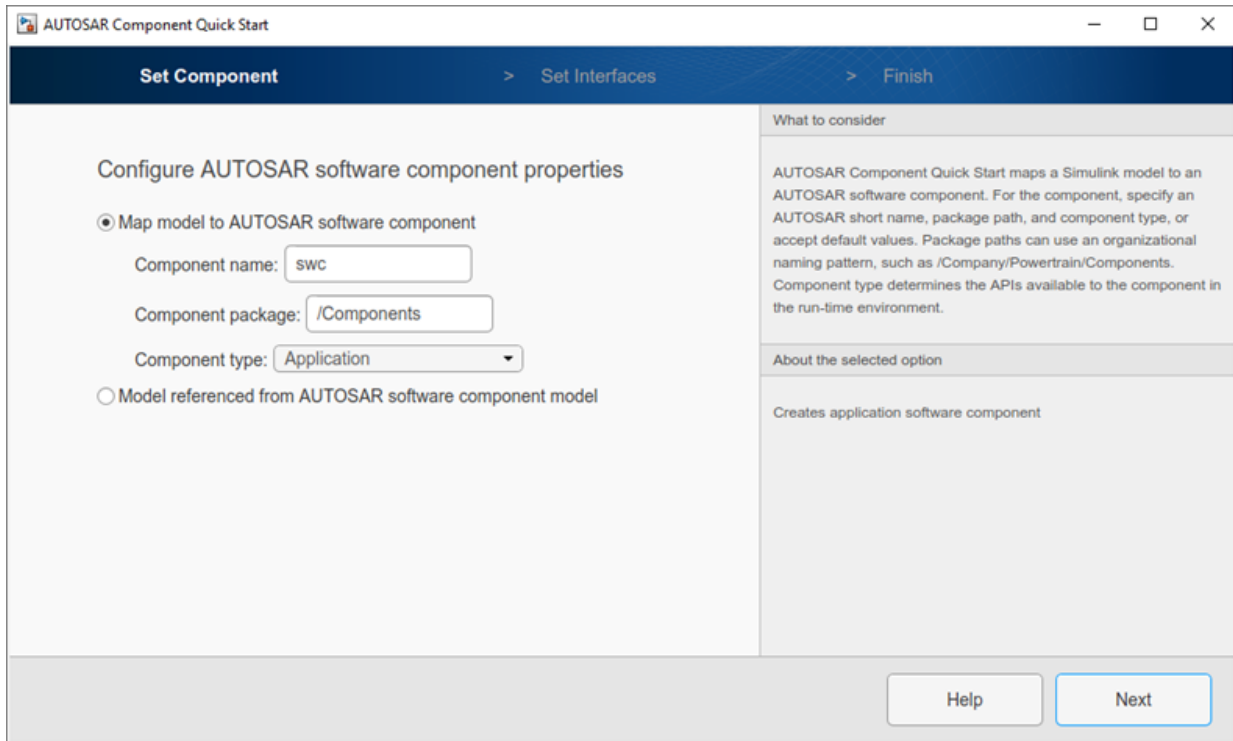
To create an AUTOSAR software component using an existing model, first open a Simulink component model for which an AUTOSAR software component is not mapped. This example uses AUTOSAR example model swc.

```
open_system('swc');
```



In the model window, on the **Modeling** tab, select **Model Settings**. In the Configuration Parameters dialog box, **Code Generation** pane, set the system target file to `autosar.tlc`. Click **OK**.

To configure the model as a mapped AUTOSAR software component, open the AUTOSAR Component Quick Start. On the **Apps** tab, click **AUTOSAR Component Designer**. The AUTOSAR Component Quick Start opens.

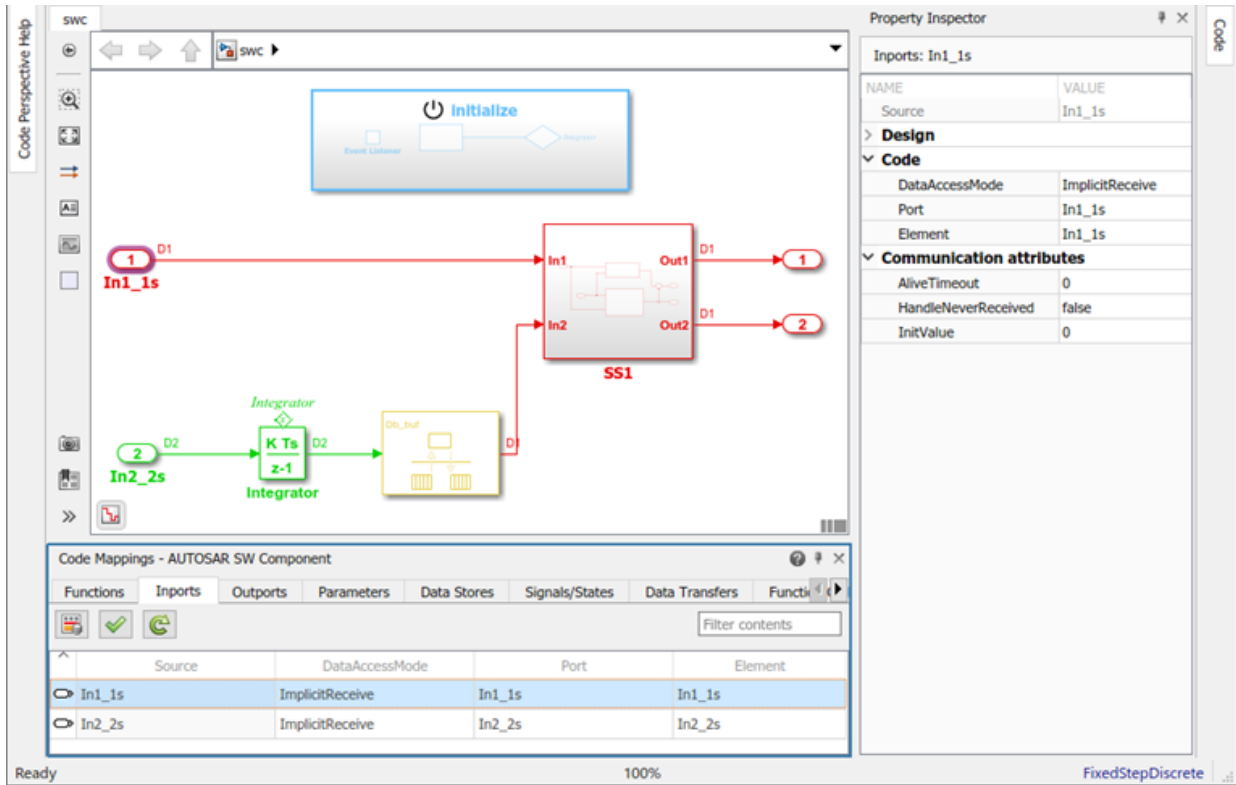


To configure the model for AUTOSAR software component development, work through the quick-start procedure. This example accepts default settings for the options in the Quick Start **Set Component** and **Set Interfaces** panes.

In the **Finish** pane, when you click **Finish**, your model opens in the AUTOSAR code perspective.

Configure AUTOSAR Software Component in Simulink

The AUTOSAR code perspective displays your model, a Property Inspector panel, and directly below the model, the Code Mappings editor.

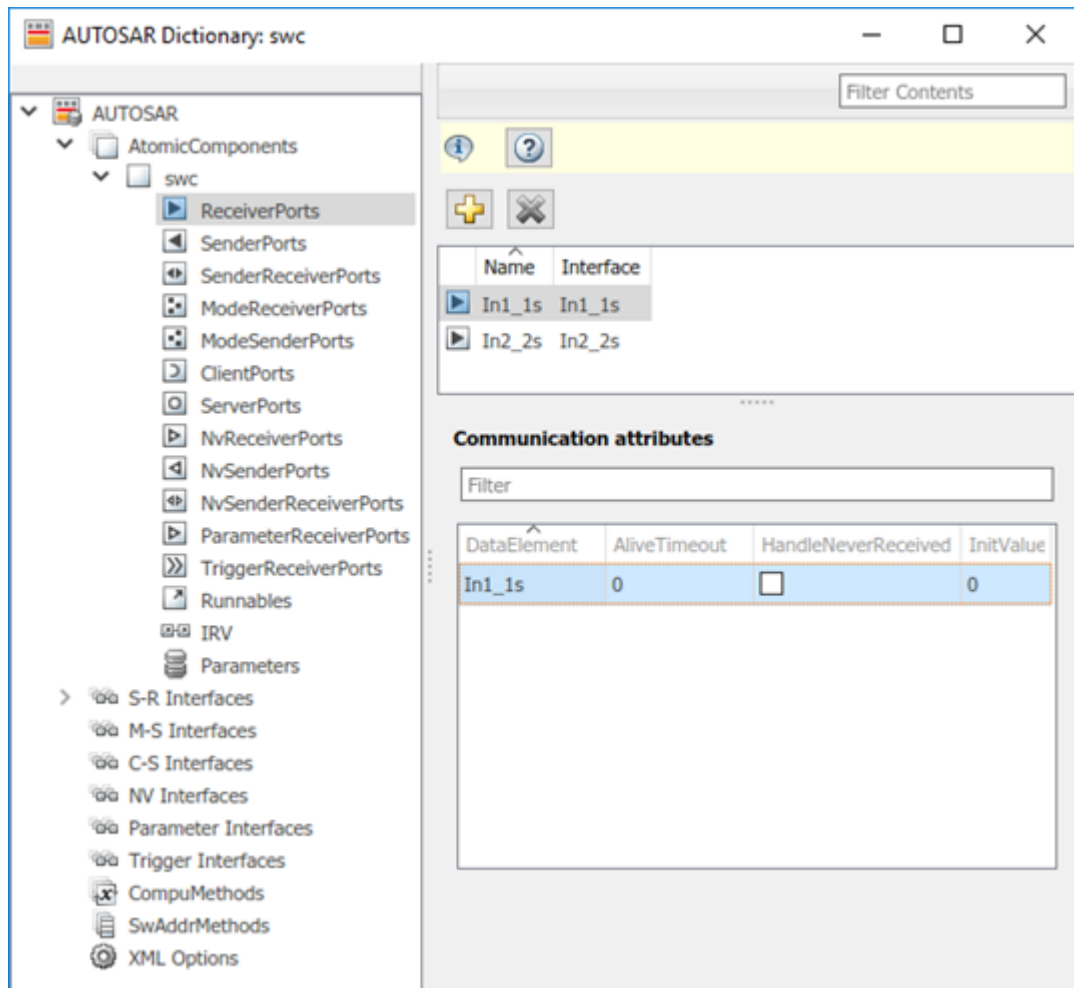


Next you use the Code Mappings editor and the AUTOSAR Dictionary to further develop the AUTOSAR component.

The Code Mappings editor displays entry-point functions, model inports, outports, parameters, and other Simulink elements relevant to your AUTOSAR platform. Use the editor to map Simulink model elements to AUTOSAR component elements from a Simulink model perspective. AUTOSAR component elements are defined in the AUTOSAR standard, and include runnable entities, ports, and inter-runnable variables (IRVs).

Open each Code Mapping tab and examine the mapped model elements. To modify the AUTOSAR mapping for an element, select an element and modify its associated properties. When you select an element, it is highlighted in the model, and the Property Inspector displays its code and communication attributes.

To configure the AUTOSAR properties of the mapped AUTOSAR software component, open the AUTOSAR Dictionary. In the Code Mappings editor, click the AUTOSAR Dictionary button, which is the leftmost icon. The AUTOSAR Dictionary opens in the AUTOSAR view that corresponds to the Simulink element that you last selected and mapped in the Code Mappings editor. If you selected and mapped a Simulink inport, the dictionary opens in ReceiverPorts view and displays the AUTOSAR port to which you mapped the inport.



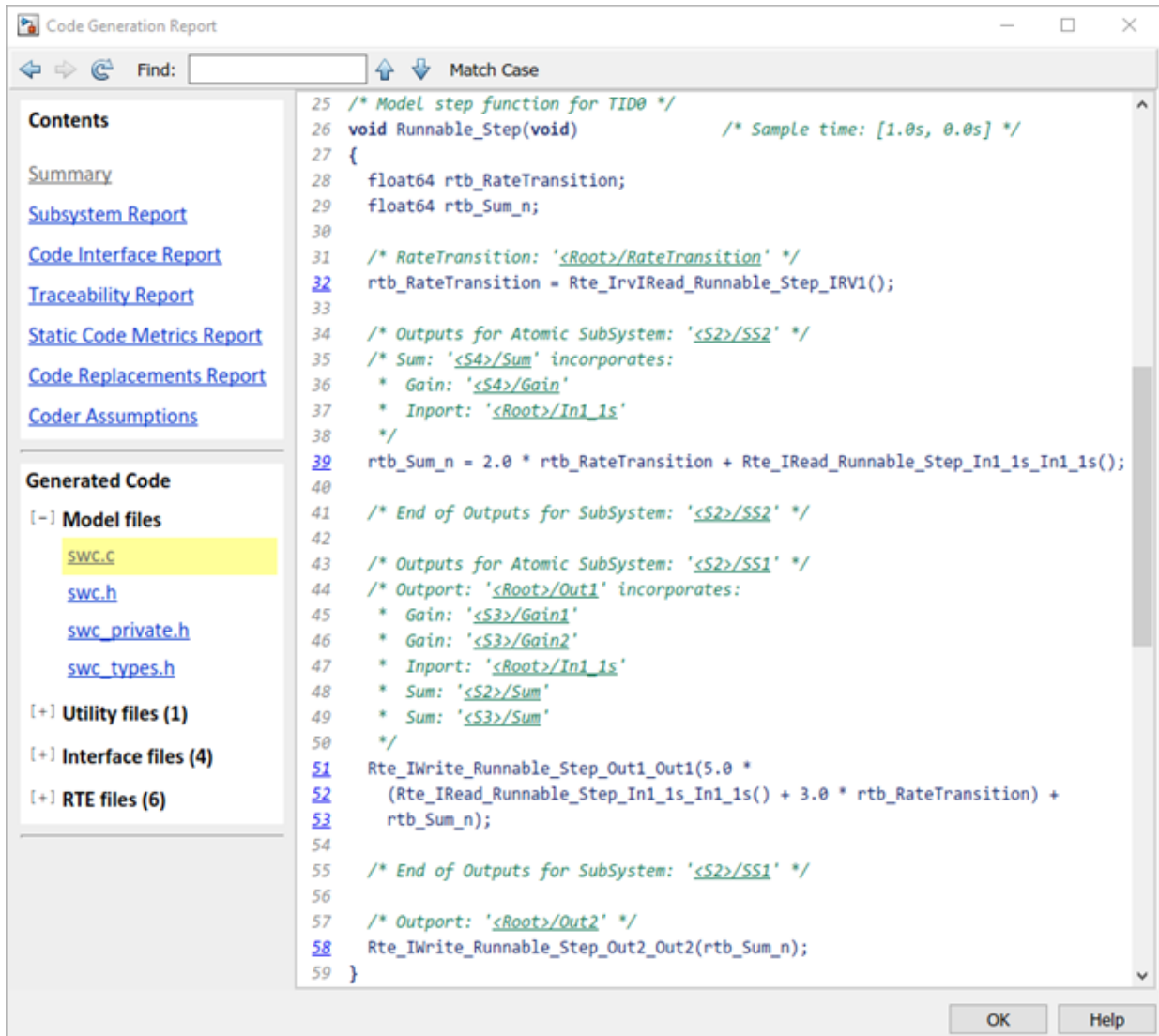
The AUTOSAR Dictionary displays the mapped AUTOSAR component and its elements, communication interfaces, computation methods, software address methods, and XML options. Use the dictionary to configure AUTOSAR elements and properties from an AUTOSAR component perspective.

Open each node and examine its AUTOSAR elements. To modify an AUTOSAR element, select an element and modify its associated properties. AUTOSAR XML and AUTOSAR-compliant C code generated from the model reflect your modifications.

Generate C Code and ARXML Descriptions (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, you can build the AUTOSAR model. Building the AUTOSAR model generates AUTOSAR-compliant C code and exports AUTOSAR XML (arxml) descriptions. In the model window, press **Ctrl+B** or, on the **AUTOSAR** tab, select **Generate Code**.

When the build completes, a code generation report opens. Examine the report. Verify that your Code Mappings editor and AUTOSAR Dictionary changes are reflected in the C code and arxml descriptions. For example, use the **Find** field to search for the names of the Simulink model elements and AUTOSAR component elements that you modified.



Related Links

- “AUTOSAR Component Configuration” on page 4-3
- “Code Generation” (Classic Platform)

- “AUTOSAR Blockset”

AUTOSAR arxml Importer

The AUTOSAR arxml importer imports AUTOSAR software component description files produced by an AUTOSAR authoring tool (AAT) into a Simulink model. The importer first parses arxml code that describes an AUTOSAR software component or composition. Then, based on commands that you issue, the importer imports a subset of the elements and objects in the arxml description into Simulink. The subset consists of AUTOSAR elements relevant for Simulink model-based design of an automotive application. For example, for an imported component, the subset includes AUTOSAR ports, interfaces, data types, aspects of internal behavior, and packages.

The importer creates an initial Simulink representation of each imported AUTOSAR software component, with an initial, default mapping of Simulink model elements to AUTOSAR component elements. The initial representation provides a starting point for further AUTOSAR configuration and model-based design.

As part of the import operation, the importer validates the XML in the imported arxml files. If XML validation fails for a file, the importer displays errors. For example:

```
Error
The IsService attribute is undefined for interface /mtest_pkg/mtest_if/In1
in file hArxmlFileErrorMissingIsService_SR_3p2.arxml:48.
Specify the IsService attribute to be either true or false
```

In this example message, the file name is a hyperlink, and you can click the hyperlink to see the location of the error in the arxml file.

To help support the round trip of AUTOSAR elements between an AAT and the Simulink model-based design environment, Embedded Coder:

- Preserves imported AUTOSAR XML file structure, elements, and element UUIDs for arxml export. For more information, see “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.
- Provides the ability to update an AUTOSAR model based on changes found in imported arxml files. For more information, see “Import AUTOSAR Software Component Updates” on page 3-31.

The AUTOSAR arxml importer is implemented as an arxml.importer object. For a complete list of functions, see the arxml.importer object reference page.

See Also

Related Examples

- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Component to Simulink” on page 3-24
- “Import AUTOSAR Composition to Simulink” on page 7-2
- “Import AUTOSAR Software Component Updates” on page 3-31
- “Reuse AUTOSAR Elements in Component Model” on page 3-44
- “Configure AUTOSAR Code Generation” on page 5-8
- “Import AUTOSAR Adaptive Software Descriptions” on page 6-15
- “Import AUTOSAR Adaptive Components to Simulink” on page 6-17
- “Reuse AUTOSAR Adaptive Elements in Component Model” on page 6-22
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

More About

- “Workflows for AUTOSAR” on page 1-13
- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38

Import AUTOSAR Software Component

In Simulink, you can import an AUTOSAR software component description from `arxml` files and create a model representing the AUTOSAR software component. You use the AUTOSAR `arxml` importer, which is implemented as an `arxml.importer` object. For more information, see “AUTOSAR `arxml` Importer” on page 3-17.

Use `arxml.importer` functions in the following order:

- 1 Call the `arxml.importer` function to create an importer object that represents the software component information in the specified XML file or files. For example, this call specifies a main AUTOSAR software component file, `mr_component.arxml`, and related dependent files containing data type, implementation, and interface information that completes the software component description.

```
ar = arxml.importer({'mr_component.arxml', 'mr_datatype.arxml', ...
                  'mr_implementation.arxml', 'mr_interface.arxml'})
```

This call specifies an AUTOSAR software composition file, `ThrottlePositionControlComposition.arxml`, which describes an AUTOSAR composition and its aggregated AUTOSAR components.

```
addpath(fullfile(matlabroot, 'examples', 'autosarblockset'));
ar = arxml.importer('ThrottlePositionControlComposition.arxml');
```

If you enter the `arxml.importer` function call without a terminating semicolon (;), the importer lists the AUTOSAR content of the specified XML file or files. The information includes paths to software components in the AUTOSAR package structure, which you use in the next step.

In this example, the path to software composition `ThrottlePositionControlComposition` is `/Company/Components/ThrottlePositionControlComposition`. The path to software component `Controller` is `/Company/Components/Controller`.

```
ar =
```

The file "`matlabroot/examples/autosarblockset/ThrottlePositionControlComposition.arxml`" contains:

- 1 Composition-Software-Component-Type:
'/Company/Components/ThrottlePositionControlComposition'
- 2 Application-Software-Component-Type:
'/Company/Components/Controller'
'/Company/Components/ThrottlePositionMonitor'
- 3 Sensor-Actuator-Software-Component-Type:
'/Company/Components/AccelerationPedalPositionSensor'
'/Company/Components/ThrottlePositionActuator'

```
'/Company/Components/ThrottlePositionSensor'
```

```
>>
```

- 2 To import a parsed atomic software component or composition into a Simulink model, call function `createComponentAsModel`, `createCompositionAsModel`, or `updateModel`. If you have not specified all dependencies for the components, you will see errors.

- `createComponentAsModel` — Create Simulink representation of AUTOSAR arxml atomic software component.

For example:

```
createComponentAsModel(ar, '/Company/Components/Controller', ...  
    'ModelPeriodicRunnablesAs', 'AtomicSubsystem')
```

The `ModelPeriodicRunnablesAs` property controls whether the importer models AUTOSAR periodic runnables as atomic subsystems with periodic rates (the default) or function-call subsystems with periodic rates. Specify `AtomicSubsystem` unless your design requires use of function-call subsystems. For more information, see “Import AUTOSAR Software Component with Multiple Runnables” on page 3-23.

To import Simulink data objects for AUTOSAR data into a Simulink data dictionary, you can set the `DataDictionary` property on the model creation. If the specified dictionary does not already exist, the importer creates it.

To explicitly designate an AUTOSAR runnable as the initialization runnable in a component, use the `InitializationRunnable` property on the model creation.

For more information, see the `createComponentAsModel` reference page and the example “Import AUTOSAR Component to Simulink” on page 3-24.

- `createCompositionAsModel` — Create Simulink representation of AUTOSAR arxml software composition.

For example:

```
createCompositionAsModel(ar, '/Company/Components/ThrottlePositionControlComposition')
```

To include existing Simulink atomic software component models in the composition model, use the `ComponentModels` property on the composition model creation.

For more information, see the `createCompositionAsModel` reference page and the example “Import AUTOSAR Composition to Simulink” on page 7-2.

- `updateModel` — Update AUTOSAR model with `arxml` changes.

For example:

```
open_system('Controller')
ar2 = arxml.importer('ThrottlePositionControlComposition_updated.arxml');
updateModel(ar2,'Controller');
```

For more information, see the `updateModel` reference page, “Import AUTOSAR Software Component Updates” on page 3-31, and the example “Import AUTOSAR Component to Simulink” on page 3-24.

After you import your software component or composition into Simulink, you can develop the behavior and configuration of the component or composition model. To refine the component configuration, see “AUTOSAR Component Configuration” on page 4-3.

To configure AUTOSAR code generation options and XML export options, see “Configure AUTOSAR Code Generation” on page 5-8.

To help support the round trip of AUTOSAR elements between an AUTOSAR authoring tool (AAT) and the Simulink model-based design environment, `arxml` import preserves imported AUTOSAR XML file structure, elements, and element UUIDs for `arxml` export. For more information, see “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.

See Also

`arxml.importer`

Related Examples

- “Import AUTOSAR Component to Simulink” on page 3-24
- “Import AUTOSAR Composition to Simulink” on page 7-2
- “Import AUTOSAR Software Component Updates” on page 3-31
- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “AUTOSAR arxml Importer” on page 3-17
- “Workflows for AUTOSAR” on page 1-13

Import AUTOSAR Software Component with Multiple Runnables

The AUTOSAR arxml importer functions `createComponentAsModel` and `createCompositionAsModel` can import AUTOSAR software components with multiple runnable entities into a new Simulink model. Use the `ModelPeriodicRunnablesAs` property on the model creation to specify whether the importer models AUTOSAR periodic runnables as atomic subsystems with periodic rates (the default) or function-call subsystems with periodic rates.

If you set `ModelPeriodicRunnablesAs` to the default value, `AtomicSubsystem`, the importer creates rate-based models. If the arxml code contains periodic runnables, the importer adds rate-based model content, including atomic subsystems and data transfer lines with rate transitions, and maps them to corresponding periodic runnables and IRVs imported from the AUTOSAR software component.

If you set `ModelPeriodicRunnablesAs` to `FunctionCallSubsystem`, the importer creates function-call-based models. The importer adds function-call subsystem or function blocks and signal lines and maps them to corresponding runnables and IRVs imported from the AUTOSAR software component.

Set `ModelPeriodicRunnablesAs` to `AtomicSubsystem` unless your design requires use of function-call subsystems. The following call directs the importer to import a multi-runnable AUTOSAR software component and map it into a new rate-based model:

```
addpath(fullfile(matlabroot,'examples','autosarblockset'))
ar = arxml.importer('ThrottlePositionControlComposition.arxml')
createComponentAsModel(ar,'/Company/Components/Controller',...
'ModelPeriodicRunnablesAs','AtomicSubsystem')
```

For more information, see “Model AUTOSAR Software Components” on page 2-3.

See Also

`createComponentAsModel` | `createCompositionAsModel`

Related Examples

- “Import AUTOSAR Component to Simulink” on page 3-24
- “Import AUTOSAR Composition to Simulink” on page 7-2

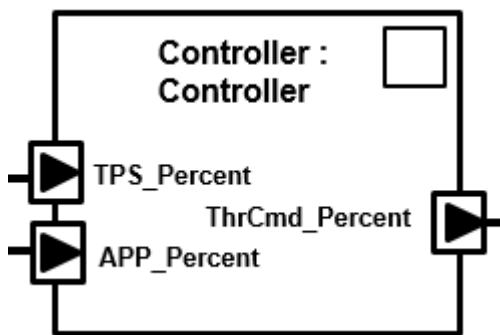
Import AUTOSAR Component to Simulink

Create Simulink® model from XML description of AUTOSAR software component.

Import AUTOSAR Component from arxml File to Simulink

Here is an AUTOSAR application software component that implements a controller in an automotive throttle position control system. The controller component takes input values from an accelerator pedal position (APP) sensor and a throttle position sensor (TPS). The controller translates the values into input values for a throttle actuator.

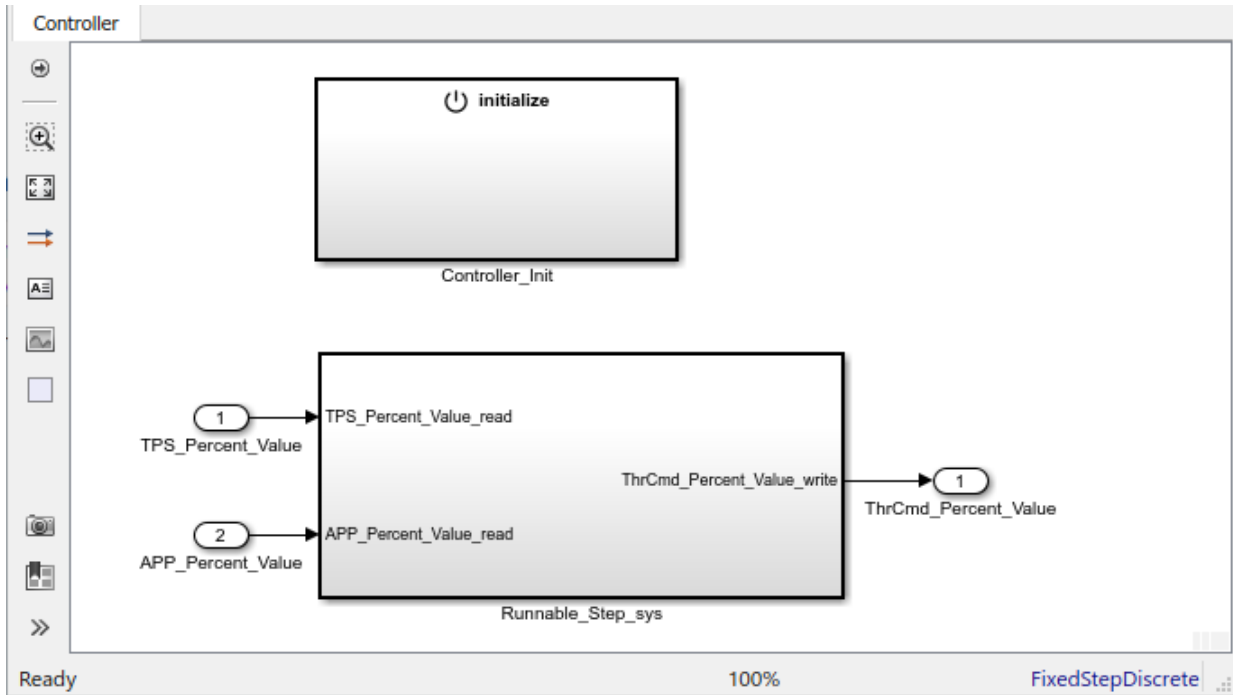
The component was created in an AUTOSAR authoring tool and exported to the file `ThrottlePositionControlComposition.arxml`.



Use the MATLAB function `createComponentAsModel` to import the `arxml` description and create an initial Simulink representation of the AUTOSAR component.

```
ar = arxml.importer('ThrottlePositionControlComposition.arxml');  
createComponentAsModel(ar, '/Company/Components/Controller', ...  
    'ModelPeriodicRunnablesAs', 'AtomicSubsystem');
```

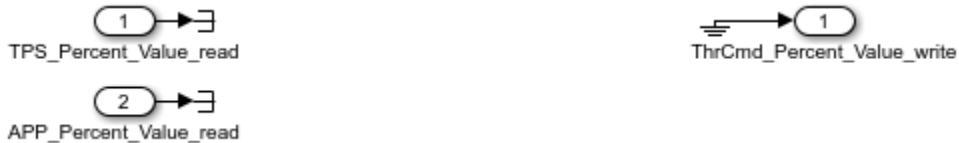
The function call creates a component model that represents an AUTOSAR application software component. An atomic subsystem represents an AUTOSAR periodic runnable, and an Initialize Function block represents an AUTOSAR initialize runnable. Simulink inports and outports represent AUTOSAR ports.



Develop AUTOSAR Component Algorithm, Simulate, and Generate Code

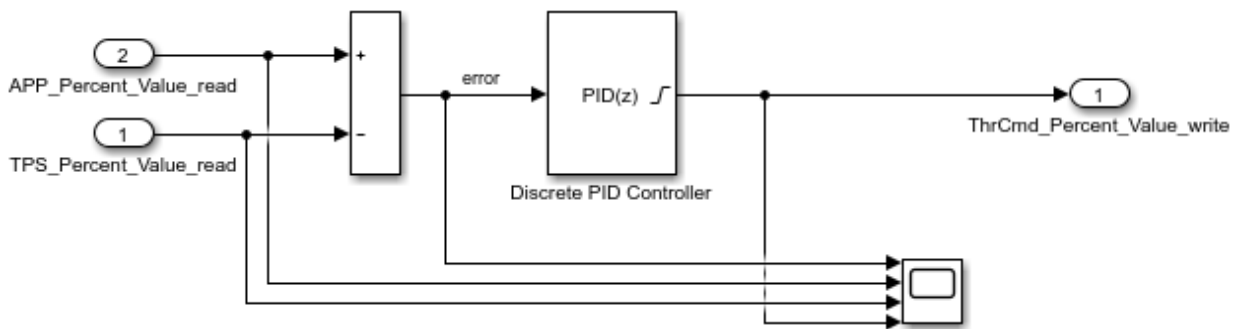
After creating an initial Simulink representation of the AUTOSAR component, you develop the component. You refine the AUTOSAR configuration and create algorithmic model content.

For example, the `Runnable_Step_sys` subsystem in the `Controller` component model contains an initial stub implementation of the controller behavior.



Here is a possible implementation of the throttle position controller behavior. (To explore this implementation, open model `autosar_sw_c_controller.slx` at `matlabroot/examples/autosarblockset`.) The component takes as inputs an APP sensor percent

value from a pedal position sensor and a TPS percent value from a throttle position sensor. Based on these values, the controller calculates the *error*. The error is the difference between where the operator wants the throttle, based on the pedal sensor, and the current throttle position. In this implementation, a Discrete PID Controller block uses the error value to calculate a throttle command percent value to provide to a throttle actuator. A scope displays the error value and the Discrete PID Controller block output value over time.



As you develop AUTOSAR components, you can:

- Simulate the component model individually or in a containing composition or test harness.
- Generate arxml component description files and algorithmic C code for testing in Simulink or integration into an AUTOSAR run-time environment. (AUTOSAR code generation requires Simulink Coder and Embedded Coder.)

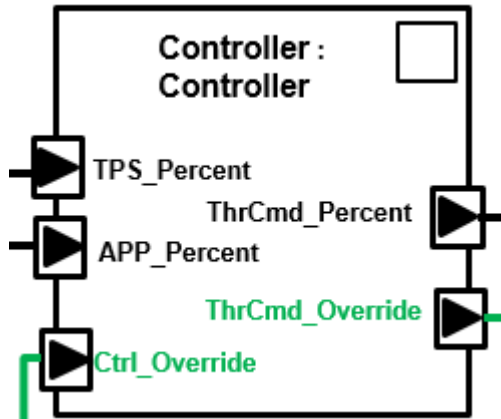
For more information on developing, simulating, and building AUTOSAR components, see example “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103.

Update AUTOSAR Component Model with Architectural Changes from Authoring Tool

Suppose that, after you imported the AUTOSAR software component into Simulink and began developing algorithms, architectural changes were made to the component in the AUTOSAR authoring tool.

Here is the revised component. The changes add a control override receive port and a throttle command override provide port. In the AUTOSAR authoring tool, the revised

component is exported to the file
ThrottlePositionControlComposition_updated.arxml.

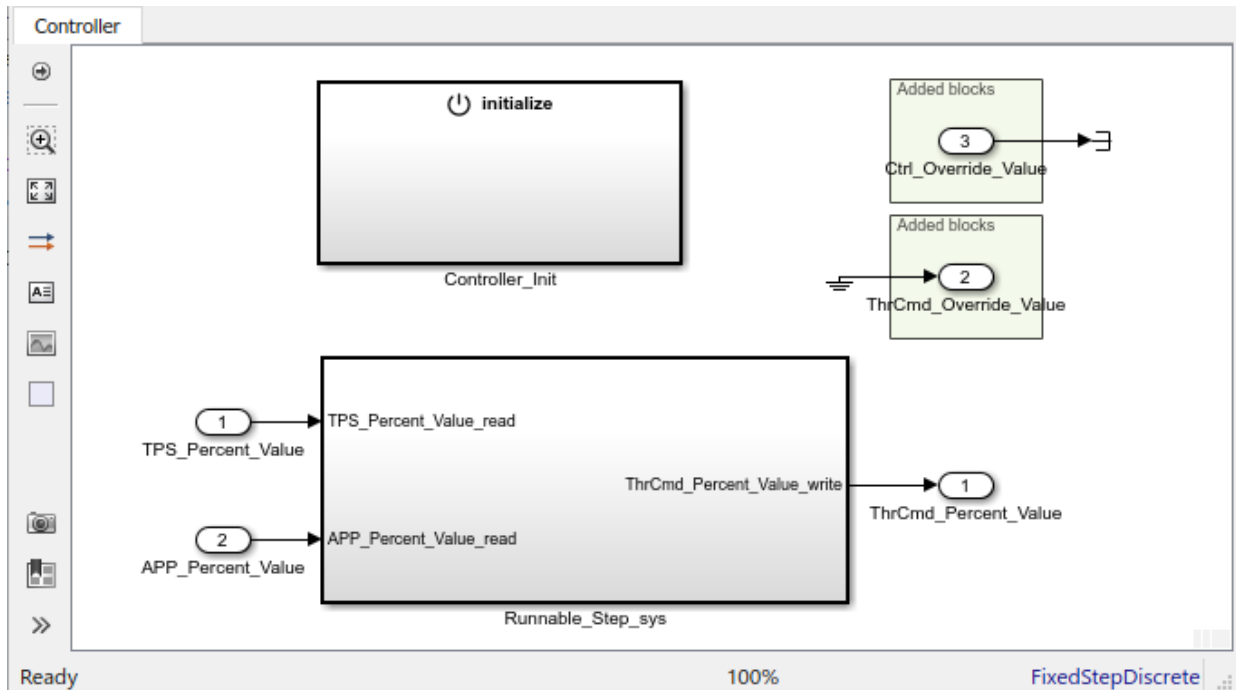


Use the MATLAB function `updateModel` to import the architectural revisions from the `arxml` file. The function updates the AUTOSAR component model with the changes and reports the results.

```
ar2 = arxml.importer('ThrottlePositionControlComposition_updated.arxml');
updateModel(ar2, 'Controller');
```

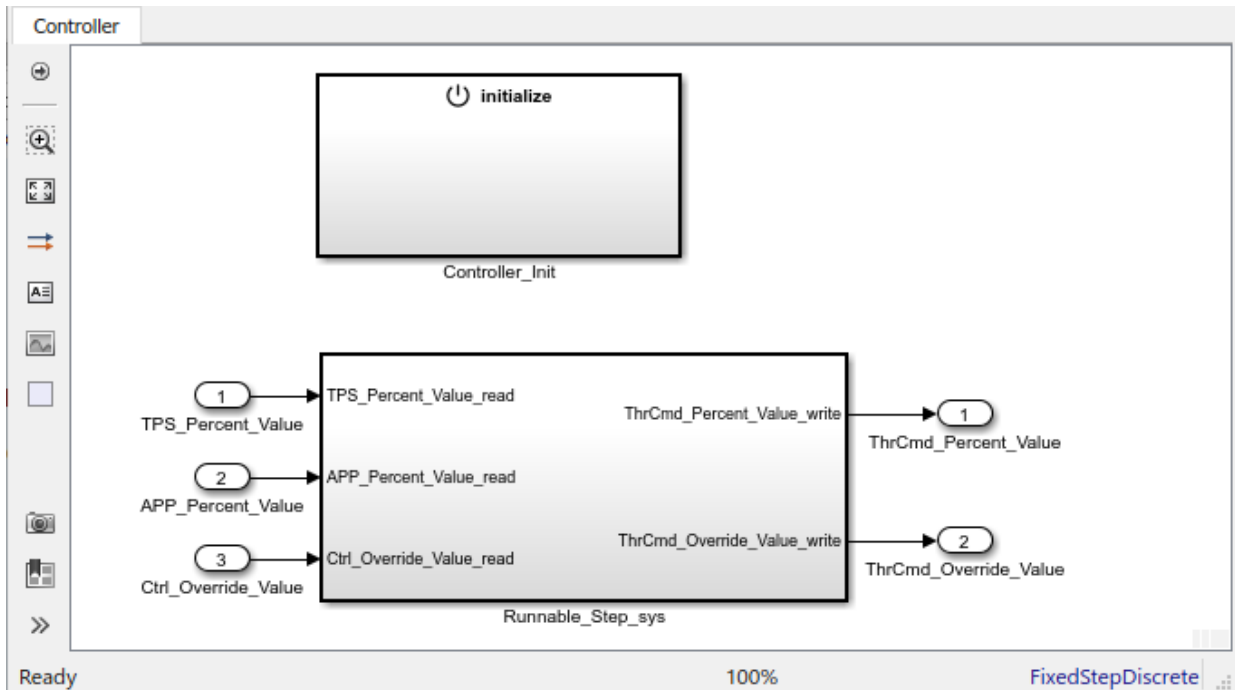
```
### Updating model Controller
### Saving original model as Controller_backup.slx
### Creating HTML report Controller_update_report.html
```

After the update, in the component model, highlighting indicates where changes occurred.



The function also generates and displays an HTML AUTOSAR update report. The report lists changes that the update made to Simulink and AUTOSAR elements in the component model. In the report, you can click hyperlinks to navigate from change descriptions to model changes.

Connect the added blocks, update the imports and outputs inside the subsystem, and update the model diagram. For example:



Related Links

- [createComponentAsModel](#)
- [updateModel](#)
- ["Component Creation"](#)
- ["Import AUTOSAR Software Component Updates"](#) on page 3-31
- ["Design and Simulate AUTOSAR Components and Generate Code"](#) on page 4-103

Import AUTOSAR Software Composition with Atomic Software Components (Classic Platform)

You can import an AUTOSAR software composition from `arxml` files into a new Simulink model. AUTOSAR compositions aggregate AUTOSAR software components and potentially other compositions. Use the `arxml.importer.createCompositionAsModel` function to import a composition.

The following types of AUTOSAR atomic software components, if found in the `arxml` description of a composition, are imported and represented as component models.

- Application component
- Sensor-actuator component
- Complex device driver component
- ECU abstraction component
- Service proxy component

Application and sensor-actuator components are frequently imported, created, and modeled in Simulink. For complex device driver, ECU abstraction, or service proxy components that you import from compositions, you can model only the application side of their behavior in Simulink. For example, a complex device driver component can access Runtime Environment (RTE) device driver interfaces as an application-level component. But you cannot model the corresponding Basic Software (BSW) device drivers in Simulink.

See Also

`createCompositionAsModel`

Related Examples

- “Import AUTOSAR Composition to Simulink” on page 7-2

Import AUTOSAR Software Component Updates

After you create a Simulink model that represents an AUTOSAR software component, the arxml description of the component can change independently. Using `arxml.importer` function `updateModel`, you can import the modified arxml description and update the model to reflect the changes. The update generates an HTML report that details automatic updates applied to the model, and additional manual changes that you must perform.

In this section...

“Update Model with AUTOSAR Software Component Changes” on page 3-31

“AUTOSAR Update Report Section Examples” on page 3-34

Update Model with AUTOSAR Software Component Changes

To update a model with AUTOSAR software component changes described in arxml files:

- 1 Open a model for which you previously imported or exported arxml files. This example uses the Controller model created by live script “Import AUTOSAR Component to Simulink” on page 3-24.

```
% Create and open AUTOSAR controller component model
addpath(fullfile(matlabroot,'examples','autosarblockset'))
ar = arxml.importer('ThrottlePositionControlComposition.arxml');
createComponentAsModel(ar,'/Company/Components/Controller',...
    'ModelPeriodicRunnablesAs','AtomicSubsystem');
```

- 2 Issue MATLAB commands to import arxml descriptions into the model and update the model with changes.

Note The imported arxml descriptions must contain the AUTOSAR software component mapped by the model.

For example, the following commands update model Controller with changes from arxml file `ThrottlePositionControlComposition_updated.arxml`.

```
% Update AUTOSAR controller component model
ar2 = arxml.importer('ThrottlePositionControlComposition_updated.arxml');
updateModel(ar2,'Controller');

### Updating model Controller
### Saving original model as Controller_backup.slx
### Creating HTML report Controller_update_report.html
```

The AUTOSAR Update Report opens.

AUTOSAR Update Report
- □ ×

← → ↻ Find:
↑ ↓ Match Case

AUTOSAR Update Report for Controller

Software component: [/Company/Components/Controller](#)
 Original model saved as: [Controller_backup](#)

This report details the updates applied to Simulink model [Controller](#) based on differences between the imported arxml and the existing AUTOSAR configuration contained in the model. A backup of the original model has been saved to [Controller_backup](#) ([compare models](#)). The report also recommends manual model changes.

Simulink

Automatic Model Changes

- Added Inport block [Controller/Ctrl_Override_Value](#)
- Added Outport block [Controller/ThrCmd_Override_Value](#)

Automatic Workspace Changes

Required Manual Model Changes

Optional Manual Workspace Changes

AUTOSAR

Automatic AUTOSAR Element Changes

- Added DataReceiverPort /Company/Components/Controller/Ctrl_Override
- Added DataSenderPort /Company/Components/Controller/ThrCmd_Override
- Added AtomicComponent /Company/Components/Logger
- Added AssemblyConnector /Company/Components/ThrottlePositionControlComposition/ActuatorDThrCmd_HwIODLoggerDThrCmd_HwIO
- Added AssemblyConnector /Company/Components/ThrottlePositionControlComposition/ControllerDThrCmd_OverrideDActuatorDThrCmd_Override
- Added DelegationConnector /Company/Components/ThrottlePositionControlComposition/Ctrl_OverrideDDControllerDCtrl_Override
- Added ComponentPrototype /Company/Components/ThrottlePositionControlComposition/Logger
- Added DataReceiverPort /Company/Components/ThrottlePositionControlComposition/Ctrl_Override
- Added DataReceiverPort /Company/Components/ThrottlePositionActuator/ThrCmd_Override
- Added SenderReceiverInterface /Company/Interfaces/Override_Percent
- Deleted DataReceiverPort /Company/Components/ThrottlePositionMonitor/TPS_Secondary
- Deleted AssemblyConnector /Company/Components/ThrottlePositionControlComposition/TPS_SecondaryDTPS_PercentDMonitorDTPS_Secondary
- Deleted DelegationConnector /Company/Components/ThrottlePositionControlComposition/TPS2_HwIODDTPS_SecondaryDTPS_HwIO
- Deleted ComponentPrototype /Company/Components/ThrottlePositionControlComposition/TPS_Secondary
- Deleted DataReceiverPort /Company/Components/ThrottlePositionControlComposition/TPS2_HwIO

- 3 Examine the report.
 - a Verify that the `arxml` importer has updated the model content and configuration based on the `arxml` changes.
 - b Optionally, click **compare models** to compare the original model with the updated model. Tabular and graphical views of the differences open. You can click a changed element in the tabular view to navigate to a graphical view of the change.
 - c Optionally, use the **Find** field to search for a term. You can quickly navigate to specific elements or other strings of interest.
- 4 If the report lists required manual model changes, such as deleting a Simulink block, perform the required changes.

If you make a required change to the model, further configuration could be required to pass validation. To see if more manual model changes are required, repeat the update procedure, rerunning the `updateModel` function with the same `arxml` files.

For live-script update examples, see “Import AUTOSAR Component to Simulink” on page 3-24 and “Import AUTOSAR Composition to Simulink” on page 7-2.

AUTOSAR Update Report Section Examples

An `arxml` update operation generates an AUTOSAR Update Report in HTML format. The report displays change information in sections:

- “Automatic Model Changes” on page 3-34
- “Automatic Workspace Changes” on page 3-35
- “Required Manual Model Changes” on page 3-36
- “Automatic AUTOSAR Element Changes” on page 3-36

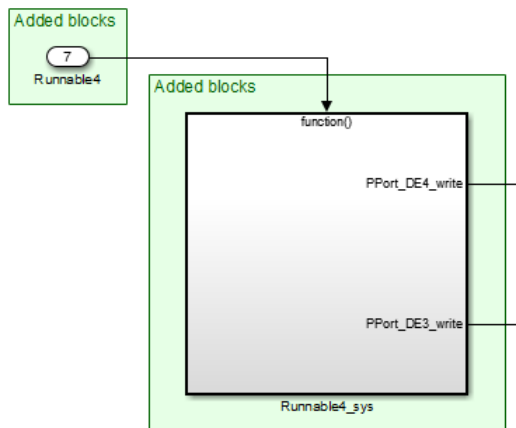
Automatic Model Changes

The AUTOSAR Update Report section **Automatic Model Changes** lists Simulink block additions, block property updates, and model parameter updates made by the importer. For example:

Automatic Model Changes

- Updated OutDataTypeStr of Outport [mySWC/Runnable3/TicToc_in](#) from Inherit: auto to int8
- Updated PortDimensions of Outport [mySWC/Runnable3/TicToc_in](#) from -1 to 1
- Updated SignalType of Outport [mySWC/Runnable3/TicToc_in](#) from auto to real
- Updated SamplingMode of Outport [mySWC/Runnable3/TicToc_in](#) from auto to Sample based
- Added SubSystem block [mySWC/Runnable4_sys](#)
- Added TriggerPort block [mySWC/Runnable4_sys/function](#)
- Added Inport block [mySWC/Runnable4](#)
- Added Outport block [mySWC/Runnable4_sys/PPort_DE4_write](#)
- Added Outport block [mySWC/Runnable4_sys/PPort_DE3_write](#)

In the updated model, green highlighting identifies added blocks.



Automatic Workspace Changes

The AUTOSAR Update Report section **Automatic Workspace Changes** lists Simulink data object additions and property updates made by the importer. For example:

Automatic Workspace Changes

- Added AUTOSAR.Parameter INC2
- Updated Value of AUTOSAR.Parameter INC from 1 to 2
- Updated DataType of AUTOSAR.Parameter INC from UInt8 to uint8

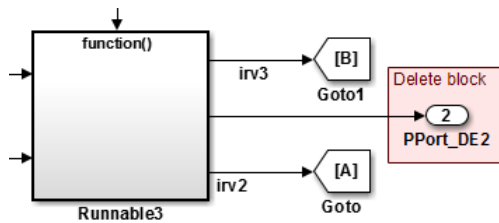
Required Manual Model Changes

The AUTOSAR Update Report section **Required Manual Model Changes** lists model changes, such as block deletions, that are required. For example:

Required Manual Model Changes

Delete Port [mySWC/PPort_DE2](#) from mySWC

In the updated model, red highlighting identifies the block to delete.



Automatic AUTOSAR Element Changes

The AUTOSAR Update Report section **Automatic AUTOSAR Element Changes** lists AUTOSAR element additions and property updates made by the importer. For example:

Automatic AUTOSAR Element Changes

- Added Runnable /pkg/swc/ASWC/IB/Runnable4
- Added TimingEvent /pkg/swc/ASWC/IB/Event
- Added InvData /pkg/swc/ASWC/IB/IRV5
- Added InvData /pkg/swc/ASWC/IB/IRV6
- Added ConstantSpecification /pkg/dt/Ground/INC2
- Added DataConstr /pkg/dt/DataConstrs/UInt8
- Added SwBaseType /pkg/dt/SwBaseTypes/uint8
- Updated SwCalibrationAccess of ParameterData /pkg/swc/ASWC/IB/INC from ReadOnly to ReadWrite
- Updated Value of LiteralReal /pkg/dt/Ground/INC/INC from 1.0 to 2.0
- Added DataConstr reference /pkg/dt/DataConstrs/UInt8 to /pkg/dt/UInt8
- Added SwBaseType reference /pkg/dt/SwBaseTypes/uint8 to /pkg/dt/UInt8
- Updated InternalBehaviorQualifiedNames of AUTOSAR XmlOptions from /pkg/swc/ASWC_ib to /pkg/swc/IB
- Updated InternalDataConstraintExport of AUTOSAR XmlOptions from false to true

See Also

updateModel

Related Examples

- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Component to Simulink” on page 3-24
- “Import AUTOSAR Composition to Simulink” on page 7-2
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “Workflows for AUTOSAR” on page 1-13

Round-Trip Preservation of AUTOSAR XML File Structure and Element Information

To support the round trip of AUTOSAR elements between an AUTOSAR authoring tool (AAT) and Simulink, `arxml` import preserves imported AUTOSAR XML file structure and content for `arxml` export. When you import `arxml` files for an AUTOSAR component into Simulink, the importer preserves:

- AUTOSAR XML file structure. You can compare the `arxml` files that you import with the corresponding `arxml` files that you export.
- AUTOSAR element information, including properties, references, and packages. The importer preserves relationships between elements.
- AUTOSAR UUIDs for identifiable elements. If an imported element does not have a UUID, none is created.

After import, you can view and configure AUTOSAR software component elements and properties in the AUTOSAR Dictionary. Use the AUTOSAR Dictionary to configure AUTOSAR elements. The properties that you modify are reflected in exported `arxml` descriptions and potentially in generated AUTOSAR-compliant C or C++ code. For more information, see “Configure AUTOSAR Elements and Properties” on page 4-8 or “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27.

AUTOSAR elements that you create in Simulink export to one or more `modelName*.arxml` files, which are separate from the imported XML files. You control the file packaging of new elements by configuring XML options in the AUTOSAR Dictionary. For example, you can set XML option **Exported XML file packaging** to `Single file` or `Modular`. For more information, see “Configure AUTOSAR XML Options” on page 4-63 or “Configure AUTOSAR Adaptive XML Options” on page 6-38.

When you export `arxml` files from a Simulink model, the code generator preserves the imported XML file structure, element information, and UUIDs, while applying your modifications. The exported files include:

- Updated versions of the same `arxml` files that you imported.
- One or more `modelName*.arxml` files, based on whether you set **Exported XML file packaging** to `Single file` or `Modular`. The `modelName*.arxml` files include:
 - Implementation descriptions.
 - If you added AUTOSAR interface or data-related elements in Simulink, interface and data descriptions.

- For the Adaptive Platform, manifests for AUTOSAR executables and service instances.

Suppose that, in a working folder, you create a Simulink model named `Controller.slx` from example arxml file `matlabroot/help/toolbox/autosar/examples/ThrottlePositionController.arxml`.

```
% Create Controller model from AUTOSAR component
addpath(fullfile(matlabroot, 'help', 'toolbox', 'autosar', 'examples'));
ar = arxml.importer('ThrottlePositionController.arxml');
createComponentAsModel(ar, '/Company/Components/Controller', 'ModelPeriodicRunnablesAs', 'AtomicSubsystem');
```

In the created model, add an AUTOSAR software address method (SwAddrMethod) named CODE and reference it from an AUTOSAR runnable function.

```
% In AUTOSAR model, add SwAddrMethod CODE to SwAddrMethods package
arProps = autosar.api.getAUTOSARProperties('Controller');
addPackageableElement(arProps, 'SwAddrMethod', ...
    '/AUTOSAR_Platform/SwAddrMethods', 'CODE', 'SectionType', 'Code')
% Map step runnable function to SwAddrMethod CODE
slMap = autosar.api.getSimulinkMapping('Controller');
mapFunction(slMap, 'StepFunction', 'Runnable_Step', 'SwAddrMethod', 'CODE')
% Display SwAddrMethod CODE path and step function mapping information
swAddrMethodPath = find(arProps, [], 'SwAddrMethod', 'PathType', 'FullyQualified', ...
    'SectionType', 'Code')
[arRunnableName, arRunnableSwAddrMethod] = getFunction(slMap, 'StepFunction')

swAddrMethodPath =
    {'/AUTOSAR_Platform/SwAddrMethods/CODE'}

arRunnableName =
    'Runnable_Step'

arRunnableSwAddrMethod =
    'CODE'
```

You can view the modifications in the AUTOSAR Dictionary, **SwAddrMethods** view, and the Code Mappings editor, **Functions** tab.

Build the model, for example, by using the command `rtwbuild('Controller')`. If the model has **Exported XML file packaging** set to Modular, the build exports three arxml files:

- `ThrottlePositionController.arxml` — Updated version of the arxml file from which the model was created. To track changes, you can compare earlier versions of an arxml file with the most recent exported version.
- `Controller_implementation.arxml` — Component implementation information (always generated).
- `Controller_datatype.arxml` — Data-related information that reflects your SwAddrMethod changes to the component model. In the file, AUTOSAR package / `AUTOSAR_Platform/SwAddrMethods` contains SwAddrMethod CODE.

See Also

Related Examples

- “Configure AUTOSAR XML Options” on page 4-63
- “Configure AUTOSAR Adaptive XML Options” on page 6-38

More About

- “Configure AUTOSAR Elements and Properties” on page 4-8
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27

Reuse AUTOSAR Element Descriptions

When developing an AUTOSAR software component in Simulink, you can reuse existing ARXML element definitions that are common to many components. For example, multiple product lines and teams might share elements such as interfaces and SwAddrMethods. Benefits of sharing and reusing AUTOSAR element definitions include lower risk of definition conflicts and easier code integration.

After you create an AUTOSAR component model, you can import shared definitions from ARXML files that are dedicated to describing AUTOSAR elements, not components. By default, the imported definitions are read-only, which prevents changes, but you can also import them as read/write. You can then reference the imported elements in your component model.

When you build the model, exported `arxml` code contains references to the shared elements. Their definitions remain in the element description `arxml` files from which you imported them. The element description files are exported with their names, file structure, and content preserved.

To set up and reuse AUTOSAR element definitions:

- 1 Create one or more `arxml` files containing definitions of AUTOSAR elements for components to share. Elements that are supported for reference use in Simulink include:
 - CompuMethod, Unit, and Dimension
 - ImplementationDataType and SwBaseType
 - ApplicationDataType
 - SwSystemConst, SwSystemConstValueSet, and PredefinedVariant
 - SwRecordLayout
 - SwAddrMethod
 - ClientServerInterface, SenderReceiverInterface, ModeSwitchInterface, NvDataInterface, ParameterInterface, and TriggerInterface.
- 2 For each component model that shares a set of definitions, use the `arxml.importer` function `updateAUTOSARProperties` to add the element definitions to the model. This example shows how to import definitions from shared descriptions file `SwAddrMethods.arxml` into example model `autosar_sw.c`.

```
addpath(fullfile(matlabroot, '/examples/autosarblockset'));
modelName = 'autosar_swC';
open_system(modelName);
ar = arxml.importer('SwAddrMethods.arxml');
updateAUTOSARProperties(ar, modelName);
```

Optionally, using property-value pairs, you can specify subsets of elements to import. For more information, see `updateAUTOSARProperties`.

The importer generates an HTML report that details the updates applied to the model.

AUTOSAR

Automatic AUTOSAR Element Changes

Added	Package /Company/Powertrain/SwAddrMethods
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/CODE
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/CALIB
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/CONST
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_NO_INIT
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_INIT
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_POWER_ON_CLEARED
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_CLEARED

When you import an element definition, its dependencies are also imported. For example, importing a `CompuMethod` definition also imports `Unit` and `PhysicalDimension` definitions. Importing an `ImplementationDataType` also imports a `SwBaseType` definition.

- 3 Your model can reference the imported elements in various ways. For example, you can select imported `SwAddrMethod` values for AUTOSAR data to group the data for measurement and calibration.
- 4 Generate model code. The exported `arxml` code contains references to the imported elements. The element description files from which you imported definitions are exported with their names, file structure, and content preserved.

[-] Interface files

[SwAddrMethods.arxml](#)

[rtwdemo_autosar_swc_component.arxml](#)

[rtwdemo_autosar_swc_datatype.arxml](#)

[rtwdemo_autosar_swc_implementation.arxml](#)

[rtwdemo_autosar_swc_interface.arxml](#)

See Also

updateAUTOSARProperties

Related Examples

- “Reuse AUTOSAR Elements in Component Model” on page 3-44

Reuse AUTOSAR Elements in Component Model

Import and reference AUTOSAR XML (arxml) element definitions

Add AUTOSAR Element Definitions to Model

When developing an AUTOSAR software component in Simulink, you can reuse existing arxml element definitions that are common to many components. After you create an AUTOSAR component model, you import the definitions from arxml files that are dedicated to describing AUTOSAR elements, not components. To help implement the component behavior, you want to reuse predefined elements such as interfaces and software address methods (SwAddrMethods).

Suppose that you are developing an AUTOSAR software component model. You want to import predefined SwAddrMethod elements that are shared by multiple product lines and teams. This example uses AUTOSAR importer function `updateAUTOSARProperties` to import definitions from shared descriptions file `SwAddrMethods.arxml` into example model `autosar_sw_c`.

```
modelName = 'autosar_sw_c';
open_system(modelName);
ar = arxml.importer('SwAddrMethods.arxml');
updateAUTOSARProperties(ar,modelName);

### Updating model autosar_sw_c
### Saving original model as autosar_sw_c_backup.slx
### Creating HTML report autosar_sw_c_update_report.html
```

The function copies the contents of the specified arxml files to the AUTOSAR Dictionary of the specified model and generates an HTML report listing the element additions.

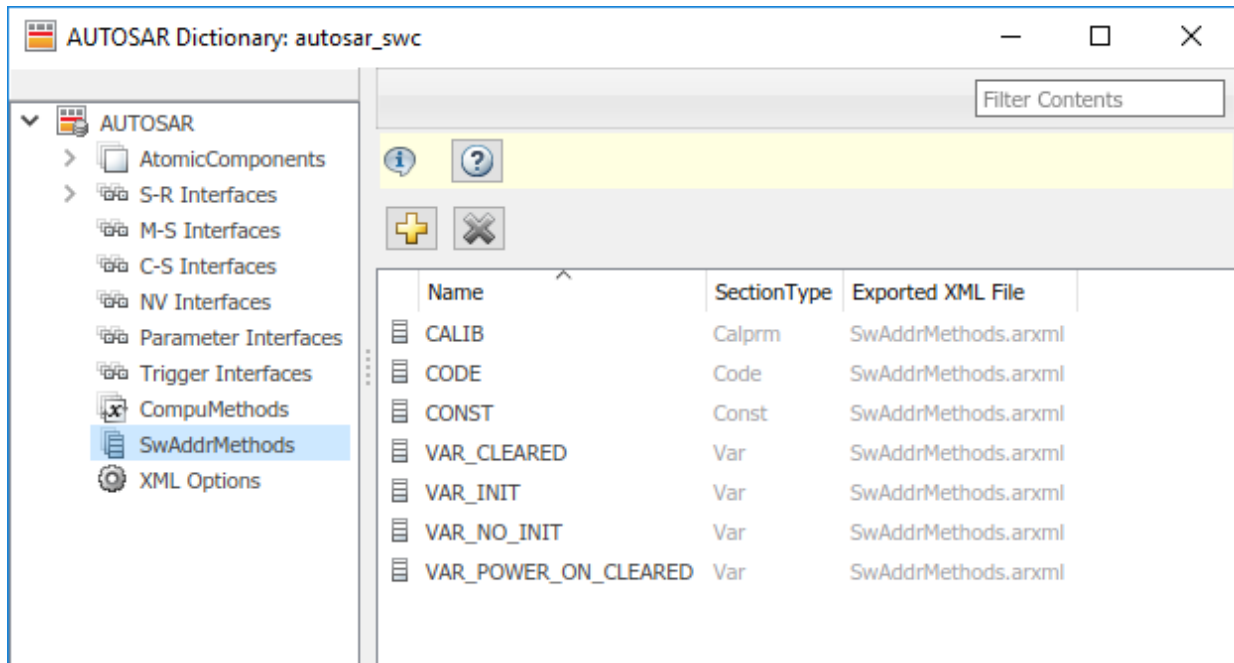
AUTOSAR

Automatic AUTOSAR Element Changes

Added	Package /Company/Powertrain/SwAddrMethods
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/CALIB
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_INIT
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/CONST
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_NO_INIT
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_POWER_ON_CLEARED
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/CODE
Added	SwAddrMethod /Company/Powertrain/SwAddrMethods/VAR_CLEARED

You can view the added elements as read-only elements in the AUTOSAR Dictionary.

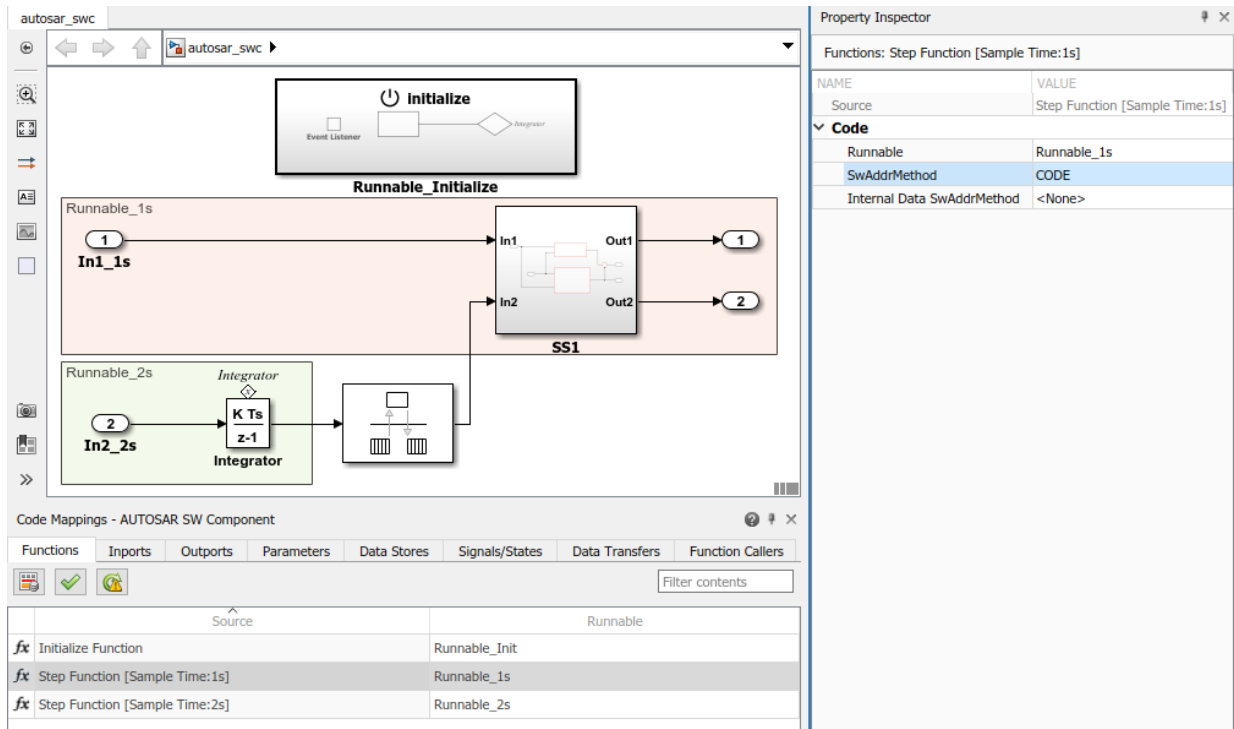
```
autosar_ui_launch(modelName);
```



Reference and Configure Imported AUTOSAR Elements

After importing the AUTOSAR elements to the software component model, you can reference and configure them in the same manner as any AUTOSAR Dictionary element. For example, use the AUTOSAR code perspective to apply imported SwAddrMethod definition CODE to a model entry-point function.

```
% Map step runnable function to SwAddrMethod CODE
slMap = autosar.api.getSimulinkMapping(modelName);
mapFunction(slMap, 'StepFunction', 'Runnable_1s', 'SwAddrMethod', 'CODE');
```



Generate AUTOSAR C Code and XML Descriptions (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, you can generate AUTOSAR-compliant C code and export arxml descriptions from the model. To build the model, enter the command `rtwbuild(modelName);`

Building the model generates an HTML code generation report. The C code contains a software address method CODE section.

```

/* SwAddrMethod CODE for Runnable */
#define ASWC_START_SEC_CODE
#include "ASWC_MemMap.h"

void Runnable_1s(void)                /* Sample time: [1.0s, 0.0s] */
{

```

```
}
```

```
#define ASWC_STOP_SEC_CODE  
#include "ASWC_MemMap.h"
```

The arxml descriptions define and reference SwAddrMethod CODE.

```
<RUNNABLE-ENTITY UUID="aee47805-d92a-5904-e77f-21f87869fd95">  
  <SHORT-NAME>Runnable_1</SHORT-NAME>  
  <MINIMUM-START-INTERVAL>0</MINIMUM-START-INTERVAL>  
  <SW-ADDR-METHOD-REF DEST="SW-ADDR-METHOD">/Company/Powertrain/SwAddrMethods/CODE</SW-ADDR-METHOD-REF>  
  <CAN-BE-INVOKED-CONCURRENTLY>false</CAN-BE-INVOKED-CONCURRENTLY>  
  
</RUNNABLE-ENTITY>
```

Export preserves the file structure and content of the shared descriptions file `SwAddrMethods.arxml` from which you added SwAddrMethod definitions.

[-] Interface files

- [SwAddrMethods.arxml](#)
- [rtwdemo_autosar_swc_component.arxml](#)
- [rtwdemo_autosar_swc_datatype.arxml](#)
- [rtwdemo_autosar_swc_implementation.arxml](#)
- [rtwdemo_autosar_swc_interface.arxml](#)

Related Links

- `updateAUTOSARProperties`
- “Reuse AUTOSAR Element Descriptions” on page 3-41
- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Software Component Updates” on page 3-31
- “AUTOSAR arxml Importer” on page 3-17

Limitations and Tips

The following limitations apply to AUTOSAR component creation.

In this section...
“Cannot Save Importer Objects in MAT-Files” on page 3-49
“ApplicationRecordDataType and ImplementationDataType Element Names Must Match” on page 3-49

Cannot Save Importer Objects in MAT-Files

If you try to save an `arxml.importer` object in a MAT-file, you lose the AUTOSAR information. If you reload the MAT-file, then the object is null (`handle = -1`), because of the Java® objects that compose the `arxml.importer` object.

ApplicationRecordDataType and ImplementationDataType Element Names Must Match

The element name of an imported `ApplicationRecordDataType` must match the element name of the corresponding `ImplementationDataType`. For example, if an imported `ApplicationRecordDataType` has element `PVAL_1` and the corresponding `ImplementationDataType` has element `IPVAL_1`, the software flags the mismatch and instructs you to rename the elements to match.

AUTOSAR Component Development

- “AUTOSAR Component Configuration” on page 4-3
- “Configure AUTOSAR Elements and Properties” on page 4-8
- “Map AUTOSAR Elements for Code Generation” on page 4-69
- “Map Calibration Data for Submodels Referenced from AUTOSAR Component Models” on page 4-86
- “Incrementally Update AUTOSAR Mapping After Model Changes” on page 4-99
- “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103
- “Configure AUTOSAR Packages” on page 4-111
- “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123
- “Configure AUTOSAR Sender-Receiver Communication” on page 4-126
- “Configure AUTOSAR Queued Sender-Receiver Communication” on page 4-145
- “Configure AUTOSAR Client-Server Communication” on page 4-171
- “Configure AUTOSAR Mode-Switch Communication” on page 4-199
- “Configure AUTOSAR Nonvolatile Data Communication” on page 4-208
- “Configure Receiver for AUTOSAR Parameter Communication” on page 4-211
- “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214
- “Configure AUTOSAR Ports By Using Simulink Bus Ports” on page 4-219
- “Configure AUTOSAR Runnables and Events” on page 4-224
- “Configure AUTOSAR Runnable Execution Order By Using Schedule Editor” on page 4-228
- “Configure AUTOSAR Initialize, Reset, or Terminate Runnables” on page 4-232
- “Add Top-Level Asynchronous Trigger to Periodic Rate-Based System” on page 4-239
- “Configure AUTOSAR Initialization Runnable (R4.1)” on page 4-242
- “Configure Disabled Mode for AUTOSAR Runnable Event” on page 4-245
- “Configure AUTOSAR Per-Instance Memory” on page 4-246

- “Configure AUTOSAR Static Memory” on page 4-251
- “Configure AUTOSAR Constant Memory” on page 4-256
- “Configure AUTOSAR Shared or Per-Instance Parameters” on page 4-259
- “Configure Variants for AUTOSAR Ports and Runnables” on page 4-265
- “Configure Variants for AUTOSAR Runnable Implementations” on page 4-269
- “Export Variation Points for AUTOSAR Calibration Data” on page 4-272
- “Configure Variants for AUTOSAR Array Sizes” on page 4-275
- “Control AUTOSAR Variants with Predefined Value Combinations” on page 4-277
- “Configure Parameters and Signals for AUTOSAR Calibration and Measurement” on page 4-280
- “Configure AUTOSAR Data for Measurement and Calibration” on page 4-284
- “Configure Lookup Tables for AUTOSAR Measurement and Calibration” on page 4-298
- “Configure AUTOSAR CompuMethods” on page 4-311
- “Configure AUTOSAR Internal Data Constraints Export” on page 4-324
- “Configure AUTOSAR Release 4.x Data Types” on page 4-326
- “Automatic AUTOSAR Data Type Generation” on page 4-330
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332
- “AUTOSAR Property and Map Function Examples” on page 4-340
- “Limitations and Tips” on page 4-363

AUTOSAR Component Configuration

After you create an AUTOSAR software component model in Simulink, use the Code Mappings editor and the AUTOSAR Dictionary to further develop the AUTOSAR component. The Code Mappings editor and the AUTOSAR Dictionary provide mapping and properties views of the component model, which can be used separately and together to configure the AUTOSAR component:

- Code Mappings editor — Using a tabbed table format, displays entry-point functions, inports, outports, and other Simulink elements relevant to your AUTOSAR platform. Use this view to map model elements to AUTOSAR component elements from a Simulink model perspective.
- AUTOSAR Dictionary — Using a tree format, displays a mapped AUTOSAR component and its elements, communication interfaces, computation methods, software address methods, and XML options. Use this view to configure AUTOSAR elements from an AUTOSAR component perspective.

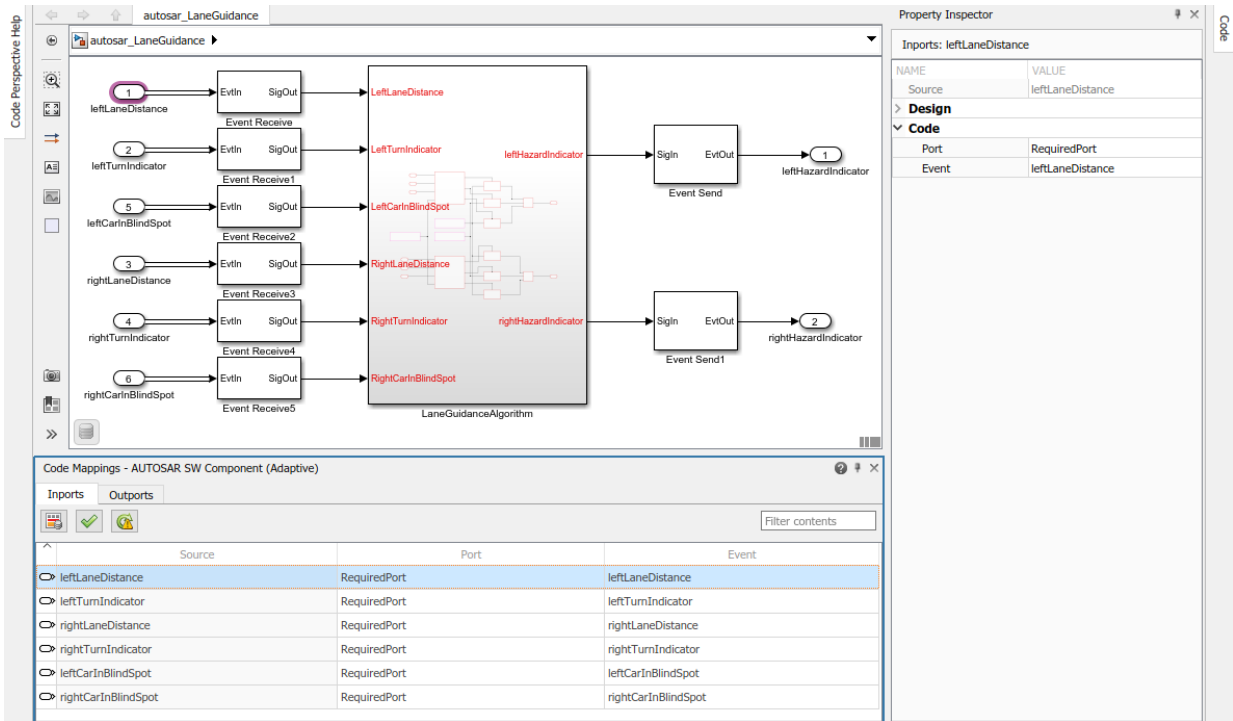
Alternatively, you can configure AUTOSAR mapping and properties programmatically. See “Configure and Map AUTOSAR Component Programmatically” on page 4-332.

In a model for which an AUTOSAR system target file (`autosar.tlc` or `autosar_adaptive.tlc`) is selected, create or open a mapped view of the AUTOSAR model. In the model window, do one of the following:


- From the **Apps** tab, open the AUTOSAR Component Designer app.
- Click the perspective control in the lower-right corner and select **Code**.

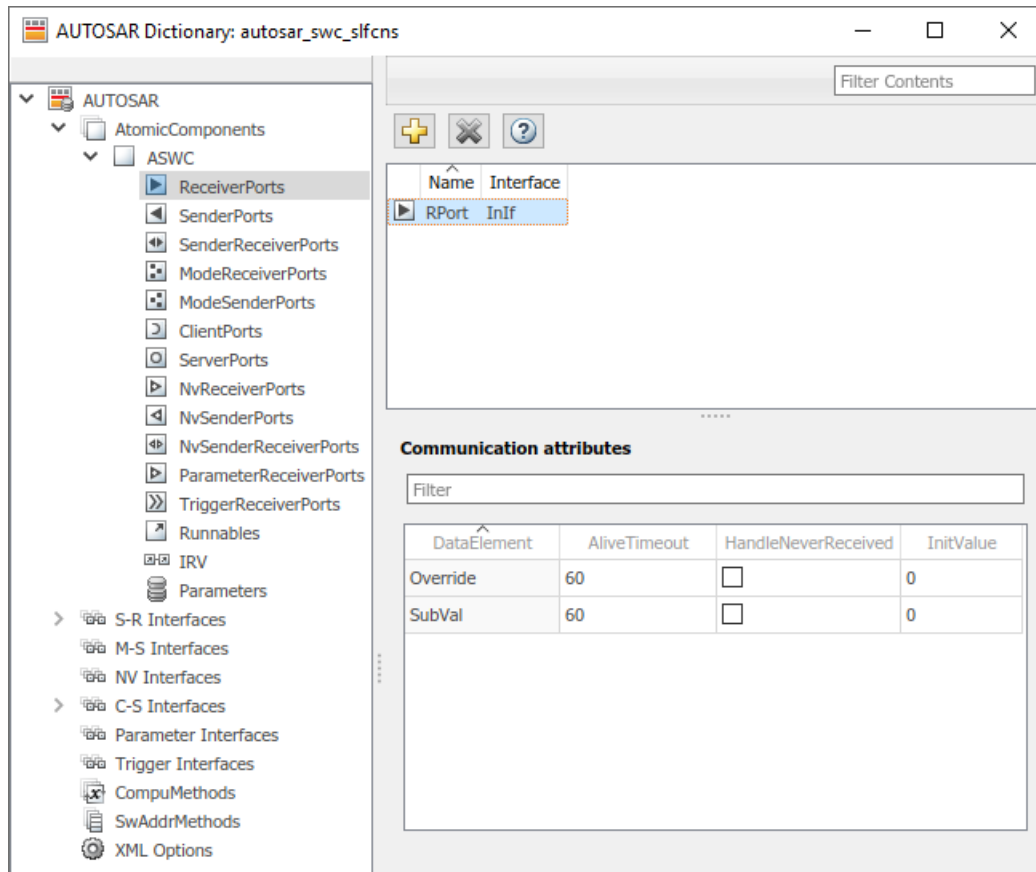
If the model has not yet been mapped to an AUTOSAR software component, the AUTOSAR Component Quick Start opens. To configure the model for AUTOSAR component development, work through the quick-start procedure and click **Finish**. For more information, see “Create Mapped AUTOSAR Component with Quick Start” on page 3-2.

The model opens in the AUTOSAR code perspective. This perspective displays a help panel, a Property Inspector dialog box, and, directly under the model, the Code Mappings editor. Here are the perspectives for the Classic and Adaptive Platforms.




The Code Mappings editor provides in-canvas access to AUTOSAR mapping information, with batch editing, element filtering, easy navigation to model elements and AUTOSAR properties, and model element traceability.

To open an AUTOSAR properties view of the component model, either click the **AUTOSAR Dictionary** button  in the Code Mappings editor or, in the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**. The AUTOSAR Dictionary opens.



As you progressively configure the model representation of the AUTOSAR component, you can:

- Freely switch between the Simulink and AUTOSAR perspectives, by selecting **AUTOSAR** tab menu entries or by clicking buttons.
- Use the **Filter contents** field (where available) to selectively display some elements, while omitting others, in the current view.
- In the Code Mappings editor, click the **Update** button  to update the Simulink to AUTOSAR mapping of the model with changes to Simulink entry-point functions, data transfers, and function callers.

- In the Code Mappings editor, click the **Validate** button  to validate the AUTOSAR component configuration.

See Also

Related Examples

- “Map AUTOSAR Elements for Code Generation” on page 4-69
- “Configure AUTOSAR Elements and Properties” on page 4-8
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332

Configure AUTOSAR Elements and Properties

In Simulink, you can use the AUTOSAR Dictionary and the Code Mappings editor separately or together to graphically configure an AUTOSAR software component and map Simulink model elements to AUTOSAR component elements. For more information, see “AUTOSAR Component Configuration” on page 4-3.

Use the AUTOSAR Dictionary to configure AUTOSAR elements from an AUTOSAR perspective. Using a tree format, the AUTOSAR Dictionary displays a mapped AUTOSAR component and its elements, communication interfaces, computation methods, software address methods, and XML options. Use the tree to select AUTOSAR elements and configure their properties. The properties that you modify are reflected in exported `arxml` descriptions and potentially in generated AUTOSAR-compliant C code.

In this section...

“AUTOSAR Elements Configuration Workflow” on page 4-8

“Configure AUTOSAR Atomic Software Components” on page 4-11

“Configure AUTOSAR Ports” on page 4-14

“Configure AUTOSAR Runnables” on page 4-29

“Configure AUTOSAR Inter-Runnable Variables” on page 4-35

“Configure AUTOSAR Parameters” on page 4-36

“Configure AUTOSAR Communication Interfaces” on page 4-38

“Configure AUTOSAR Computation Methods” on page 4-58

“Configure AUTOSAR SwAddrMethods” on page 4-61

“Configure AUTOSAR XML Options” on page 4-63

AUTOSAR Elements Configuration Workflow


To configure AUTOSAR component elements for the Classic Platform in Simulink:

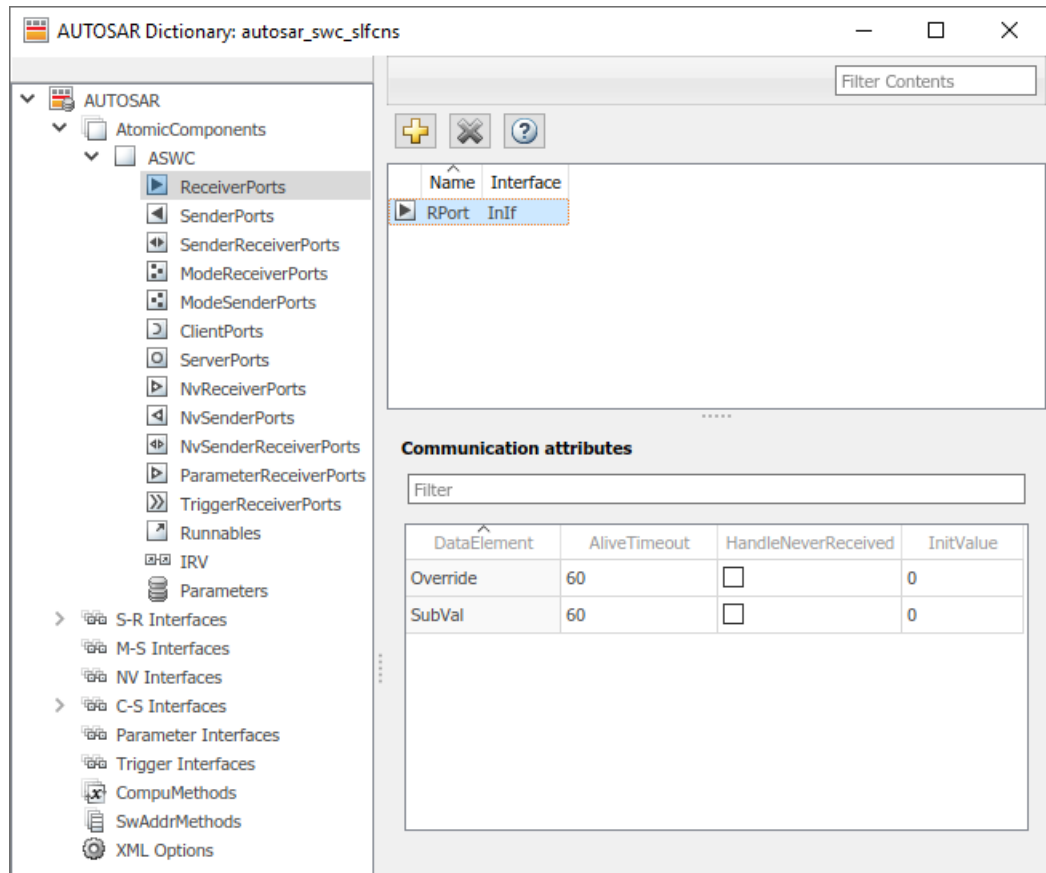
- 1 Open a model for which AUTOSAR system target file `autosar.tlc` is selected.
- 2 Create or open a mapped view of the AUTOSAR model. In the model window, do one of the following:
 - From the **Apps** tab, open the AUTOSAR Component Designer app.


- Click the perspective control in the lower-right corner and select **Code**.

If the model has not yet been mapped to an AUTOSAR software component, the AUTOSAR Component Quick Start opens. Work through the quick-start procedure and click **Finish**. For more information, see “Create Mapped AUTOSAR Component with Quick Start” on page 3-2.

The model opens in the AUTOSAR code perspective. This perspective displays a help panel, a Property Inspector dialog box, and, directly under the model, the Code Mappings editor.

- 3** Open the AUTOSAR Dictionary. Either click the **AUTOSAR Dictionary** button  in the Code Mappings editor or, in the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**.



- 4 To configure AUTOSAR elements and properties, navigate the AUTOSAR Dictionary tree. You can add elements, remove elements, or select elements to view and modify their properties. Use the **Filter Contents** field (where available) to selectively display some elements, while omitting others, in the current view.
- 5 After configuring AUTOSAR elements and properties, open the Code Mappings editor. Use the Code Mapping tabs to map Simulink elements to new or modified AUTOSAR elements.
- 6 Click the **Validate** button  to validate the AUTOSAR component configuration. If errors are reported, address them and then retry validation.

Configure AUTOSAR Atomic Software Components

AUTOSAR atomic software components contain AUTOSAR elements defined in the AUTOSAR standard, such as ports, runnables, inter-runnable variables (IRVs), and parameters. In the AUTOSAR Dictionary, component elements appear in a tree format under the component that owns them. To access component elements and their properties, you expand the component name.


Use AUTOSAR Dictionary to configure elements and properties of AUTOSAR software components.

Tips

To view or configure atomic components, go to:	AtomicComponents
To view or configure sender-receiver interfaces, go to:	S-R Interfaces
To view or configure mode-switch interfaces, go to:	M-S Interfaces
To view or configure client-server interfaces, go to:	C-S Interfaces
To view or configure nonvolatile data interfaces, go to:	NV Interfaces
To view or configure parameter interfaces, go to:	Parameter Interfaces
To view or configure trigger interfaces, go to:	Trigger Interfaces
To view or configure CompuMethods, go to:	CompuMethods
To view or configure SwAddrMethods, go to:	SwAddrMethods
To view or configure ARXML options, go to:	XML Options

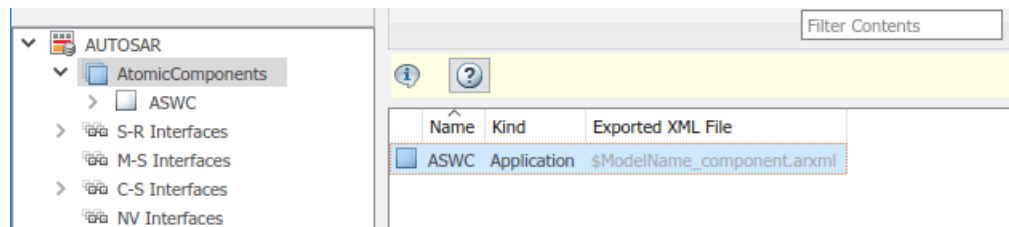
To configure AUTOSAR atomic software component elements and properties:

- 1 Open a model for which a mapped AUTOSAR software component has been created. For more information, see “Component Creation”.
- 2 From the **Apps** tab, open the AUTOSAR Component Designer app.

- 3 Open the AUTOSAR Dictionary. Either click the **AUTOSAR Dictionary** button  in the Code Mappings editor or, in the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**.
- 4 In the leftmost pane of the AUTOSAR Dictionary, under **AUTOSAR**, select **AtomicComponents**.

The atomic components view in the AUTOSAR Dictionary displays atomic components and their types. You can:

- Select an AUTOSAR component and select a menu value for its kind (that is, its atomic software component type):
 - **Application** for application component
 - **ComplexDeviceDriver** for complex device driver component
 - **EcuAbstraction** for ECU abstraction component
 - **SensorAccuator** for sensor or actuator component
 - **ServiceProxy** for service proxy component
- Rename an AUTOSAR component by clicking its name and then editing the name text.



- 5 In the leftmost pane of the AUTOSAR Dictionary, expand **AtomicComponents** and select an AUTOSAR component.

The component view in the AUTOSAR Dictionary displays the name and type of the selected component, and component options for a `arxml` file export. You can:

- Modify the internal behavior qualified name to be generated for the component. Specify an AUTOSAR package path and a name.
- Modify the implementation qualified name to be generated for the component. Specify an AUTOSAR package path and a name.

- Modify the AUTOSAR package to be generated for the component. To specify the AUTOSAR package path, you can do either of the following:
 - Enter a package path in the **Package** parameter field. Package paths can use an organizational naming pattern, such as /CompanyName/Powertrain.
 - Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the component **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.

For more information about component XML options, see “Configure AUTOSAR Packages” on page 4-111.

The screenshot displays the AUTOSAR configuration interface. On the left, a tree view shows the component structure under 'AUTOSAR', with 'AtomicComponents' expanded to show 'ASWC'. Below the tree are various interface categories like S-R, M-S, C-S, NV, Parameter, and Trigger Interfaces, along with CompuMethods, SwAddrMethods, and XML Options.

The main configuration area for the 'ASWC' component is shown on the right. It contains the following information:

- Component Name:** ASWC
- Component Type:** Application

Below this information is a 'Tips' section with the text: "To view or configure software component elements, expand the 'ASWC' component tree."

The 'Component XML Options' section includes three input fields:

- Internal Behavior Qualified Name:** /Company/Powertrain/Components/ASWC_IB
- Implementation Qualified Name:** /Company/Powertrain/SwcImplementations/ASWC_Impl
- Package:** /Company/Powertrain/Components (with a button to open the package browser)

Configure AUTOSAR Ports

An AUTOSAR software component contains communication ports defined in the AUTOSAR standard, including sender-receiver (S-R), client-server (C-S), mode-switch (M-S), nonvolatile (NV) data, trigger, and parameter interfaces. In the AUTOSAR Dictionary, communication ports appear in a tree format under the component that owns them and under a port type name. To access port elements and their properties, you expand the component name and expand the port type name.

- “Sender-Receiver Ports” on page 4-14
- “Mode-Switch Ports” on page 4-18
- “Client-Server Ports” on page 4-20
- “Nonvolatile Data Ports” on page 4-23
- “Parameter Receiver Ports” on page 4-27
- “Trigger Receiver Ports” on page 4-28

Sender-Receiver Ports

The AUTOSAR Dictionary views of sender and receiver ports support modeling AUTOSAR sender-receiver (S-R) communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR S-R ports, S-R interfaces, and S-R data elements in your model. For more information, see “Configure AUTOSAR Sender-Receiver Communication” on page 4-126 and “Configure AUTOSAR Queued Sender-Receiver Communication” on page 4-145.



To configure AUTOSAR S-R port elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

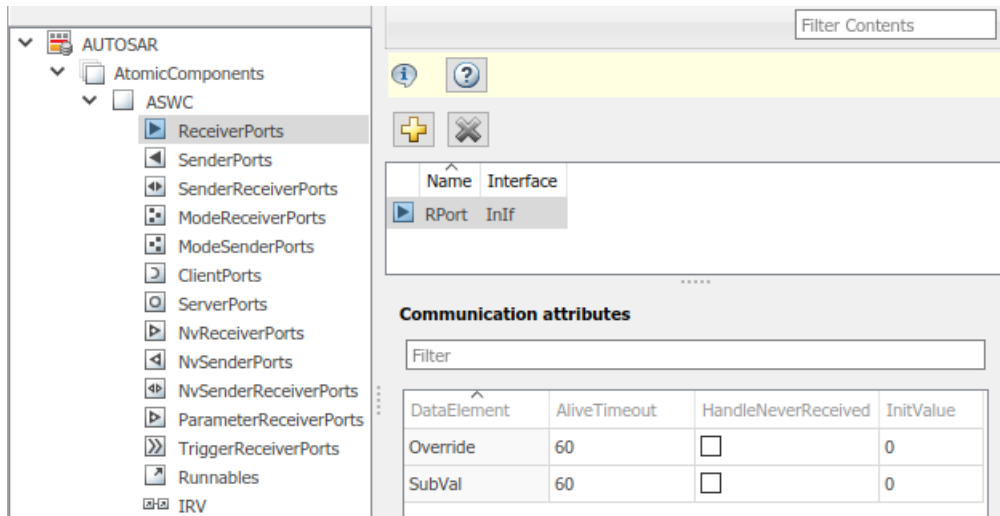
- 1 In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **ReceiverPorts**.

The receiver ports view in the AUTOSAR Dictionary lists receiver ports and their properties. You can:

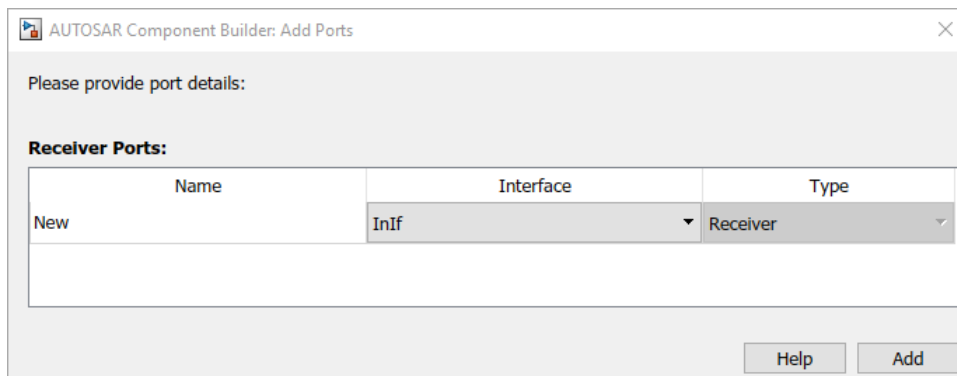
- Select an AUTOSAR receiver port, and view and optionally reselect its associated S-R interface.
- Rename an AUTOSAR receiver port by clicking its name and then editing the name text.
- When you select a port that is configured for `QueuedExplicitReceive` data access, the AUTOSAR Dictionary displays additional port communication

specification (ComSpec) attributes. For AUTOSAR receiver ports, you can modify ComSpec attributes `AliveTimeout`, `HandleNeverReceived`, and `InitValue`. For more information, see “Configure AUTOSAR Sender-Receiver Port ComSpecs” on page 4-141.

- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.





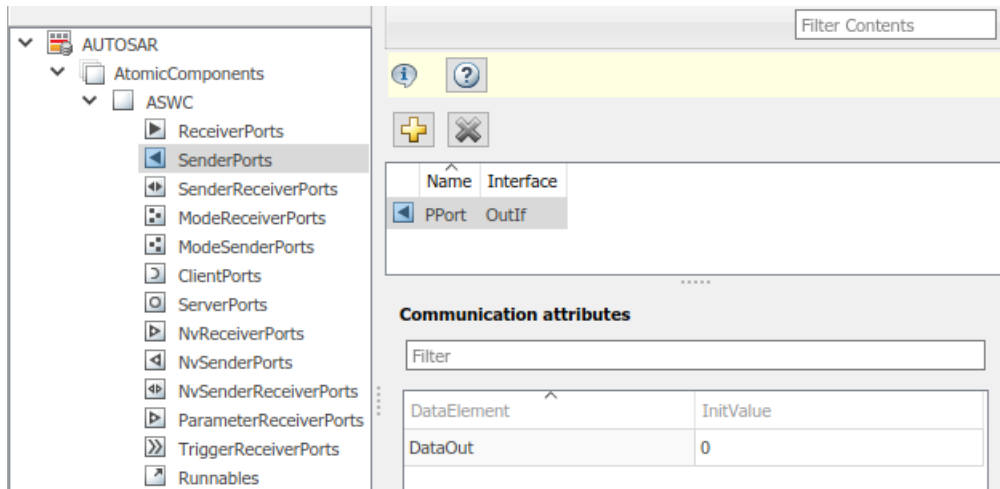
The Add Ports dialog box lets you add a receiver port and associate it with an existing S-R interface. To add the port and return to the receiver ports view, click **Add**.



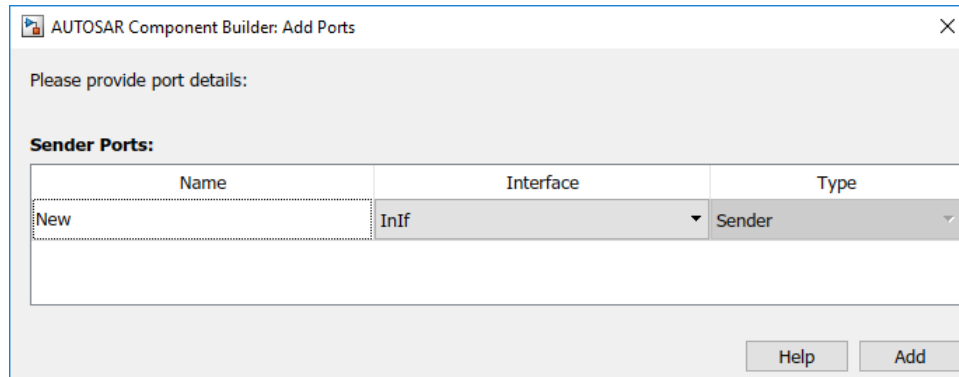
- 2 In the leftmost pane of the AUTOSAR Dictionary, select **SenderPorts**.

The sender ports view in the AUTOSAR Dictionary lists sender ports and their properties. You can:

- Select an AUTOSAR sender port, and view and optionally reselect its associated S-R interface.
- Rename an AUTOSAR sender port by clicking its name and then editing the name text.
- When you select a port that is configured for QueuedExplicitSend data access, the AUTOSAR Dictionary displays additional port communication specification (ComSpec) attributes. For AUTOSAR sender ports, you can modify ComSpec attribute `InitValue`. For more information, see “Configure AUTOSAR Sender-Receiver Port ComSpecs” on page 4-141.
- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.





The Add Ports dialog box lets you add a sender port and associate it with an existing S-R interface. Click **Add** to add the port and return to the sender ports view.

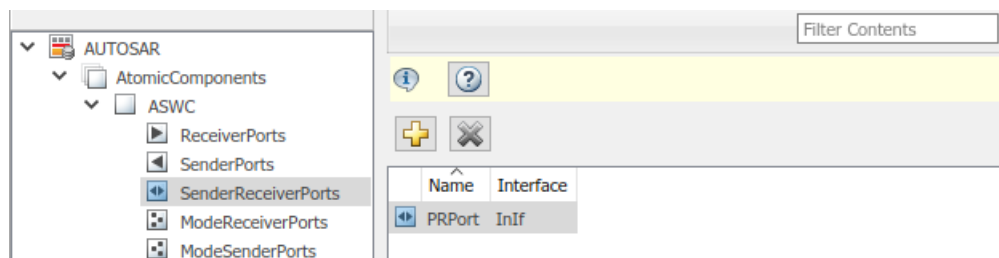


- 3 In the leftmost pane of the AUTOSAR Dictionary, select **SenderReceiverPorts**.

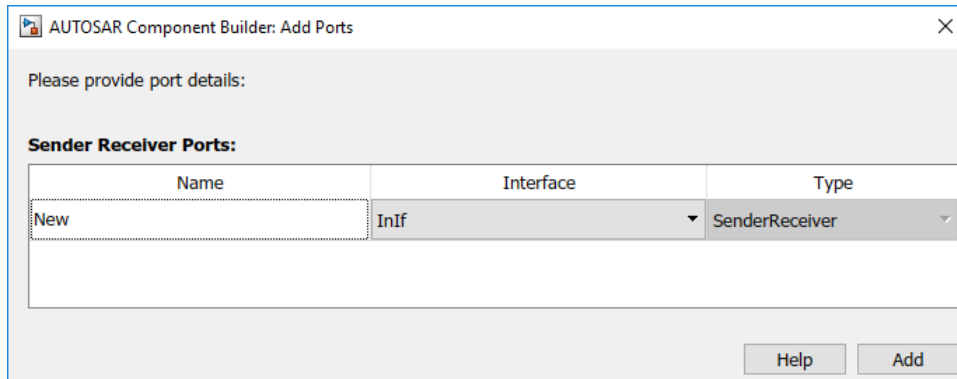
The sender-receiver ports view in the AUTOSAR Dictionary lists sender-receiver ports and their properties. You can:

- Select an AUTOSAR sender-receiver port, and view and optionally reselect its associated S-R interface.
- Rename an AUTOSAR sender-receiver port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.

Note AUTOSAR sender-receiver ports require AUTOSAR schema version 4.1 or higher. To select a schema version for the model, go to **AUTOSAR Code Generation Options** (Embedded Coder) in the Configuration Parameters dialog box.



The Add Ports dialog box lets you add a sender-receiver port and associate it with an existing S-R interface. Click **Add** to add the port and return to the sender-receiver ports view.




Mode-Switch Ports

The AUTOSAR Dictionary views of mode sender and receiver ports support modeling AUTOSAR mode-switch (M-S) communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR M-S ports and M-S interfaces in your model. For more information, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.

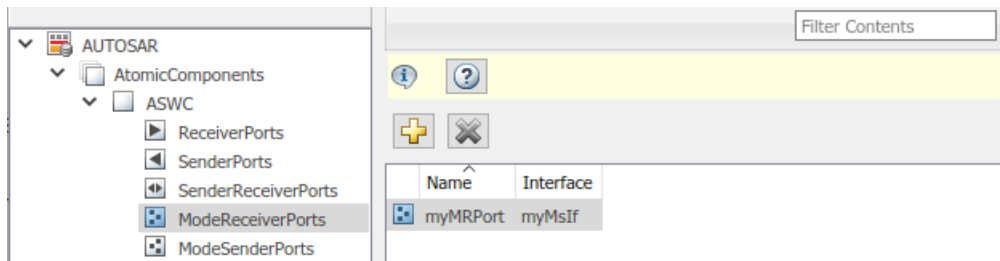
To configure AUTOSAR M-S port elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

- 1 In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **ModeReceiverPorts**.

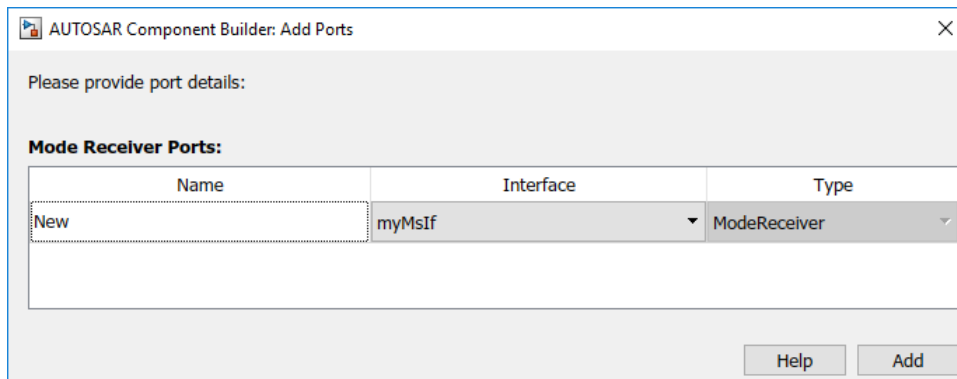
The mode receiver ports view in the AUTOSAR Dictionary lists mode receiver ports and their properties. You can:

- Select an AUTOSAR mode receiver port, and view and optionally reselect its associated M-S interface.
- Rename an AUTOSAR mode receiver port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.

- Select a port and then click the **Delete** button  to remove it.




The Add Ports dialog box lets you add a mode receiver port and associate it with an existing M-S interface. If an M-S interface does not exist in the component, you must create one before adding the port. Click **Add** to add the port and return to the mode receiver ports view.

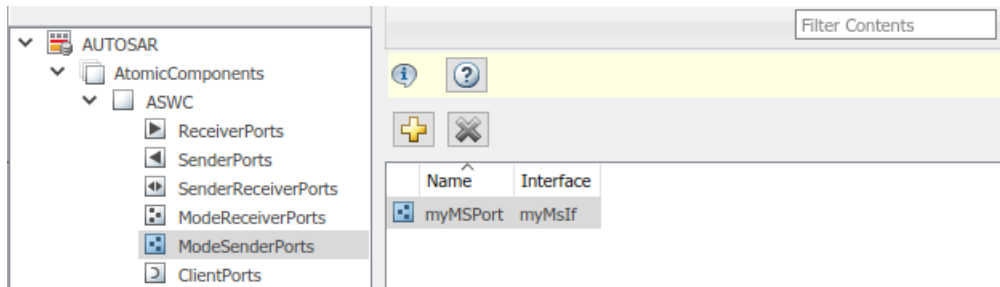


- 2 In the leftmost pane of the AUTOSAR Dictionary, select **ModeSenderPorts**.

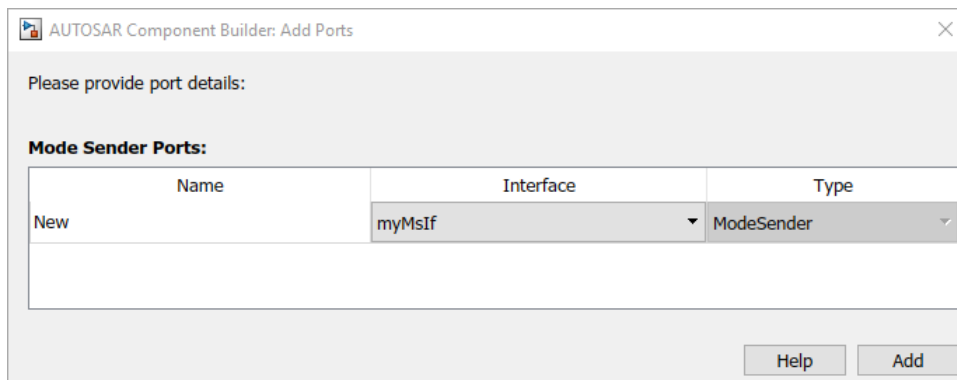
The mode sender ports view in the AUTOSAR Dictionary lists mode sender ports and their properties. You can:

- Select an AUTOSAR mode sender port, and view and optionally reselect its associated M-S interface.
- Rename an AUTOSAR mode sender port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.

- Select a port and then click the **Delete** button  to remove it.



The Add Ports dialog box lets you add a mode sender port and associate it with an existing M-S interface. If an M-S interface does not exist in the component, you must create one before adding the port. Click **Add** to add the port and return to the mode sender ports view.





Client-Server Ports

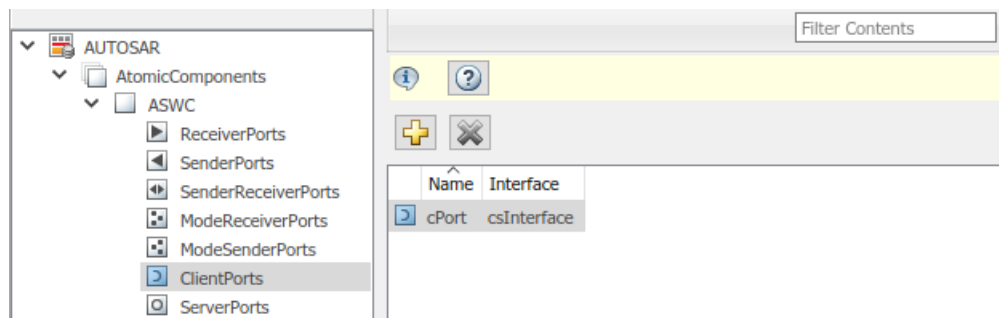
The AUTOSAR Dictionary views of client and server ports support modeling AUTOSAR client-server (C-S) communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR C-S ports, C-S interfaces, and C-S operations in your model. For more information, see “Configure AUTOSAR Client-Server Communication” on page 4-171.

To configure AUTOSAR C-S port elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

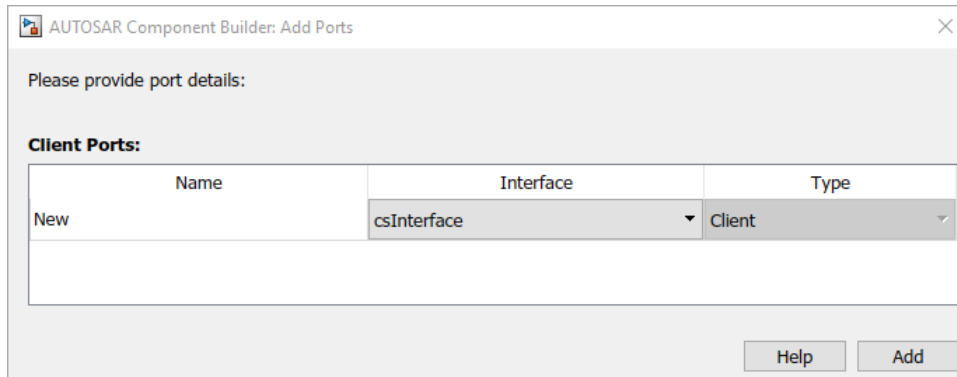
- 1 In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **ClientPorts**.

The client ports view in the AUTOSAR Dictionary lists client ports and their properties. You can:

- Select an AUTOSAR client port, and view and optionally reselect its associated C-S interface.
- Rename an AUTOSAR client port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a client port.
- Select a port and then click the **Delete** button  to remove it.





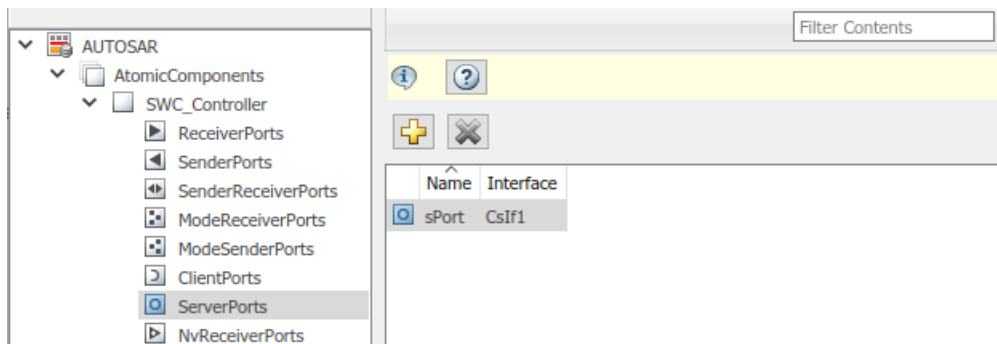
The Add Ports dialog box lets you add a client port and associate it with an existing C-S interface. If a C-S interface does not exist in the component, you must create one before adding the port. Click **Add** to add the port and return to the client ports view.



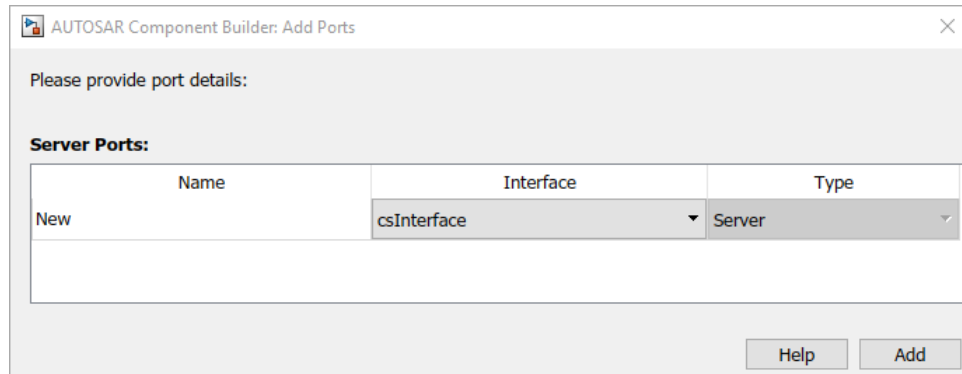
- 2 In the leftmost pane of the AUTOSAR Dictionary, select **ServerPorts**.

The server ports view in the AUTOSAR Dictionary lists server ports and their properties. You can:

- Select an AUTOSAR server port, and view and optionally reselect its associated C-S interface.
- Rename an AUTOSAR server port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a server port.
- Select a port and then click the **Delete** button  to remove it.



The Add Ports dialog box lets you add a server port and associate it with an existing C-S interface. If a C-S interface does not exist in the component, you must create one before adding the port. Click **Add** to add the port and return to the server ports view.





Nonvolatile Data Ports

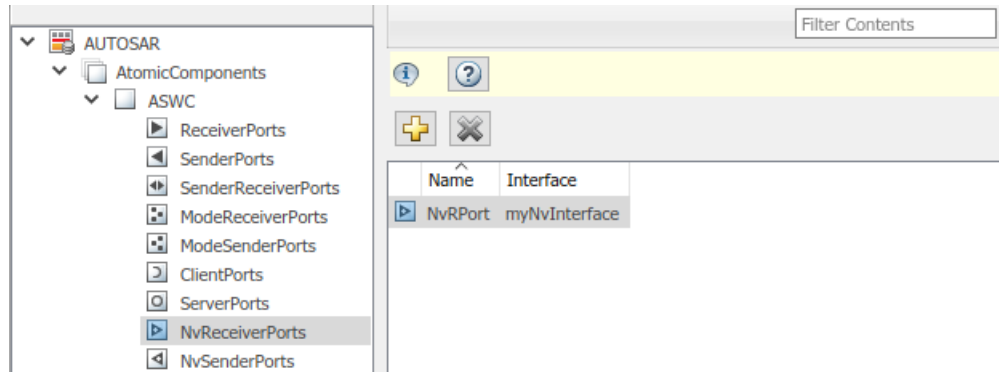
The AUTOSAR Dictionary views of nonvolatile (NV) sender and receiver ports support modeling AUTOSAR NV data communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR NV ports, NV interfaces, and NV data elements in your model. For more information, see “Configure AUTOSAR Nonvolatile Data Communication” on page 4-208.

To configure AUTOSAR NV port elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

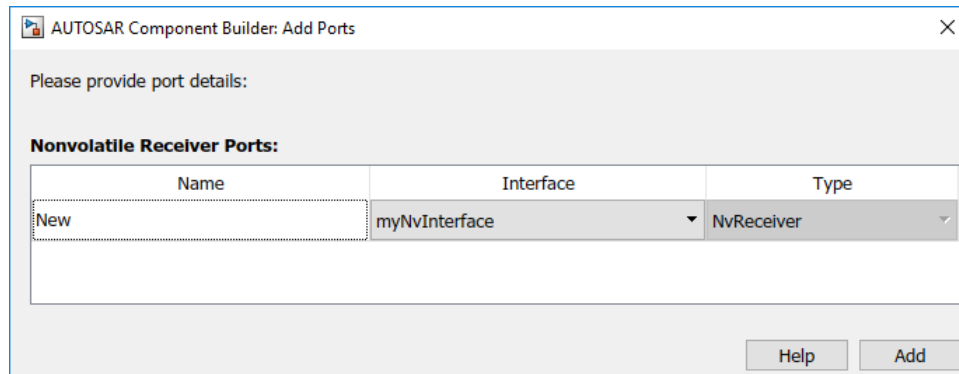
- 1 In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **NvReceiverPorts**.

The NV receiver ports view in the AUTOSAR Dictionary lists NV receiver ports and their properties. You can:

- Select an AUTOSAR NV receiver port, and view and optionally reselect its associated NV data interface.
- Rename an AUTOSAR NV receiver port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.




The Add Ports dialog box lets you add an NV receiver port and associate it with an existing NV interface. Click **Add** to add the port and return to the NV receiver ports view.

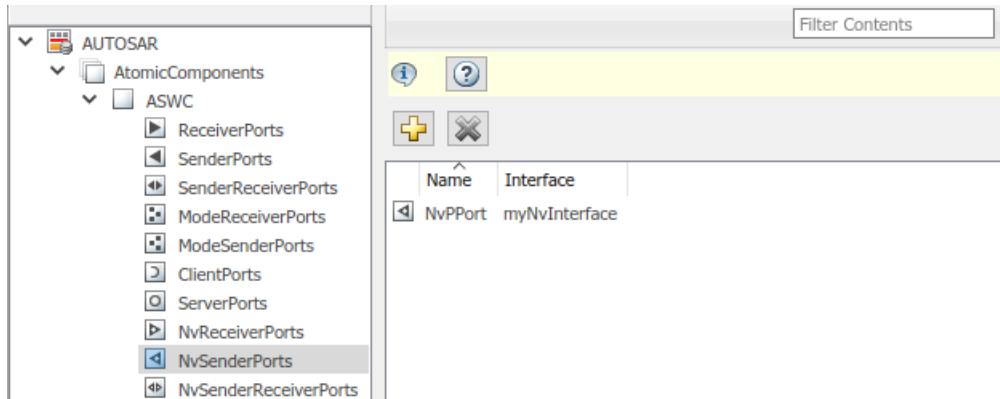


- 2 In the leftmost pane of the AUTOSAR Dictionary, select **NvSenderPorts**.

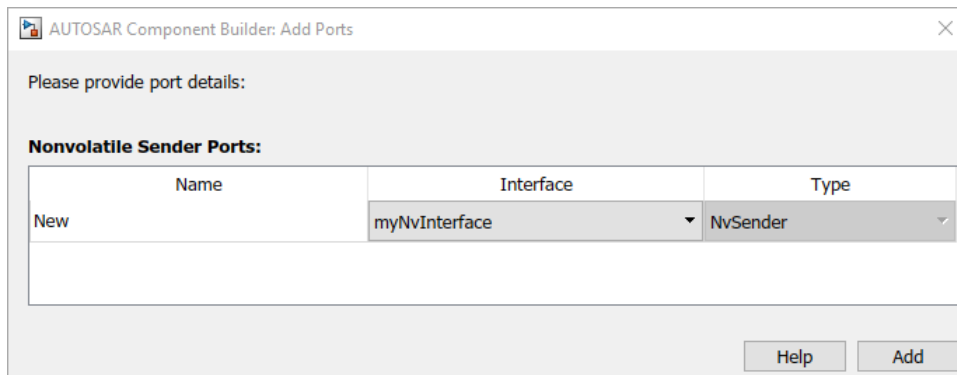
The NV sender ports view in the AUTOSAR Dictionary lists NV sender ports and their properties. You can:

- Select an AUTOSAR NV sender port, and view and optionally reselect its associated NV data interface.
- Rename an AUTOSAR NV sender port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.

- Select a port and then click the **Delete** button  to remove it.





The Add Ports dialog box lets you add an NV sender port and associate it with an existing NV interface. Click **Add** to add the port and return to the NV sender ports view.



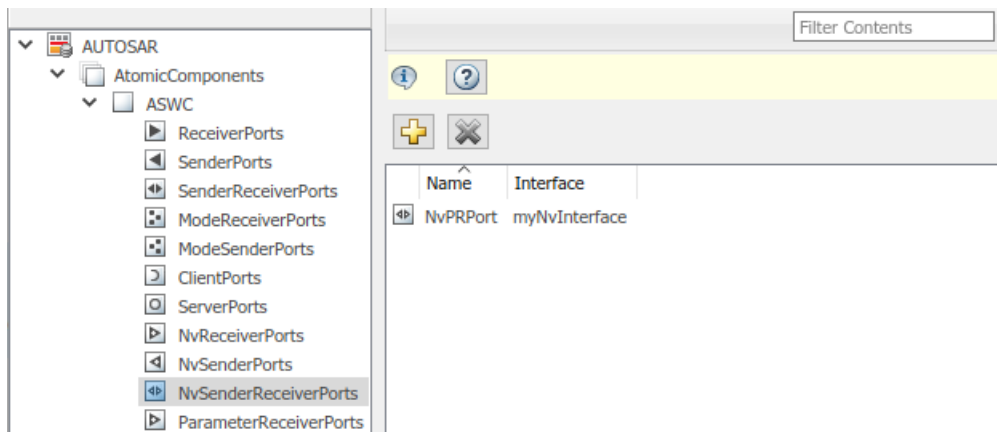
- 3 In the leftmost pane of the AUTOSAR Dictionary, select **NvSenderReceiverPorts**.

The NV sender-receiver ports view in the AUTOSAR Dictionary lists NV sender-receiver ports and their properties. You can:

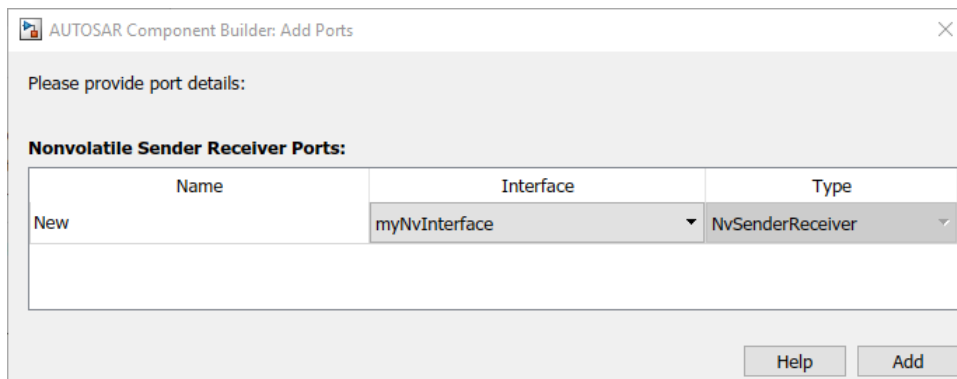
- Select an AUTOSAR NV sender-receiver port, and view and optionally reselect its associated NV data interface.
- Rename an AUTOSAR NV sender-receiver port by clicking its name and then editing the name text.

- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.

Note AUTOSAR NV sender-receiver ports require AUTOSAR schema version 4.1 or higher. To select a schema version for the model, go to **AUTOSAR Code Generation Options** (Embedded Coder) in the Configuration Parameters dialog box.



The Add Ports dialog box lets you add an NV sender-receiver port and associate it with an existing NV interface. Click **Add** to add the port and return to the NV sender-receiver ports view.





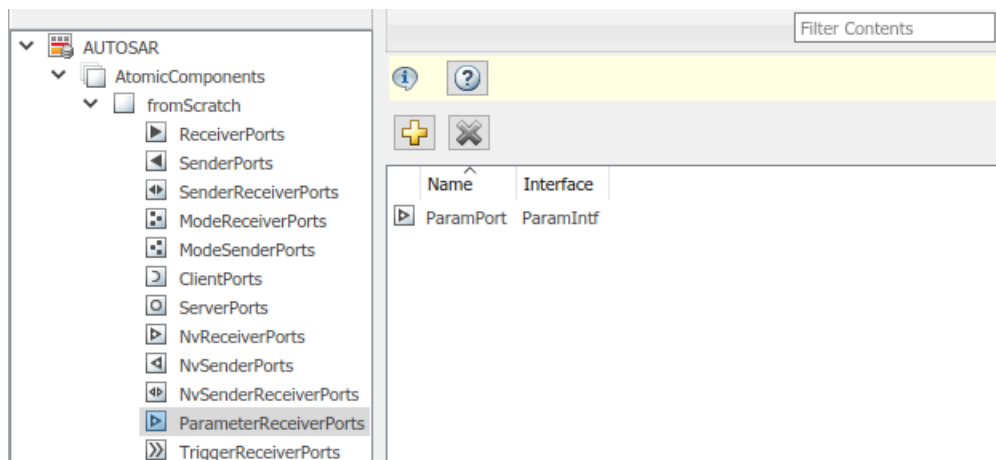
Parameter Receiver Ports

The AUTOSAR Dictionary view of parameter receiver ports supports modeling the receiver side of AUTOSAR parameter communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR parameter receiver ports, parameter interfaces, and parameter data elements in your model. For more information, see “Configure Receiver for AUTOSAR Parameter Communication” on page 4-211.

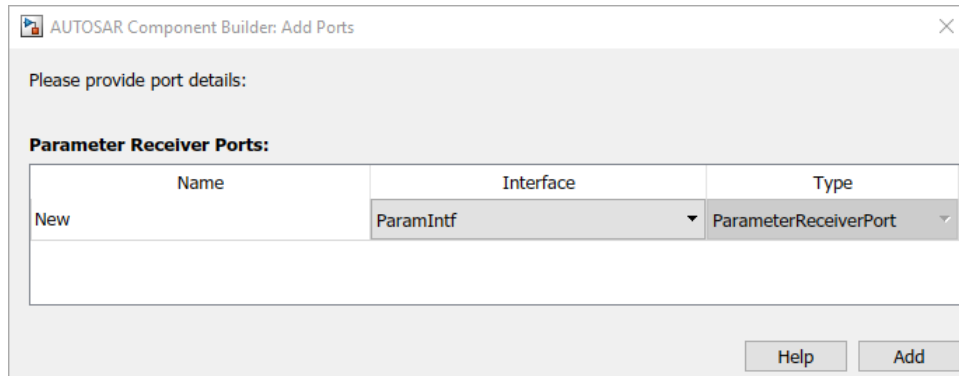
To configure AUTOSAR parameter receiver port elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **ParameterReceiverPorts**.

The parameter receiver ports view in the AUTOSAR Dictionary lists parameter receiver ports and their properties. You can:

- Select an AUTOSAR parameter receiver port, and view and optionally reselect its associated parameter interface.
- Rename an AUTOSAR parameter receiver port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.



The Add Ports dialog box lets you specify the name of the new port and associate it with an existing parameter interface. Click **Add** to add the port and return to the parameter receiver ports view.





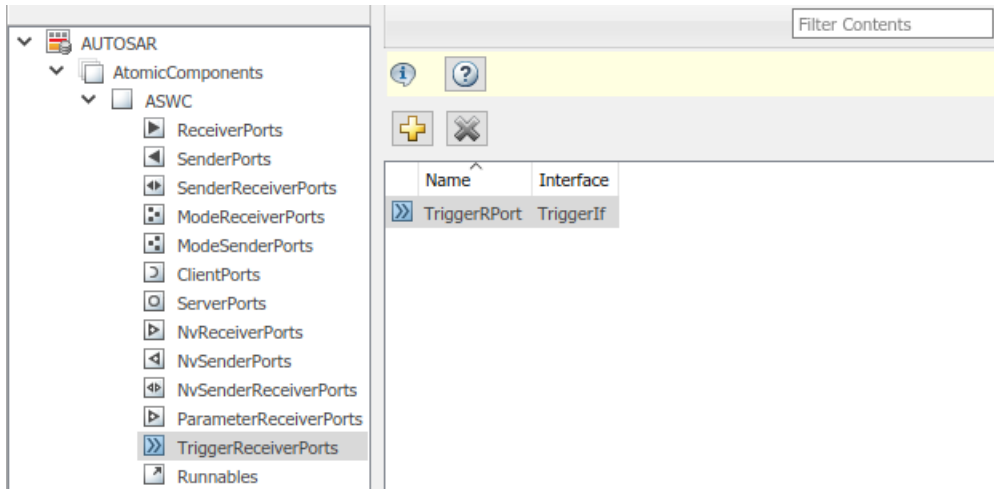
Trigger Receiver Ports

The AUTOSAR Dictionary view of trigger receiver ports supports modeling the receiver side of AUTOSAR trigger communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR trigger receiver ports, trigger interfaces, and triggers in your model. For more information, see “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214.

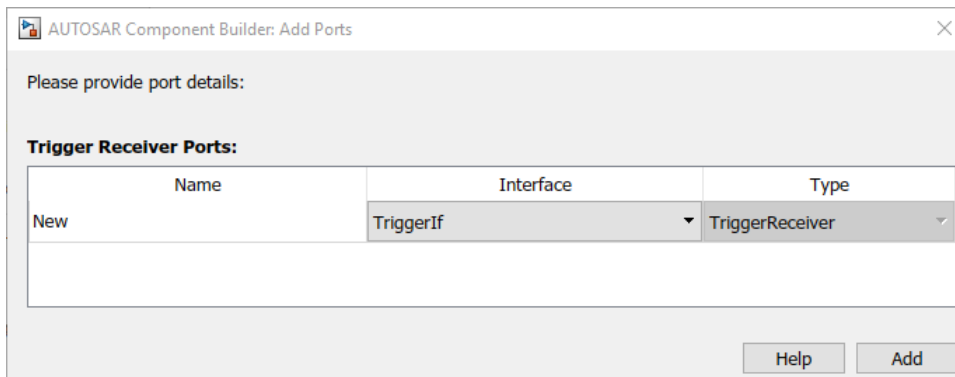
To configure AUTOSAR trigger receiver port elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **TriggerReceiverPorts**.

The trigger receiver ports view in the AUTOSAR Dictionary lists trigger receiver ports and their properties. You can:

- Select an AUTOSAR trigger receiver port, and view and optionally reselect its associated trigger interface.
- Rename an AUTOSAR trigger receiver port by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Ports dialog box to add a port.
- Select a port and then click the **Delete** button  to remove it.



The Add Ports dialog box lets you specify the name of the new port and associate it with an existing trigger interface. Click **Add** to add the port and return to the trigger receiver ports view.



Configure AUTOSAR Runnables

The **Runnables** view in the AUTOSAR Dictionary supports modeling AUTOSAR runnable entities (runnables) and events, which implement aspects of internal AUTOSAR component behavior, in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR runnables and associated events that activate them. For more information, see “Configure AUTOSAR Runnables and Events” on page 4-224.

In the AUTOSAR Dictionary, runnables appear in a tree format under the component that owns them. To access runnable and event elements and their properties, you expand the component name.

To configure AUTOSAR runnable and event elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **Runnables**.

The runnables view in the AUTOSAR Dictionary lists runnables for the AUTOSAR component. You can:

- Rename an AUTOSAR runnable by clicking its name and then editing the name text.
- Modify the symbol name for a runnable. The specified AUTOSAR runnable symbol-name is exported in arxml and C code. For example, in the display below, if you change the symbol-name of Runnable1 from Runnable1 to test_symbol, the symbol-name test_symbol appears in the exported arxml and C code as shown below.

Example 4.1. autosar_swc_expcns.arxml



```
<RUNNABLE-ENTITY UUID="...">
  <SHORT-NAME>Runnable1</SHORT-NAME>
  ...
  <SYMBOL>test_symbol</SYMBOL>
  ...
</RUNNABLE-ENTITY>
```

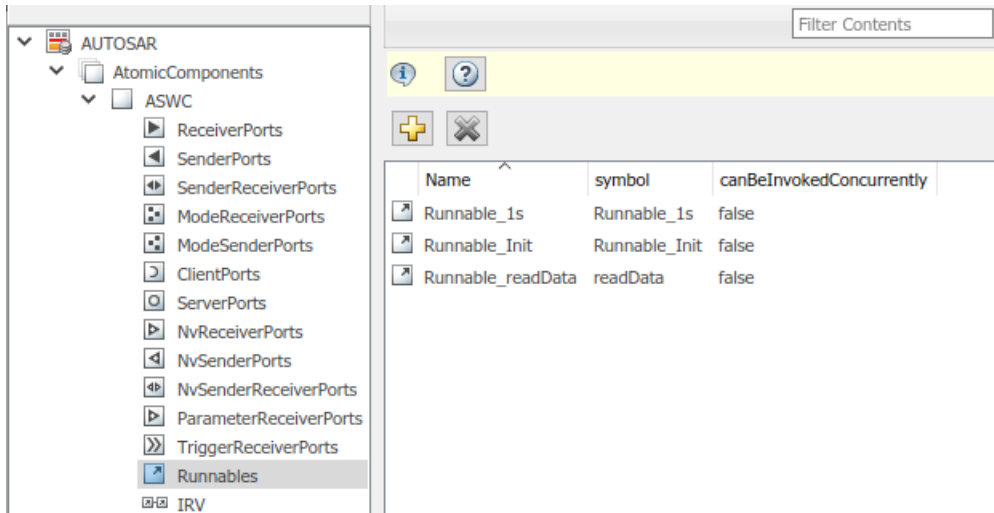
Example 4.2. autosar__swc_expcns.c

```
/* Model step function for TID1 */
void test_symbol(void)          /* Explicit Task: Runnable1 */
{
  ...
}
```

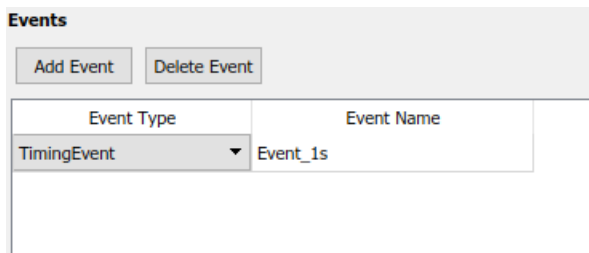
Note For an AUTOSAR server runnable — that is, a runnable with an `OperationInvokedEvent` — the **symbol** name must match the Simulink server function name.

- For an AUTOSAR server runnable, set the runnable property `canBeInvokedConcurrently` to designate whether to enforce concurrency constraints. For nonserver runnables, leave `canBeInvokedConcurrently` set to `false`. For more information, see “Concurrency Constraints for AUTOSAR Server Runnables” on page 4-195.

- Click the **Add** button  to add an AUTOSAR runnable.
- Select an AUTOSAR runnable and then click the **Delete** button  to remove it.



Select a runnable to see its list of associated events. The **Events** pane lists each AUTOSAR event with its type — TimingEvent, DataReceivedEvent, ModeSwitchEvent, OperationInvokedEvent, InitEvent, DataReceiveErrorEvent, or ExternalTriggerOccurredEvent — and name. You can rename an AUTOSAR event by clicking its name and then editing the name text. You can use the buttons **Add Event** and **Delete Event** to add or delete events from a runnable.



If you select an event of type DataReceivedEvent, the runnable is activated by a DataReceivedEvent. Select the event name to display its **Trigger** property. Select a trigger for the event from the list of available trigger ports.

Events

Add Event Delete Event

Event Type	Event Name
DataReceivedEvent	Event

Event Properties

Trigger RPort.SubVal

If you select an event of type `DataReceiveErrorEvent`, the runnable is activated by a `DataReceiveErrorEvent`. Select the event name to display its **Trigger** property. Select a trigger for the event from the list of available trigger ports. (For more information on using a `DataReceiveErrorEvent`, see “Configure AUTOSAR Receiver Port for `DataReceiveErrorEvent`” on page 4-138.)

Events

Add Event Delete Event

Event Type	Event Name
DataReceiveErrorEvent	DRE_Evt

Event Properties

Trigger RPort.Override

If you select an event of type `ModeSwitchEvent`, the **Mode Activation** and **Mode Receiver Port** properties are displayed. Select a mode receiver port for the event from the list of configured mode-receiver ports. Select a mode activation value for the event from the list of values (`OnEntry`, `OnExit`, or `OnTransition`). Based on the value you select, one or two **Mode Declaration** drop-down lists appear. Select a mode (or two modes) for the event, among those declared by the mode declaration group associated with the Simulink inport that models the AUTOSAR mode-receiver port. (For more information on using a `ModeSwitchEvent`, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.)

Events

Add Event Delete Event

Event Type	Event Name
ModeSwitchEvent	Event_Run

Event Properties

Mode Activation: OnTransition

Mode Receiver Port: MRPort

Transition From

Mode Declaration: Sleep

Transition To

Mode Declaration: Run

If you select an event of type `OperationInvokedEvent`, the runnable becomes an AUTOSAR server runnable. Select the event name to display its **Trigger** property. Select a trigger for the event from the list of available server port and operation combinations. The **Operation Signature** is displayed below the **Trigger** property. (For more information on using an `OperationInvokedEvent`, see “Configure AUTOSAR Client-Server Communication” on page 4-171.)

Events

Add Event Delete Event

Event Type	Event Name
OperationInvokedEvent	Event_readData

Event Properties

Trigger: SrvPort.readData

Operation Signature:
Error readData(Out Data)

If you select an event of type `InitEvent`, you can rename the event by clicking its name and then editing the name text. (For more information on using an `InitEvent`, see “Configure AUTOSAR Initialization Runnable (R4.1)” on page 4-242.)

Note AUTOSAR `InitEvents` require AUTOSAR schema version 4.1 or higher. To select a schema version for the model, go to **AUTOSAR Code Generation Options** (Embedded Coder) in the Configuration Parameters dialog box.

The screenshot shows a dialog box titled "Events". At the top, there are two buttons: "Add Event" and "Delete Event". Below these buttons is a table with two columns: "Event Type" and "Event Name". The "Event Type" column contains a dropdown menu with "InitEvent" selected. The "Event Name" column contains the text "Event".

Event Type	Event Name
InitEvent	Event

If you select an event of type `ExternalTriggerOccurredEvent`, the runnable is activated when an AUTOSAR software component or service signals an external trigger event. Select the event name to display its **Trigger** property. Select a trigger for the event from the list of available trigger receiver port and trigger combinations. (For more information on using an `ExternalTriggerOccurredEvent`, see “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214.)

The screenshot shows a dialog box titled "Events". At the top, there are two buttons: "Add Event" and "Delete Event". Below these buttons is a table with two columns: "Event Type" and "Event Name". The "Event Type" column contains a dropdown menu with "ExternalTriggerOccurredEvent" selected. The "Event Name" column contains the text "Event_Trigger". Below the table is a section titled "Event Properties" with a "Trigger" label and a dropdown menu containing "TriggerRPort.Trigger1".

Event Type	Event Name
ExternalTriggerOccurredEvent	Event_Trigger

Event Properties

Trigger: TriggerRPort.Trigger1



Configure AUTOSAR Inter-Runnable Variables

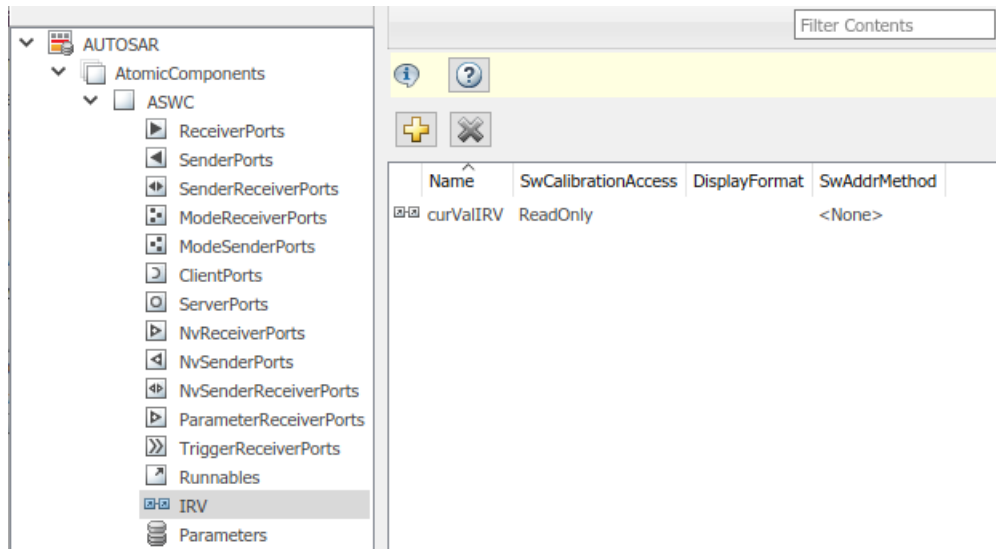
The **IRV** view in the AUTOSAR Dictionary supports modeling AUTOSAR inter-runnable variables (IRVs), which connect runnables and implement aspects of internal AUTOSAR component behavior, in Simulink. You use the AUTOSAR Dictionary to create AUTOSAR IRVs and configure IRV data properties. For more information, see “Configure AUTOSAR Data for Measurement and Calibration” on page 4-284.

In the AUTOSAR Dictionary, IRVs appear in a tree format under the component that owns them. To access IRV elements and their properties, you expand the component name.

To configure AUTOSAR IRV elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **IRV**.

The IRV view in the AUTOSAR Dictionary lists IRVs for the AUTOSAR component. You can:

- Rename an AUTOSAR IRV by clicking its name and then editing the name text.
- Specify the level of measurement and calibration tool access to IRV data. Select an IRV and set its **SwCalibrationAccess** value to **ReadOnly**, **ReadWrite**, or **NotAccessible**.
- Optionally specify the format to be used by measurement and calibration tools to display the IRV data. In the **DisplayFormat** field, enter an ANSI® C **printf** format specifier string. For example, **%2.1d** specifies a signed decimal number, with a minimum width of 2 characters and a maximum precision of 1 digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.
- Optionally specify a software address method for the IRV data. Select or enter a value for **SwAddrMethod**. AUTOSAR software components use **SwAddrMethods** to group data in memory for access by measurement and calibration tools. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.
- Click the **Add** button  to add an AUTOSAR IRV.
- Select an AUTOSAR IRV and then click the **Delete** button  to remove it.



Configure AUTOSAR Parameters



The **Parameters** view in the AUTOSAR Dictionary supports modeling AUTOSAR internal calibration parameters, for use with AUTOSAR integrated and distributed lookups, in Simulink. You use the AUTOSAR Dictionary to create AUTOSAR internal parameters and configure parameter data properties. For port-based calibration parameters, you create “Parameter Interfaces” on page 4-51.

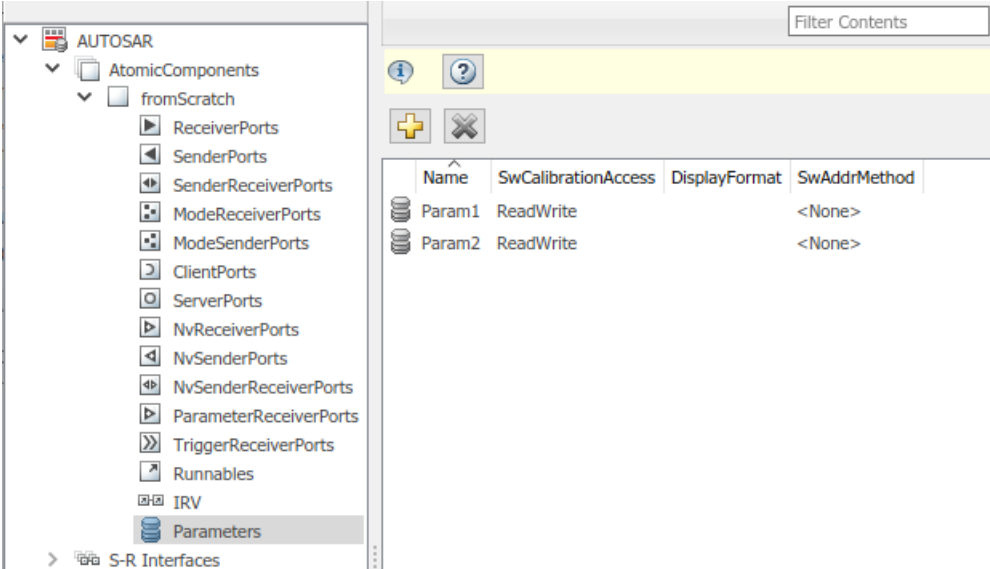
In the AUTOSAR Dictionary, internal parameters appear in a tree format under the component that owns them. To access parameter elements and their properties, you expand the component name.

To configure AUTOSAR parameter elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **Parameters**.

The parameters view in the AUTOSAR Dictionary lists internal parameters for the AUTOSAR component. You can:

- Rename an AUTOSAR parameter by clicking its name and then editing the name text.

- Specify the level of measurement and calibration tool access to parameters. Select a parameter and set its **SwCalibrationAccess** value to `ReadOnly`, `ReadWrite`, or `NotAccessible`.
- Optionally specify the format to be used by measurement and calibration tools to display the parameter data. In the **DisplayFormat** field, enter an ANSI C `printf` format specifier string. For example, `%2.1d` specifies a signed decimal number, with a minimum width of 2 characters and a maximum precision of 1 digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.
- Optionally specify a software address method for the parameter data. Select or enter a value for **SwAddrMethod**. AUTOSAR software components use `SwAddrMethods` to group data in memory for access by measurement and calibration tools. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.
- Click the **Add** button  to add an AUTOSAR internal parameter.
- Select an AUTOSAR internal parameter and then click the **Delete** button  to remove it.



Name	SwCalibrationAccess	DisplayFormat	SwAddrMethod
Param1	ReadWrite		<None>
Param2	ReadWrite		<None>

Configure AUTOSAR Communication Interfaces

An AUTOSAR software component uses communication interfaces defined in the AUTOSAR standard, including sender-receiver (S-R), client-server (C-S), mode-switch (M-S), nonvolatile (NV) data, trigger, and parameter interfaces. In the AUTOSAR Dictionary, communication interfaces appear in a tree format under the interface type name. To access interface elements and their properties, you expand the interface type name.

- “Sender-Receiver Interfaces” on page 4-38
- “Mode-Switch Interfaces” on page 4-41
- “Client-Server Interfaces” on page 4-43
- “Nonvolatile Data Interfaces” on page 4-48
- “Parameter Interfaces” on page 4-51
- “Trigger Interfaces” on page 4-54



Sender-Receiver Interfaces

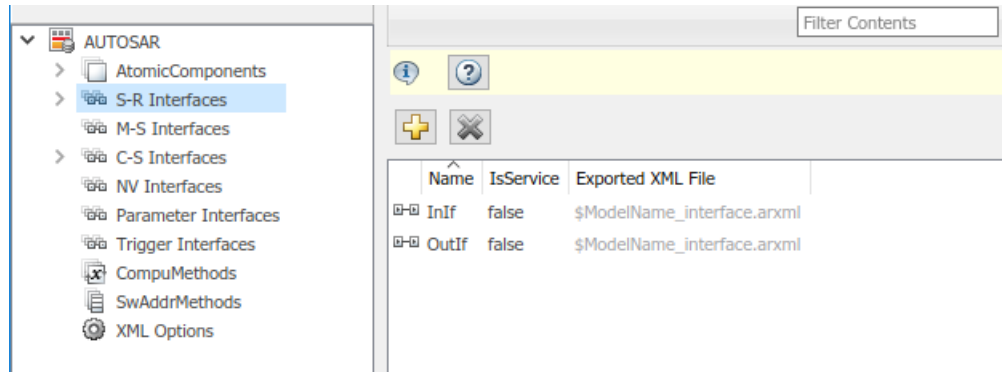
The **S-R Interfaces** view in the AUTOSAR Dictionary supports modeling AUTOSAR sender-receiver (S-R) communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR S-R ports, S-R interfaces, and S-R data elements in your model. For more information, see “Configure AUTOSAR Sender-Receiver Communication” on page 4-126 and “Configure AUTOSAR Queued Sender-Receiver Communication” on page 4-145.

To configure AUTOSAR S-R interface elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

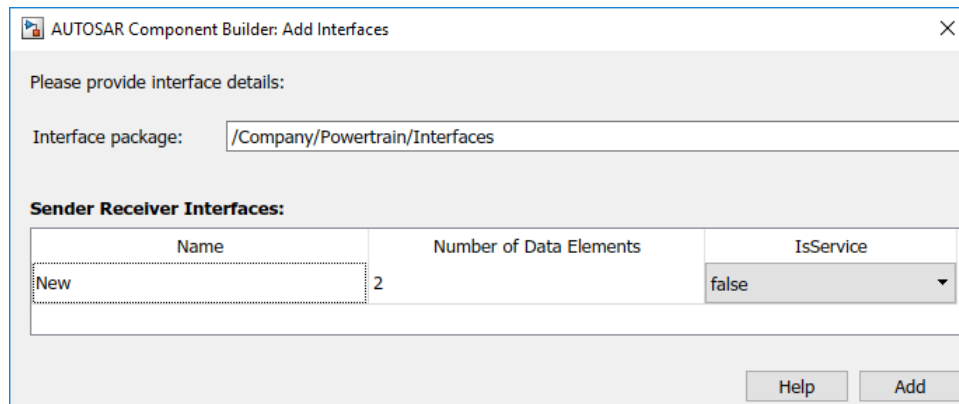
- 1 In the leftmost pane of the AUTOSAR Dictionary, select **S-R Interfaces**.

The S-R interfaces view in the AUTOSAR Dictionary lists AUTOSAR sender-receiver interfaces and their properties. You can:

- Select an S-R interface and then select a menu value to specify whether or not it is a service.
- Rename an S-R interface by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Interfaces dialog box to add one or more S-R interfaces.
- Select an S-R interface and then click the **Delete** button  to remove it.



The Add Interfaces dialog box lets you specify the name of the new interface, the number of associated data elements it contains, whether the interface is a service, and the path of the Interface package. Click **Add** to add the interface and return to the S-R interfaces view.



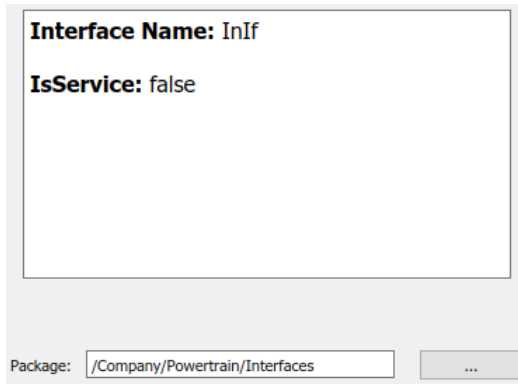
- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **S-R Interfaces** and select an S-R interface from the list.

The S-R interface view in the AUTOSAR Dictionary displays the name of the selected S-R interface, whether or not it is a service, and the AUTOSAR package to be generated for the interface.

To modify the AUTOSAR package for the interface, you can do either of the following:

- Enter a package path in the **Package** parameter field.

- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.





The screenshot shows a configuration window for an interface. It has a title bar and a main content area. The main content area contains two labels: "Interface Name: InIf" and "IsService: false". Below the main content area, there is a "Package:" label followed by a text input field containing "/Company/Powertrain/Interfaces" and a button with three dots "..." to its right.

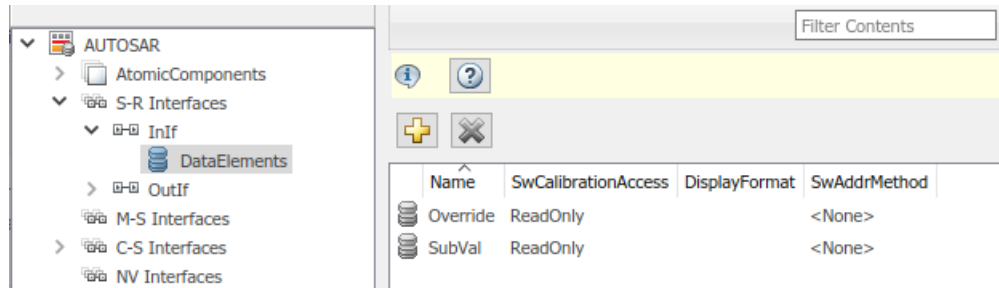
- 3 In the leftmost pane of the AUTOSAR Dictionary, expand the selected interface and select **DataElements**.

The data elements view in the AUTOSAR Dictionary lists AUTOSAR sender-receiver interface data elements and their properties. You can:

- Select an S-R interface data element and edit the name value.
- Specify the level of measurement and calibration tool access to S-R interface data elements. Select a data element and set its **SwCalibrationAccess** value to **ReadOnly**, **ReadWrite**, or **NotAccessible**.
- Optionally specify the format to be used by measurement and calibration tools to display the data element. In the **DisplayFormat** field, enter an ANSI C `printf` format specifier string. For example, `%2.1d` specifies a signed decimal number, with a minimum width of 2 characters and a maximum precision of 1 digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.
- Optionally specify a software address method for the data element. Select or enter a value for **SwAddrMethod**. AUTOSAR software components use **SwAddrMethods** to group data in memory for access by measurement and

calibration tools. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.

- Click the **Add** button  to add a data element.
- Select a data element and then click the **Delete** button  to remove it.



Mode-Switch Interfaces



The **M-S Interfaces** view in the AUTOSAR Dictionary supports modeling AUTOSAR mode-switch (M-S) communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR M-S ports and M-S interfaces in your model. For more information, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.

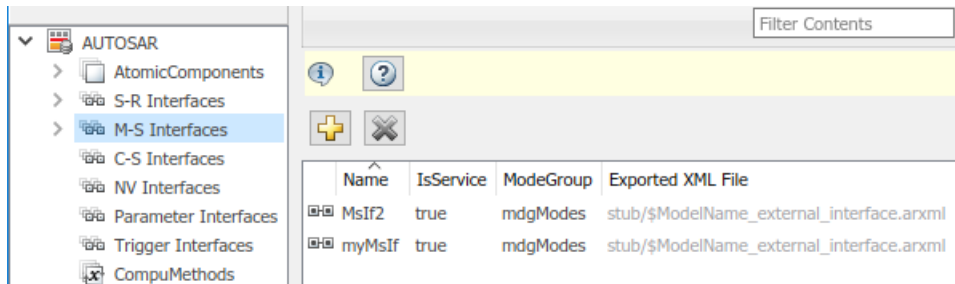
To configure AUTOSAR M-S interface elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

- 1 In the leftmost pane of the AUTOSAR Dictionary, select **M-S Interfaces**.

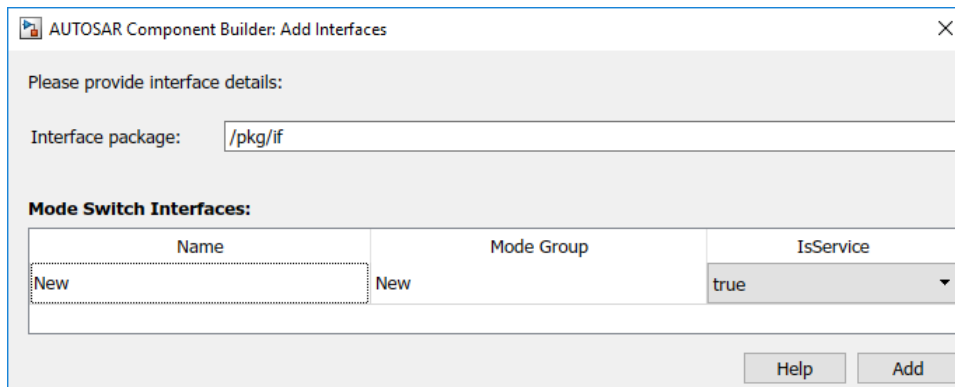
The M-S interfaces view in the AUTOSAR Dictionary lists AUTOSAR mode-switch interfaces and their properties. You can:

- Select an M-S interface, specify whether or not it is a service, and modify the name of its associated mode group.
 - The **IsService** property defaults to `true`. The `true` setting assumes that the M-S interface participates in run-time mode management, for example, performed by the Basic Software Mode Manager.
 - A mode group contains mode values, declared in Simulink using enumeration. For more information, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.

- Rename an M-S interface by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Interfaces dialog box to add one or more M-S interfaces.
- Select an M-S interface and then click the **Delete** button  to remove it.



The Add Interfaces dialog box lets you specify the name of the new interface, the name of a mode group, whether the interface is a service, and the path of the Interface package. Click **Add** to add the interface and return to the M-S interfaces view.



- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **M-S Interfaces** and select an M-S interface from the list.

The M-S interface view in the AUTOSAR Dictionary displays the name of the selected M-S interface, whether or not it is a service, its associated mode group, and the AUTOSAR package for the interface.

To modify the AUTOSAR package for the interface, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.

The screenshot shows a configuration window for an interface. It contains the following text:

Interface Name: myMsIf

IsService: true

ModeGroup: mdgModes

At the bottom, there is a text field labeled "Package:" containing the value "/pkg/If" and a button with three dots to its right.



Client-Server Interfaces

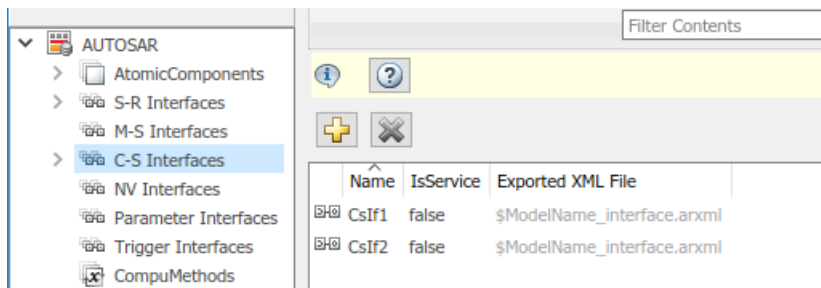
The **C-S Interfaces** view in the AUTOSAR Dictionary supports modeling AUTOSAR client-server (C-S) communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR C-S ports, C-S interfaces, and C-S operations in your model. For more information, see “Configure AUTOSAR Client-Server Communication” on page 4-171.

To configure AUTOSAR C-S interface elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

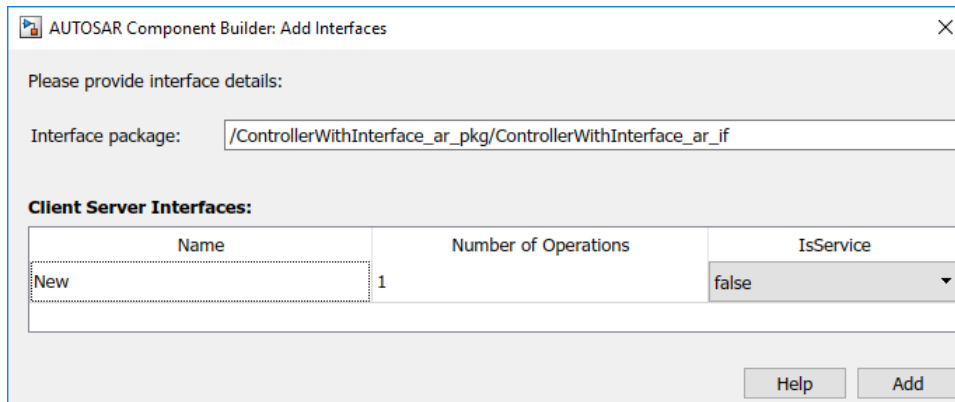
- 1 In the leftmost pane of the AUTOSAR Dictionary, select **C-S Interfaces**.

The C-S interfaces view in the AUTOSAR Dictionary lists AUTOSAR client-server interfaces and their properties. You can:

- Select a C-S interface and then select a menu value to specify whether or not it is a service.
- Rename a C-S interface by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Interfaces dialog box to add one or more C-S interfaces.
- Select a C-S interface and then click the **Delete** button  to remove it.



The Add Interfaces dialog box lets you specify the name of the new interface, the number of associated operations it contains, whether the interface is a service, and the path of the Interface package. Click **Add** to add the interface and return to the C-S interfaces view.



- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **C-S Interfaces** and select a C-S interface from the list.

The C-S interface view in the AUTOSAR Dictionary displays the name of the selected C-S interface, whether or not it is a service, and the AUTOSAR package for the interface.

To modify the AUTOSAR package for the interface, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.



Interface Name: CsIf1

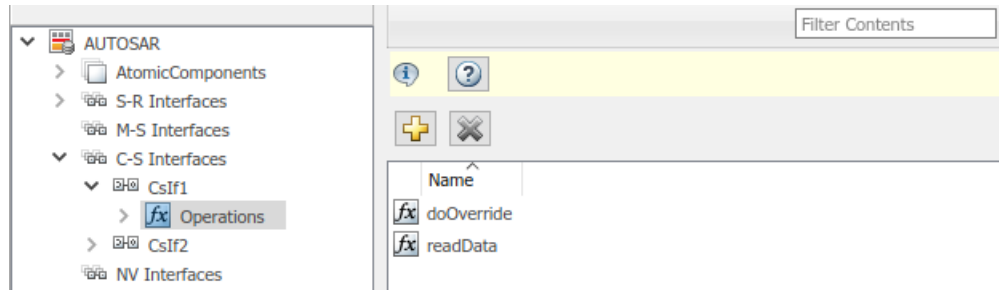
IsService: false

Package: /ControllerWithInterface_ar_pkg/ControllerWithInterface_ar_jf

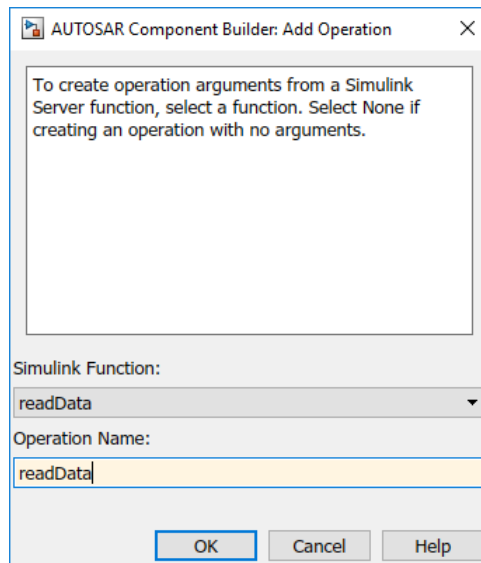
- 3 In the leftmost pane of the AUTOSAR Dictionary, expand the selected interface and select **Operations**.

The operations view in the AUTOSAR Dictionary lists AUTOSAR client-server interface operations. You can:

- Select a C-S interface operation and edit the name value.
- Click the **Add** button  to open an Add Operation dialog box to add a C-S interface operation.
- Select an operation and then click the **Delete** button  to remove it.

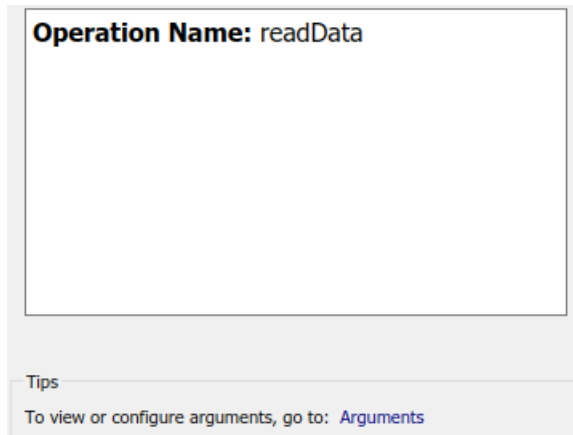


The Add Operation dialog box lets you specify the name of a new C-S interface operation. To create operation arguments from a Simulink function, select the associated Simulink function among those present in the configuration. Select None if you are creating an operation without arguments.



- 4 In the leftmost pane of the AUTOSAR Dictionary, expand **Operations** and select an operation from the list.



The operations view in the AUTOSAR Dictionary displays the name of the selected C-S operation.

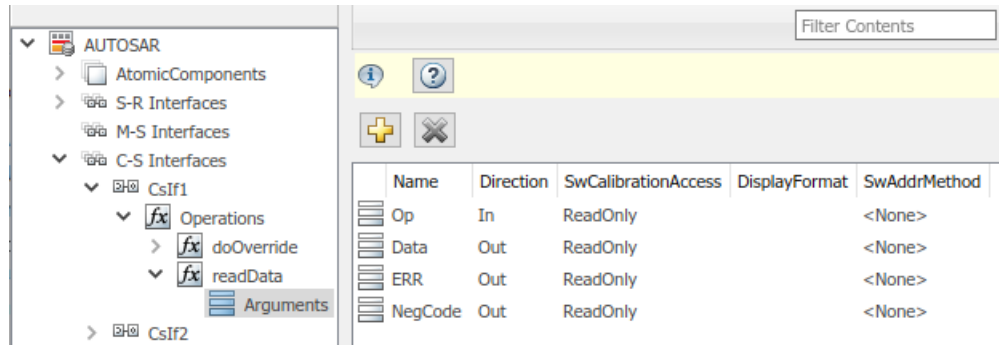


- 5 In the leftmost pane of the AUTOSAR Dictionary, expand the selected operation and select **Arguments**.

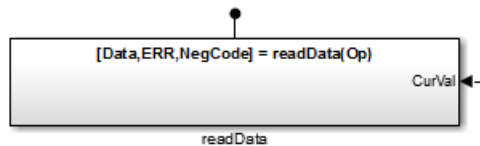
The arguments view in the AUTOSAR Dictionary lists AUTOSAR client-server operation arguments and their properties. You can:

- Select a C-S operation argument and edit the name value.
- Specify the direction of the C-S operation argument. Set its **Direction** value to **In**, **Out**, **InOut**, or **Error**. Select **Error** if the operation argument returns application error status. For more information, see “Configure AUTOSAR Client-Server Error Handling” on page 4-190.
- Specify the level of measurement and calibration tool access to C-S operation arguments. Select an argument and set its **SwCalibrationAccess** value to **ReadOnly**, **ReadWrite**, or **NotAccessible**.
- Optionally specify the format to be used by measurement and calibration tools to display the argument. In the **DisplayFormat** field, enter an ANSI C `printf` format specifier string. For example, `%2.1d` specifies a signed decimal number, with a minimum width of 2 characters and a maximum precision of 1 digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.
- Optionally specify a software address method for the argument. Select or enter a value for **SwAddrMethod**. AUTOSAR software components use **SwAddrMethods** to group data in memory for access by measurement and calibration tools. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.

- Click the **Add** button  to add an argument.
- Select an argument and then click the **Delete** button  to remove it.



The displayed server operation arguments were created from the following Simulink Function block.





Nonvolatile Data Interfaces

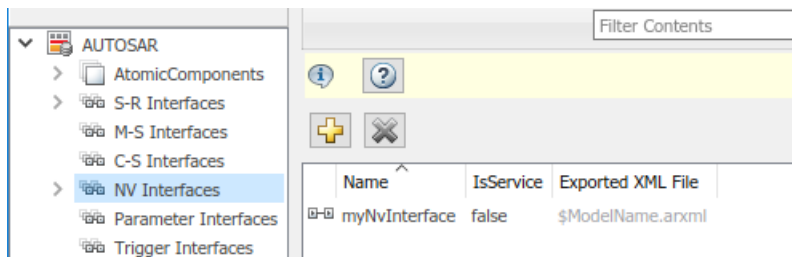
The **NV Interfaces** view in the AUTOSAR Dictionary supports modeling AUTOSAR nonvolatile (NV) data communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR NV ports, NV interfaces, and NV data elements in your model. For more information, see “Configure AUTOSAR Nonvolatile Data Communication” on page 4-208.

To configure AUTOSAR NV interface elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

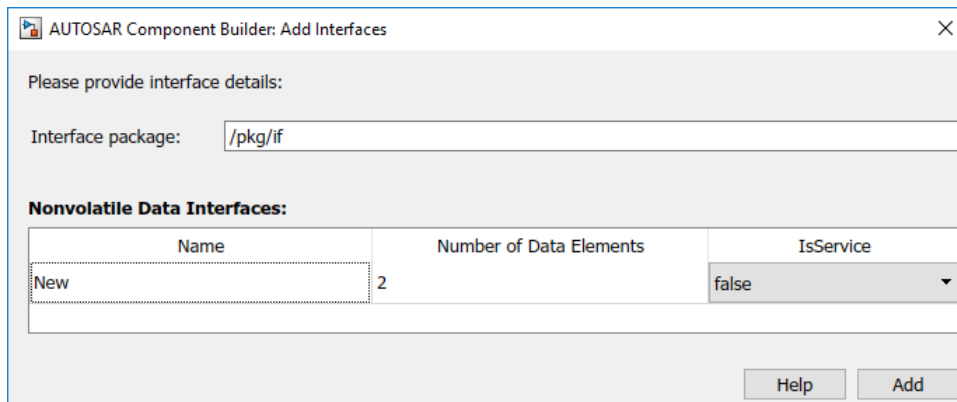
- 1 In the leftmost pane of the AUTOSAR Dictionary, select **NV Interfaces**.

The NV interfaces view in the AUTOSAR Dictionary lists AUTOSAR NV data interfaces and their properties. You can:

- Select an NV interface and then select a menu value to specify whether or not it is a service.
- Rename an NV interface by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Interfaces dialog box to add one or more NV interfaces.
- Select an NV interface and then click the **Delete** button  to remove it.



The Add Interfaces dialog box lets you specify the name of the new interface, the number of associated data elements it contains, whether the interface is a service, and the path of the Interface package. Click **Add** to add the interface and return to the NV interfaces view.

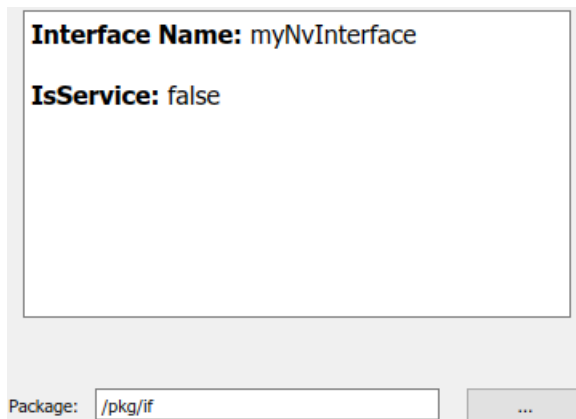


- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **NV Interfaces** and select an NV interface from the list.

The NV interface view in the AUTOSAR Dictionary displays the name of the selected NV data interface, whether or not it is a service, and the AUTOSAR package to be generated for the interface.

To modify the AUTOSAR package for the interface, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.



The screenshot shows a configuration window for an NV interface. It contains the following text:

Interface Name: myNvInterface

IsService: false



At the bottom, there is a text field labeled "Package:" containing the value "/pkg/if" and a button with three dots "..." to its right.

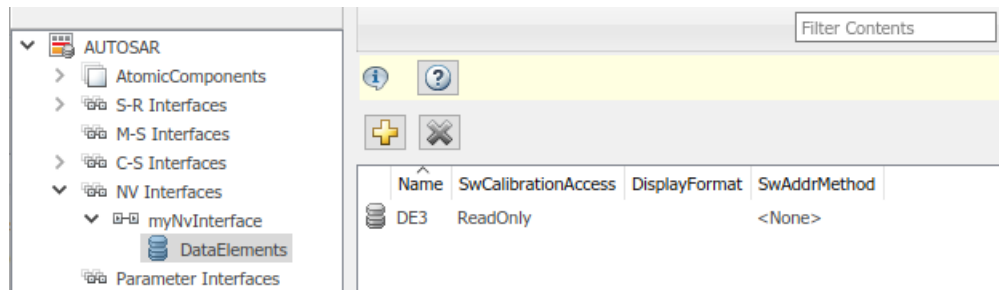
- 3 In the leftmost pane of the AUTOSAR Dictionary, expand the selected interface and select **DataElements**.

The data elements view in the AUTOSAR Dictionary lists AUTOSAR NV interface data elements and their properties. You can:

- Select an NV interface data element and edit the name value.
- Specify the level of measurement and calibration tool access to the NV interface data elements. Select a data element and set its **SwCalibrationAccess** value to **ReadOnly**, **ReadWrite**, or **NotAccessible**.
- Optionally specify the format to be used by measurement and calibration tools to display the data element. In the **DisplayFormat** field, enter an ANSI C `printf`

format specifier string. For example, `%2.1d` specifies a signed decimal number, with a minimum width of 2 characters and a maximum precision of 1 digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.

- Optionally specify a software address method for the data element. Select or enter a value for **SwAddrMethod**. AUTOSAR software components use **SwAddrMethods** to group data in memory for access by measurement and calibration tools. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.
- Click the **Add** button  to add a data element.
- Select a data element and then click the **Delete** button  to remove it.





Parameter Interfaces

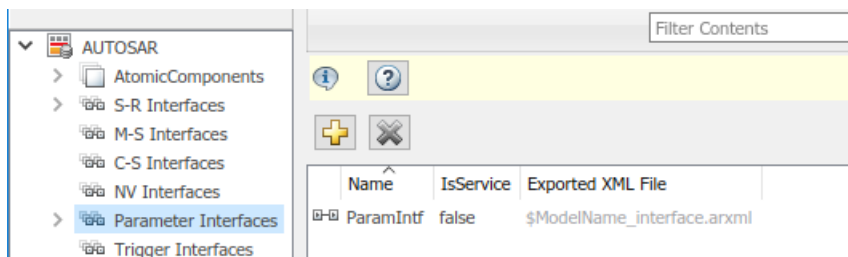
The **Parameter Interfaces** view in the AUTOSAR Dictionary supports modeling the receiver side of AUTOSAR parameter communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR parameter receiver ports, parameter interfaces, and parameter data elements in your model. For more information, see “Configure Receiver for AUTOSAR Parameter Communication” on page 4-211.

To configure AUTOSAR parameter interface elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

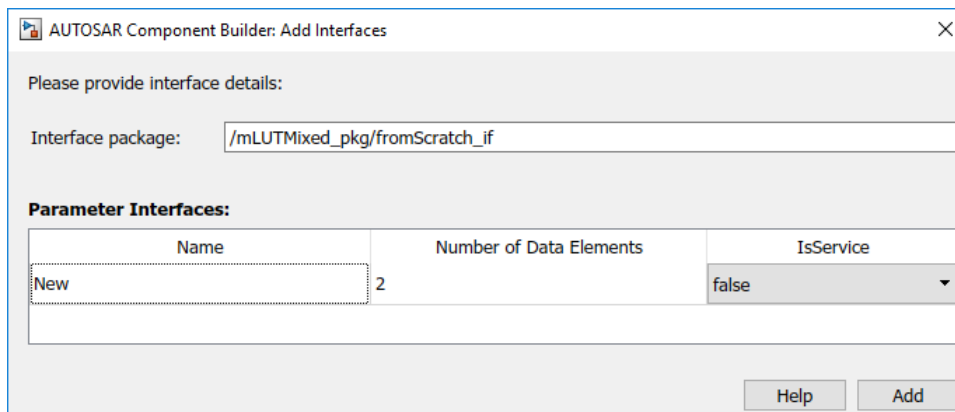
- 1 In the leftmost pane of the AUTOSAR Dictionary, select **Parameter Interfaces**.

The parameter interfaces view in the AUTOSAR Dictionary lists AUTOSAR parameter interfaces and their properties. You can:

- Select a parameter interface and then select a menu value to specify whether or not it is a service.
- Rename a parameter interface by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Interfaces dialog box to add one or more parameter interfaces.
- Select a parameter interface and then click the **Delete** button  to remove it.



The Add Interfaces dialog box lets you specify the name of the new interface, the number of associated data elements it contains, whether the interface is a service, and the path of the Interface package. Click **Add** to add the interface and return to the parameter interfaces view.



- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **Parameter Interfaces** and select a parameter interface from the list.

The parameter interface view in the AUTOSAR Dictionary displays the name of the selected parameter interface, whether or not it is a service, and the AUTOSAR package to generate for the interface.

To modify the AUTOSAR package for the interface, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.



The screenshot shows a configuration window for a parameter interface. At the top, it displays 'Interface Name: ParamIntf'. Below that, it shows 'IsService: false'. At the bottom, there is a 'Package:' label followed by a text input field containing '/mLUTMixed_pkg/fromScratch_if' and a button with three dots '...' to its right.

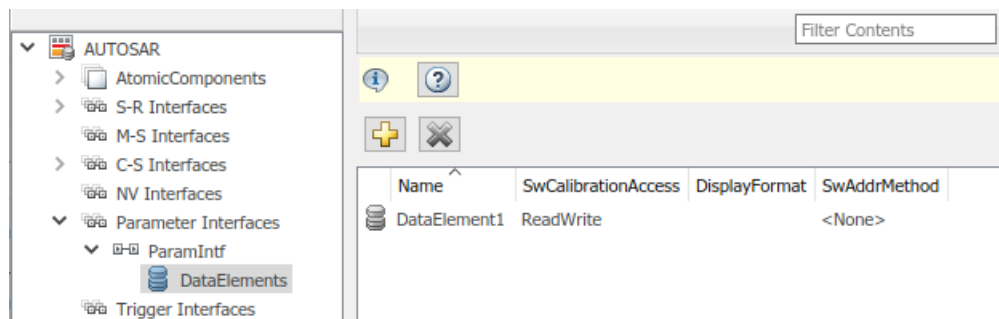
- 3 In the leftmost pane of the AUTOSAR Dictionary, expand the selected interface and select **DataElements**.

The data elements view in the AUTOSAR Dictionary lists AUTOSAR parameter interface data elements and their properties. You can:

- Select a parameter interface data element and edit the name value.
- Specify the level of measurement and calibration tool access to parameter interface data elements. Select a data element and set its **SwCalibrationAccess** value to **ReadOnly**, **ReadWrite**, or **NotAccessible**.
- Optionally specify the format to be used by measurement and calibration tools to display the data element. In the **DisplayFormat** field, enter an ANSI C `printf` format specifier string. For example, `%2.1d` specifies a signed decimal number,

with a minimum width of 2 characters and a maximum precision of 1 digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.

- Optionally specify a software address method for the data element. Select or enter a value for **SwAddrMethod**. AUTOSAR software components use **SwAddrMethods** to group data in memory for access by measurement and calibration tools. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.
- Click the **Add** button  to add a data element.
- Select a data element and then click the **Delete** button  to remove it.





Trigger Interfaces

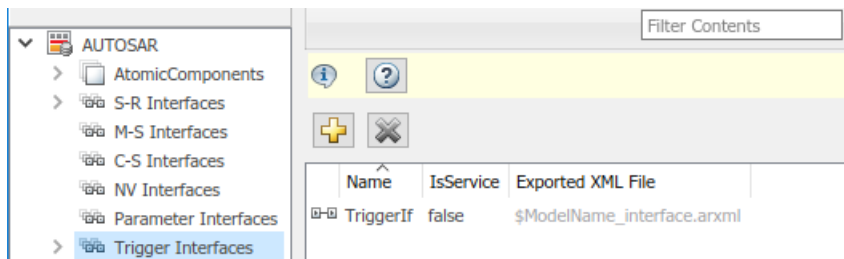
The **Trigger Interfaces** view in the AUTOSAR Dictionary supports modeling the receiver side of AUTOSAR trigger communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR trigger receiver ports, trigger interfaces, and triggers in your model. For more information, see “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214.

To configure AUTOSAR trigger interface elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary.

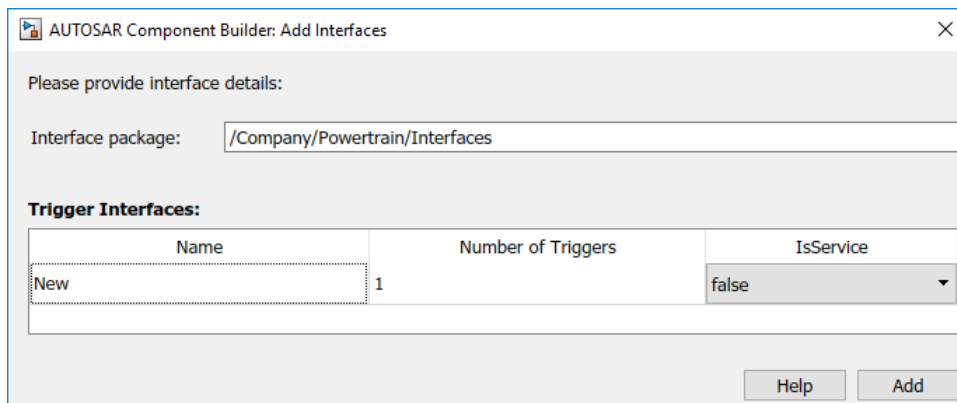
- 1 In the leftmost pane of the AUTOSAR Dictionary, select **Trigger Interfaces**.

The trigger interfaces view in the AUTOSAR Dictionary lists AUTOSAR trigger interfaces and their properties. You can:

- Select a trigger interface and then select a menu value to specify whether or not it is a service.
- Rename a trigger interface by clicking its name and then editing the name text.
- Click the **Add** button  to open an Add Interfaces dialog box to add one or more trigger interfaces.
- Select a trigger interface and then click the **Delete** button  to remove it.



The Add Interfaces dialog box lets you specify the name of the new interface, the number of associated triggers it contains, whether the interface is a service, and the path of the Interface package. Click **Add** to add the interface and return to the trigger interfaces view.

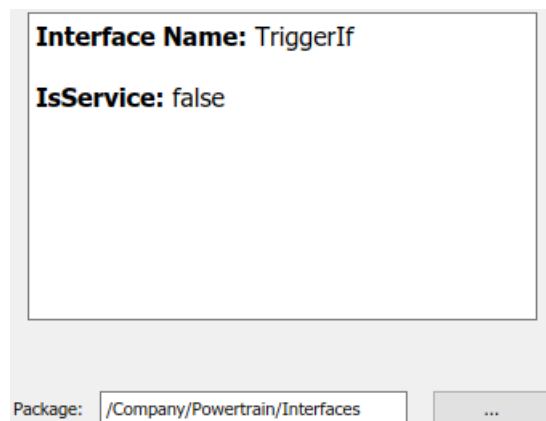


- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **Trigger Interfaces** and select a trigger interface from the list.

The trigger interface view in the AUTOSAR Dictionary displays the name of the selected trigger interface, whether or not it is a service, and the AUTOSAR package to be generated for the interface.

To modify the AUTOSAR package for the interface, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.



- 3** In the leftmost pane of the AUTOSAR Dictionary, expand the selected interface and select **Triggers**.

The triggers view in the AUTOSAR Dictionary lists AUTOSAR triggers and their properties. You can:



- Select a trigger and edit the name value.
- If the trigger is periodic, you can use **CseCode** and **CseCodeFactor** to specify a period for the trigger. (Otherwise, leave the period unspecified.)
 - To specify the time base of the period, select a value from the **CseCode** menu. The values are based on ASAM codes for scaling unit (CSE).

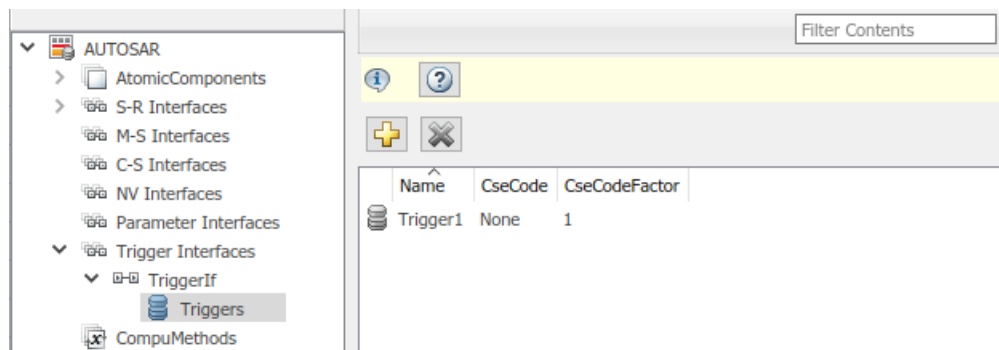
- To specify the scaling factor for the period, enter an integer value in the **CseCodeFactor** field.

For example, to specify a period of 15 milliseconds, set **CseCode** to CSE3 (1 millisecond) and set **CseCodeFactor** to 15.

CseCode	Time Base
None	Unspecified (trigger is not periodic)
CSE0	1 μ sec (microsecond)
CSE1	10 μ sec
CSE2	100 μ sec
CSE3	1 msec (millisecond)
CSE4	10 msec
CSE5	100 msec
CSE6	1 second
CSE7	10 seconds
CSE8	1 minute
CSE9	1 hour
CSE10	1 day
CSE20	1 fs (femtosecond)
CSE21	10 fs
CSE22	100 fs
CSE23	1 ps (picosecond)
CSE24	10 ps
CSE25	100 ps
CSE26	1 ns (nanosecond)
CSE27	10 ns
CSE28	100 ns
CSE100	Angular degrees
CSE101	Revolutions (1 = 360 degrees)
CSE102	Cycle (1 = 720 degrees)

CseCode	Time Base
CSE997	Computing cycle
CSE998	When frame available
CSE999	Always when there is a new value
CSE1000	Nondeterministic (no fixed scaling)

- Click the **Add** button  to add a trigger.
- Select a trigger and then click the **Delete** button  to remove it.



Configure AUTOSAR Computation Methods



The **CompuMethods** view in the AUTOSAR Dictionary supports modeling AUTOSAR computation methods (CompuMethods), which specify conversions between internal values and physical representation of AUTOSAR data, in Simulink. You use the AUTOSAR Dictionary to create and configure AUTOSAR CompuMethods. For more information, see “Configure AUTOSAR CompuMethods” on page 4-311.

To configure AUTOSAR CompuMethod elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. Select **CompuMethods**.

The CompuMethods view in the AUTOSAR Dictionary displays CompuMethods and their properties. You can:

- Select a CompuMethod and modify properties, such as name, category, unit, display format for measurement and calibration, AUTOSAR package to be generated for the

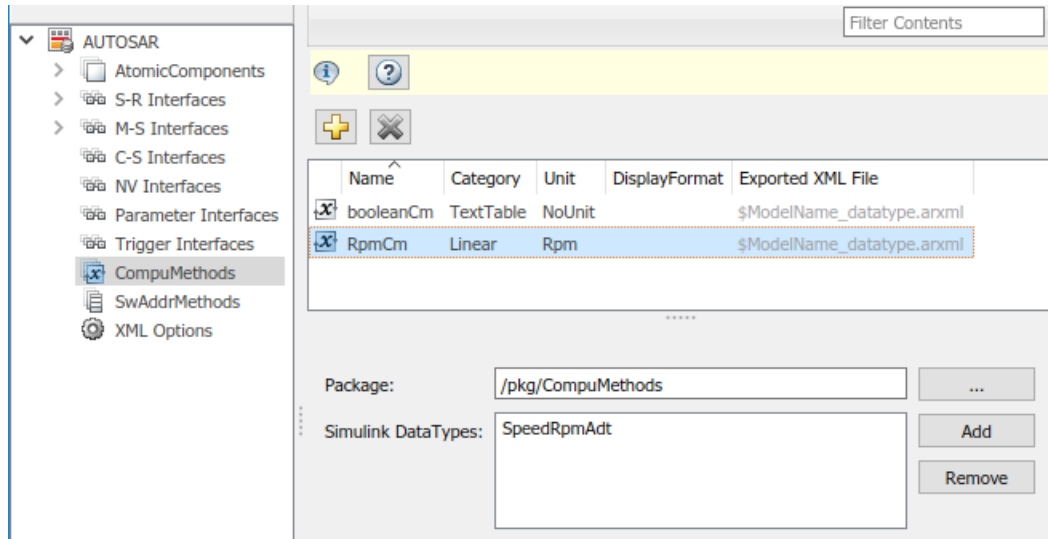
CompuMethod, and a list of Simulink data types that reference the CompuMethod. For property descriptions, see “Configure AUTOSAR CompuMethod Properties” on page 4-311.

- Click the **Add** button  to open an Add CompuMethod dialog box to add a CompuMethod.
- Select a CompuMethod and then click the **Delete** button  to remove it.

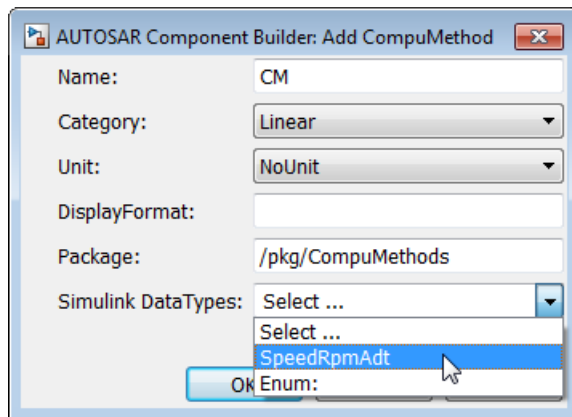
To modify the AUTOSAR package for a CompuMethod, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the CompuMethod **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.

To associate a CompuMethod with a Simulink data type used in the model, select a CompuMethod and click the **Add** button to the right of **Simulink DataTypes**. This action opens a dialog box with a list of available data types. Select a data type and click OK to add it to the **Simulink DataTypes** list. To remove a data type from the **Simulink DataTypes** list, select the data type and click **Remove**.

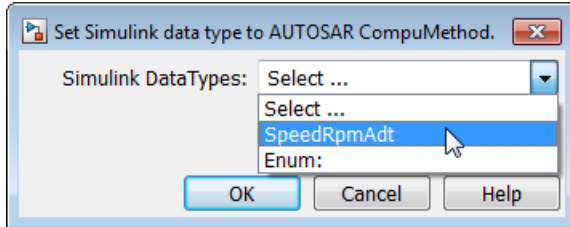


The Add CompuMethod dialog box lets you create a new CompuMethod and specify its initial properties, such as name, category, unit, display format for measurement and calibration, AUTOSAR package to be generated for the CompuMethod, and a Simulink data type that references the CompuMethod.



Clicking the **Add** button to the right of **Simulink DataTypes** opens the Set Simulink data type to AUTOSAR CompuMethod dialog box. This dialog box lets you select a Simulink data type to add to **Simulink DataTypes**, the list of Simulink data types that reference a

CompuMethod. In the list of available data types, select a `Simulink.NumericType` or `Simulink.AliasType`, or enter the name of a Simulink enumerated type.



Configure AUTOSAR SwAddrMethods

The **SwAddrMethods** view in the AUTOSAR Dictionary supports modeling AUTOSAR software address methods (SwAddrMethods). AUTOSAR software components use SwAddrMethods to group data and function definitions in memory, primarily for efficiency, performance, and data access by run-time calibration tools. In the AUTOSAR Dictionary, you can view or create AUTOSAR SwAddrMethods and then assign SwAddrMethods to data and functions that you want to group together. For more information, see “Configure SwAddrMethod” on page 4-291.

To configure AUTOSAR SwAddrMethod elements and properties, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. Select **SwAddrMethods**.



The SwAddrMethods view in the AUTOSAR Dictionary displays SwAddrMethods and their properties. You can:

- Select a SwAddrMethod and modify properties, such as name, section type, and AUTOSAR package to be generated for the SwAddrMethod.

To modify the section type, select a value from the **SectionType** drop-down list. The listed values correspond to SwAddrMethod section types listed in the AUTOSAR standard.

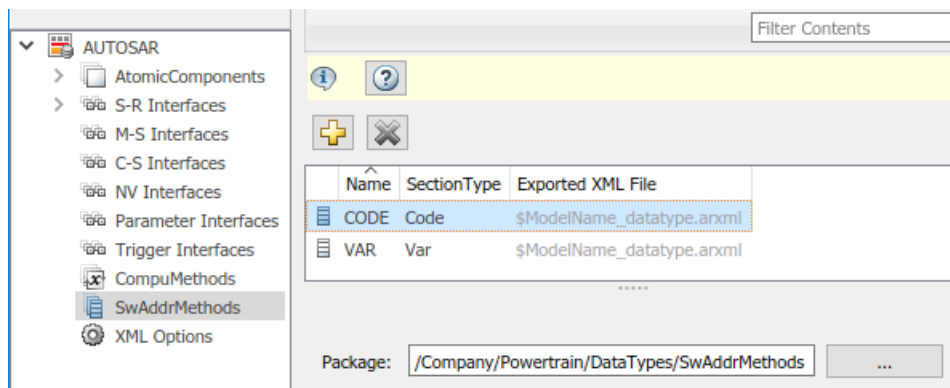
SectionType Value	SwAddrMethod Section Type
CalibrationVariables	CALIBRATION-VARIABLES
Calprm	CALPRM
Code	CODE

SectionType Value	SwAddrMethod Section Type
ConfigData	CONFIG-DATA
Const	CONST
ExcludeFromFlash	EXCLUDE-FROM-FLASH
Var	VAR

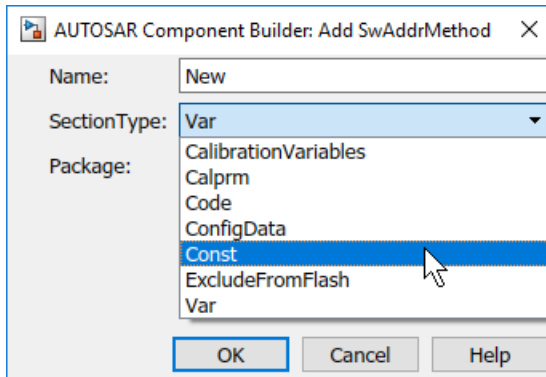
- Click the **Add** button  to open an Add SwAddrMethod dialog box to add a SwAddrMethod.
- Select a SwAddrMethod and then click the **Delete** button  to remove it.

To modify the AUTOSAR package for a SwAddrMethod, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- Click the button to the right of the **Package** field to open the AUTOSAR Package Browser. Use the browser to navigate to an existing package or create a new package. When you select a package in the browser and click **Apply**, the SwAddrMethod **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.



The Add SwAddrMethod dialog box lets you create a new SwAddrMethod and specify its initial properties, such as name, section type, and AUTOSAR package to be generated for the SwAddrMethod.

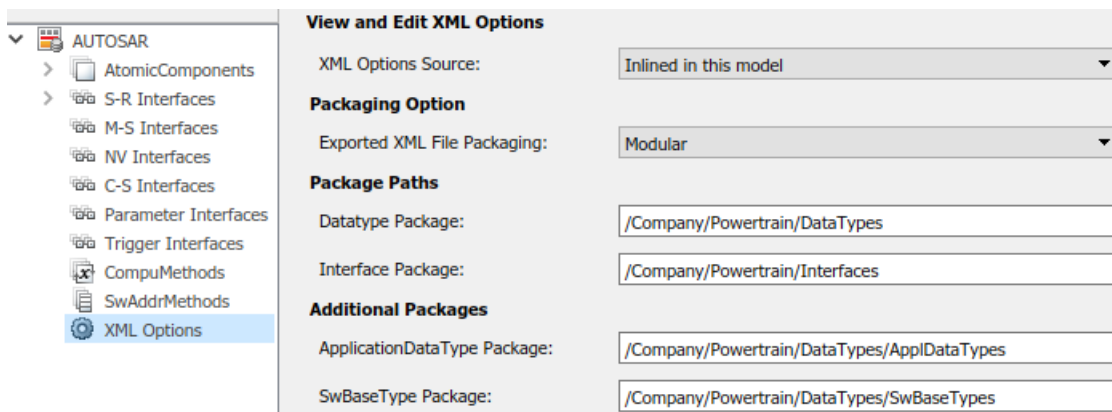


Configure AUTOSAR XML Options

To configure AUTOSAR XML options for a xml file export, open a model for which a mapped AUTOSAR software component has been created and open the AUTOSAR Dictionary. Select **XML Options**.

The XML options view in the AUTOSAR Dictionary displays XML export parameters and their values. You can configure:

- XML options source (for components in architecture modeling)
- XML file packaging for AUTOSAR elements created in Simulink
- AUTOSAR package paths
- Aspects of exported AUTOSAR XML content



- “XML Options Source” on page 4-64
- “Exported XML File Packaging” on page 4-64
- “AUTOSAR Package Paths” on page 4-65
- “Additional XML Options” on page 4-66

XML Options Source

The XML options view displays the parameter **XML Options Source**. If the current component model is contained in an AUTOSAR architecture model, this parameter indicates which XML options to use in model builds. Specify `Inherit` from `AUTOSAR architecture model` to use shared architecture model XML option settings, which promote consistency across the model hierarchy. Specify `Inlined in this model` to override the shared settings with the component model local XML option settings.

If the current component model is not contained in an AUTOSAR architecture model, the **XML Options Source** parameter has no effect.

Alternatively, you can programmatically configure the XML options source by calling the `AUTOSAR set` function. For property `XmlOptionsSource`, specify either `Inlined` or `Inherit`. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);  
set(arProps, 'XmlOptions', 'XmlOptionsSource', 'Inlined');
```

For more information about architecture model XML options, see “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32.

Exported XML File Packaging

In the XML options view, you can specify the granularity of XML file packaging for AUTOSAR elements created in Simulink. (Imported AUTOSAR XML files retain their file structure, as described in “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.) Select one of the following values for **Exported XML file packaging**.

- `Single file` — Exports XML into a single file, `modelname.arxml`.
- `Modular` — Exports XML into multiple files, named according to the type of information contained.

Exported File Name	By Default Contains...
<i>modelname_component.arxml</i>	Software components, including calibration components. This is the main arxml file exported for the Simulink model. In addition to AUTOSAR software components, the file includes elements for which AUTOSAR packages (AR-PACKAGEs) are not configured, and AR-PACKAGEs that do not align with the package paths in the other exported arxml files. For more information on AR-PACKAGEs and their location in modular exported arxml files, see “AR-PACKAGE Location in Exported ARXML Files” on page 4-119.
<i>modelname_datatype.arxml</i>	Data types and related elements.
<i>modelname_implementation.arxml</i>	Software component implementation.
<i>modelname_interface.arxml</i>	Communication interfaces, including S-R, C-S, M-S, NV, parameter, and trigger interfaces.
<i>modelname_behavior.arxml</i>	Software component internal behavior (generated only for schema 3.x or earlier).

Alternatively, you can programmatically configure exported XML file packaging by calling the AUTOSAR `set` function. For property `ArxmlFilePackaging`, specify either `SingleFile` or `Modular`. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'XmlOptions', 'ArxmlFilePackaging', 'SingleFile');
```

For more information, see “Generate AUTOSAR C and XML Files” on page 5-12.

AUTOSAR Package Paths

In the XML options view, you can configure AUTOSAR packages (AR-PACKAGEs), which contain groups of AUTOSAR elements and reside in a hierarchical AR-PACKAGE structure. (The AR-PACKAGE structure for a component is logically distinct from the arxml file partitioning selected with the XML option **Exported XML file packaging** or imported from AUTOSAR XML files.) For more information about AUTOSAR packages, see “Configure AUTOSAR Packages” on page 4-111.

Inspect and modify the AUTOSAR package paths grouped under the headings **Package Paths** and **Additional Packages**.

Package Paths	
Datatype Package:	<input type="text" value="/Company/Powertrain/DataTypes"/>
Interface Package:	<input type="text" value="/Company/Powertrain/Interfaces"/>
Additional Packages	
ApplicationDataType Package:	<input type="text" value="/Company/Powertrain/DataTypes/ApplDataTypes"/>
SwBaseType Package:	<input type="text" value="/Company/Powertrain/DataTypes/SwBaseTypes"/>
DataTypeMappingSet Package:	<input type="text"/>
ConstantSpecification Package:	<input type="text" value="/Company/Powertrain/DataTypes/Ground"/>
Physical DataConstraints Package:	<input type="text" value="/Powertrain/DataTypes/ApplDataTypes/DataConstrs"/>
SystemConstant Package:	<input type="text" value="/Company/Powertrain/DataTypes/SystemConstants"/>
SwAddressMethod Package:	<input type="text" value="/Company/Powertrain/DataTypes/SwAddrMethods"/>
ModeDeclarationGroup Package:	<input type="text"/>
CompuMethod Package:	<input type="text" value="/Company/Powertrain/DataTypes/CompuMethods"/>
Unit Package:	<input type="text" value="/Company/Powertrain/DataTypes/Units"/>
SwRecordLayout Package:	<input type="text"/>
Internal DataConstraints Package:	<input type="text" value="/Company/Powertrain/DataTypes/DataConstrs"/>

Alternatively, you can programmatically configure an AUTOSAR package path by calling the AUTOSAR `set` function. Specify a package property name and a package path. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);  
set(arProps, 'XmlOptions', 'ApplicationDataTypePackage', '/Company/Powertrain/DataTypes/ApplDataTypes');
```

For more information about AUTOSAR package property names and defaults, see “Configure AUTOSAR Packages and Paths” on page 4-113.

Additional XML Options

In the XML options view, under the heading **Additional Options**, you can configure aspects of exported AUTOSAR XML content.

Additional Options	
ImplementationDataType Reference:	Allowed
SwCalibrationAccess DefaultValue:	ReadWrite
CompuMethod Direction:	InternalToPhys
Internal DataConstraints Export:	<input checked="" type="checkbox"/>

You can:

- Optionally override the default behavior for generating AUTOSAR application data types in arxml code. To force generation of an application data type for each AUTOSAR data type, change the value of **ImplementationDataType Reference** from Allowed to NotAllowed. For more information, see “Control Application Data Type Generation” on page 4-326.
- Control the default value of the **SwCalibrationAccess** property of generated AUTOSAR measurement variables, calibration parameters, and signal and parameter data objects. Select one of the following values for **SwCalibrationAccess DefaultValue**:
 - ReadOnly — Read access only.
 - ReadWrite (default) — Read and write access.
 - NotAccessible — Not accessible with measurement and calibration tools.

For more information, see “Configure SwCalibrationAccess” on page 4-285.

- Control the direction of CompuMethod conversion for linear-function CompuMethods. Select one of the following values for **CompuMethod Direction**:
 - InternalToPhys (default) — Generate CompuMethod sections for conversion of internal values into their physical representations.
 - PhysToInternal — Generate CompuMethod sections for conversion of physical values into their internal representations.
 - Bidirectional — Generate CompuMethod sections for both internal-to-physical and physical-to-internal conversion directions.

For more information, see “Configure CompuMethod Direction for Linear Functions” on page 4-314.

- Optionally override the default behavior for generating internal data constraint information for AUTOSAR implementation data types in arxml code. To force export

of internal data constraints for implementation data types, select the option **Internal DataConstraints Export**. For more information, see “Configure AUTOSAR Internal Data Constraints Export” on page 4-324.

Alternatively, you can programmatically configure the additional XML options by calling the AUTOSAR set function. Specify a property name and value. The valid property names are ImplementationTypeReference, SwCalibrationAccessDefault, CompuMethodDirection, and InternalDataConstraintExport. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'XmlOptions', 'ImplementationTypeReference', 'NotAllowed');
set(arProps, 'XmlOptions', 'SwCalibrationAccessDefault', 'ReadOnly');
set(arProps, 'XmlOptions', 'CompuMethodDirection', 'PhysToInternal');
set(arProps, 'XmlOptions', 'InternalDataConstraintExport', true);
```

See Also

Related Examples

- “Map AUTOSAR Elements for Code Generation” on page 4-69
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “AUTOSAR Component Configuration” on page 4-3

Map AUTOSAR Elements for Code Generation

In Simulink, you can use the Code Mappings editor and the AUTOSAR Dictionary separately or together to graphically configure an AUTOSAR software component and map Simulink model elements to AUTOSAR component elements. For more information, see “AUTOSAR Component Configuration” on page 4-3.

Use the Code Mappings editor to map Simulink model elements to AUTOSAR component elements from a Simulink model perspective. The editor display consists of several tabbed tables, including **Functions**, **Inports**, and **Outports**. Use the tables to select Simulink elements and map them to corresponding AUTOSAR elements. The mappings that you configure are reflected in generated AUTOSAR-compliant C code and exported arxml descriptions.

The Code Mappings editor also provides mapping for submodels referenced from AUTOSAR software component models. For more information, see “Map Calibration Data for Submodels Referenced from AUTOSAR Component Models” on page 4-86.

In this section...

“Simulink to AUTOSAR Mapping Workflow” on page 4-69

“Map Entry-Point Functions to AUTOSAR Runnables” on page 4-71

“Map Inports and Outports to AUTOSAR Sender-Receiver Ports” on page 4-72

“Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74

“Map Data Stores to AUTOSAR Variables” on page 4-77

“Map Block Signals and States to AUTOSAR Variables” on page 4-80

“Map Data Transfers to AUTOSAR Inter-Runnable Variables” on page 4-82

“Map Function Callers to AUTOSAR Client-Server Ports and Operations” on page 4-83

“Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84

Simulink to AUTOSAR Mapping Workflow

To map Simulink model elements to AUTOSAR software component elements:

- 1 Open a model for which AUTOSAR system target file `autosar.tlc` is selected.
- 2 Create or open a mapped view of the AUTOSAR model. In the model window, do one of the following:

- From the **Apps** tab, open the AUTOSAR Component Designer app.
- Click the perspective control in the lower-right corner and select **Code**.

If the model has not yet been mapped to an AUTOSAR software component, the AUTOSAR Component Quick Start opens. To configure the model for AUTOSAR component development, work through the quick-start procedure and click **Finish**. For more information, see “Create Mapped AUTOSAR Component with Quick Start” on page 3-2.

The model opens in the AUTOSAR code perspective. This perspective displays a help panel, a Property Inspector dialog box, and, directly under the model, the Code Mappings editor.

The screenshot displays the AUTOSAR Component Designer interface in the Code perspective. The main workspace shows a UML diagram with components like `Initialize_Function`, `Trigger_1s`, and `SS1`. A Property Inspector on the right shows details for the `SubVal` port. A Code Mappings editor at the bottom provides a table of mappings between source and target elements.


Source	DataAccessMode	Port	Element
SubVal	ImplicitReceive	RPort	SubVal
Override	ImplicitReceive	RPort	Override

The Code Mappings editor provides in-canvas access to AUTOSAR mapping information, with batch editing, element filtering, easy navigation to model elements and AUTOSAR properties, and model element traceability.

3 Navigate the Code Mappings editor tabs to perform these actions:

- Map a Simulink entry-point function to an AUTOSAR runnable.
- Map a Simulink inport or outport to an AUTOSAR receiver or sender port and a sender-receiver data element, with a specific data access mode.
- Map a Simulink model workspace parameter to an AUTOSAR component internal parameter.
- Map a Simulink data store to an AUTOSAR variable.
- Map a Simulink block signal or state to an AUTOSAR variable.
- Map a Simulink data transfer line to an AUTOSAR inter-runnable variable (IRV).
- Map a Simulink function caller to an AUTOSAR client port and a client-server operation.


Use the **Filter contents** field (where available) to selectively display some elements, while omitting others, in the current view.

4 After mapping model elements, click the **Validate** button  to validate the AUTOSAR component configuration. If errors are reported, address them and then retry validation.

Map Entry-Point Functions to AUTOSAR Runnables

The **Functions** tab of the Code Mappings editor supports modeling AUTOSAR runnable entities (runnables) in Simulink. After using the AUTOSAR Dictionary to create AUTOSAR runnables and AUTOSAR events, which implement aspects of internal behavior in an AUTOSAR component, open the Code Mappings editor. Use the **Functions** tab to map Simulink entry-point functions to AUTOSAR runnables.

For more information, see “Configure AUTOSAR Runnables and Events” on page 4-224.

The **Functions** tab of the Code Mappings editor maps each Simulink entry-point function to an AUTOSAR runnable. Click the **Update** button  to load or update Simulink entry-point functions in the model.

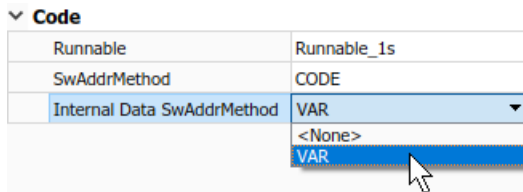
In the **Functions** tab, you can:

- Map a Simulink entry-point function by selecting the entry-point function and then selecting a menu value for an AUTOSAR runnable, among those listed for the AUTOSAR component.

Source	Runnable
<i>fx</i> Exported Function:Trigger_1s	Runnable_1s
<i>fx</i> Initialize Function	Runnable_Init
<i>fx</i> readData	Runnable_readData

- Specify software address methods (SwAddrMethods) for the runnable function code and internal data. If you specify SwAddrMethod names, code generation uses the names to group runnable function and data definitions in memory sections. For more information, see “Configure SwAddrMethod” on page 4-291.

To specify SwAddrMethods for a runnable, select the corresponding entry-point function. The Property Inspector displays the code attributes **SwAddrMethod** and **Internal Data SwAddrMethod** for the selected function. In the Property Inspector, select SwAddrMethod names among the valid values listed for each property.



To create additional SwAddrMethod names in the component, use the AUTOSAR Dictionary, SwAddrMethods view. For more information, see “Configure AUTOSAR SwAddrMethods” on page 4-61.

Note Code generation for runnable internal data SwAddrMethods requires setting the model configuration option **Code Generation > Interface > Generate separate internal data per entry-point function** (GroupInternalDataByFunction) to on.

Map Inports and Outports to AUTOSAR Sender-Receiver Ports

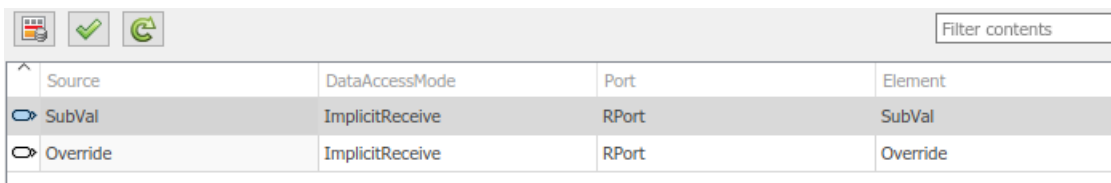
The **Inports** and **Outports** tabs of the Code Mappings editor support modeling AUTOSAR sender-receiver (S-R) communication in Simulink. After using the AUTOSAR Dictionary to create AUTOSAR S-R ports, S-R interfaces, and S-R data elements in your model, open the Code Mappings editor. Use the **Inports** and **Outports** tabs to map Simulink root

inports and outports to AUTOSAR receiver and sender ports and AUTOSAR S-R data elements.

For more information, see “Configure AUTOSAR Sender-Receiver Communication” on page 4-126 and “Configure AUTOSAR Queued Sender-Receiver Communication” on page 4-145.

The **Inports** tab of the Code Mappings editor maps each Simulink root inport to an AUTOSAR receiver port and an S-R interface data element. In the **Inports** tab, you can:

- Map a Simulink inport by selecting the inport and then selecting menu values for an AUTOSAR port and an AUTOSAR element, among those listed for the AUTOSAR component.
- Select an AUTOSAR data access mode for the port: `ImplicitReceive`, `ExplicitReceive`, `ExplicitReceiveByVal`, `QueuedExplicitReceive`, `ErrorStatus`, `IsUpdated`, `EndToEndRead`, or `ModeReceive`.



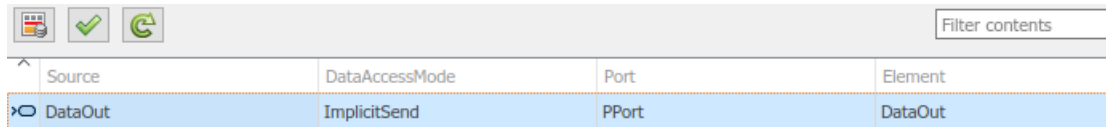
Source	DataAccessMode	Port	Element
SubVal	ImplicitReceive	RPort	SubVal
Override	ImplicitReceive	RPort	Override

When you select an inport that maps to an AUTOSAR nonqueued receiver port, the Property Inspector displays additional port communication specification (ComSpec) attributes. For AUTOSAR receiver ports, you can modify ComSpec attributes `AliveTimeout`, `HandleNeverReceived`, and `InitValue`. For more information, see “Configure AUTOSAR Sender-Receiver Port ComSpecs” on page 4-141.

Code	
DataAccessMode	ImplicitReceive
Port	RPort
Element	SubVal
Communication attributes	
AliveTimeout	60
HandleNeverReceived	false
InitValue	0

The **Outports** tab of the Code Mappings editor maps each Simulink root outport to an AUTOSAR sender port and an S-R interface data element. In the **Outports** tab, you can:

- Map a Simulink output port by selecting the output port and then selecting menu values for an AUTOSAR port and an AUTOSAR element.
- Select an AUTOSAR data access mode for the port: `ImplicitSend`, `ImplicitSendByRef`, `ExplicitSend`, `QueuedExplicitSend`, `EndToEndWrite`, or `ModeSend`.



Source	DataAccessMode	Port	Element
DataOut	ImplicitSend	PPort	DataOut

When you select an output port that maps to an AUTOSAR nonqueued sender port, the Property Inspector displays additional port communication specification (ComSpec) attributes. For AUTOSAR sender ports, you can modify the ComSpec attribute `InitValue`. For more information, see “Configure AUTOSAR Sender-Receiver Port ComSpecs” on page 4-141.

Code	
DataAccessMode	ImplicitSend
Port	PPort
Element	DataOut
Communication attributes	
InitValue	0

Map Model Workspace Parameters to AUTOSAR Component Internal Parameters

On the **Parameters** tab of the Code Mappings editor, you can map Simulink model workspace parameters to AUTOSAR parameters for AUTOSAR run-time calibration. Examples of model workspace parameters you can map include:

- Simulink parameter objects
- Simulink lookup table objects
- Simulink breakpoint objects

By mapping lookup table and breakpoint objects to AUTOSAR internal calibration parameters, you can model AUTOSAR parameters for integrated and distributed lookups. For more information, see “Configure Lookup Tables for AUTOSAR Measurement and Calibration” on page 4-298.

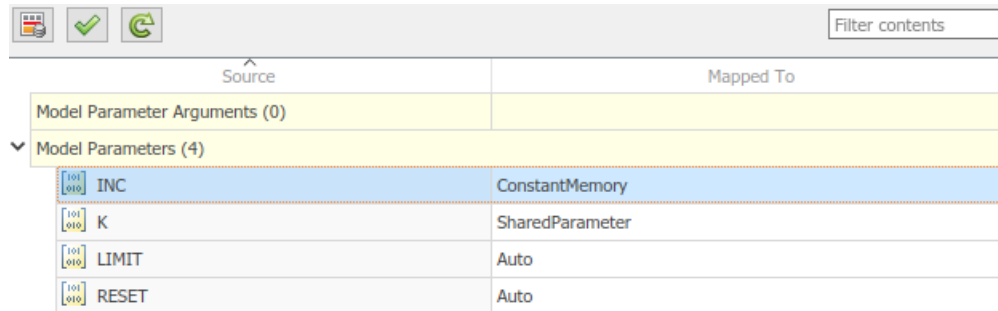
After creating model workspace parameters, for example, using Model Explorer, open the Code Mappings editor and select the **Parameters** tab. Select Simulink model workspace parameters and map them to AUTOSAR component internal parameters, such as constant memory, shared parameters, or per-instance parameters.

For more information, see “Configure AUTOSAR Constant Memory” on page 4-256 and “Configure AUTOSAR Shared or Per-Instance Parameters” on page 4-259.

The **Parameters** tab lists each Simulink model workspace parameter that you can map to an AUTOSAR parameter. On the **Parameters** tab:

- If a Simulink model workspace parameter is not configured as a model argument (that is, not unique to each instance of a multi-instance model), you can map the parameter by selecting it and then selecting a menu value for an AUTOSAR parameter type. For this workflow, the valid parameter types are `ConstantMemory`, `SharedParameter`, or `Auto`. To accept software mapping defaults, specify `Auto`.

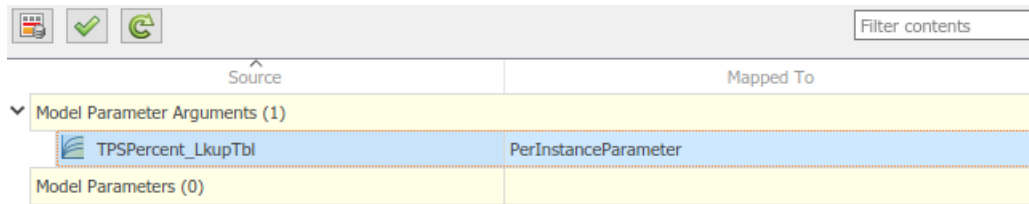
For example, here is the **Parameters** tab for example model `autosar_sw_counter`.



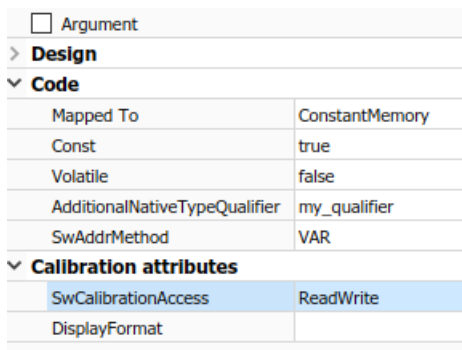
Source	Mapped To
Model Parameter Arguments (0)	
Model Parameters (4)	
INC	ConstantMemory
K	SharedParameter
LIMIT	Auto
RESET	Auto

- If a Simulink model workspace parameter is configured as a model argument (that is, unique to each instance of a multi-instance model), map the parameter by selecting it and then selecting a menu value for an AUTOSAR parameter type. For this workflow, the valid parameter types are `PerInstanceParameter` or `Auto`. To accept software mapping defaults, specify `Auto`.

For example, here is the **Parameters** tab for example model `autosar_sw_throttle_sensor`. Example model `autosar_composition` contains two instances of `autosar_sw_throttle_sensor`.



- If you select a parameter type other than `Auto`, use the Property Inspector to view or modify other code and calibration attributes for the parameter.



Attribute	Purpose
Const (ConstantMemory only)	Specify whether to include C type qualifier <code>const</code> in generated code for the AUTOSAR parameter. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.
Volatile (ConstantMemory only)	Specify whether to include C type qualifier <code>volatile</code> in generated code for the AUTOSAR parameter. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.

Attribute	Purpose
AdditionalNativeTypeQualifier (ConstantMemory only)	Specify an AUTOSAR additional native type qualifier to include in generated code for the AUTOSAR parameter. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.
SwAddrMethod	Select a SwAddrMethod name from the names listed as valid for the AUTOSAR parameter. Code generation uses the SwAddrMethod name to group AUTOSAR parameters in a memory section for access by measurement and calibration tools. For more information, see “Configure SwAddrMethod” on page 4-291.
SwCalibrationAccess	Specify how measurement and calibration tools can access the AUTOSAR parameter. Valid access values include ReadOnly , ReadWrite , and NotAccessible . For more information, see “Configure SwCalibrationAccess” on page 4-285.
DisplayFormat	Specify display format for the AUTOSAR parameter. AUTOSAR display format specifications control the width and precision display for measurement and calibration data. For more information, see “Configure DisplayFormat” on page 4-287.

Map Data Stores to AUTOSAR Variables

On the **Data Stores** tab of the Code Mappings editor, you can map Simulink data store memory blocks to AUTOSAR variables for AUTOSAR run-time calibration. After creating data store memory blocks in your model, open the Code Mappings editor and select the **Data Stores** tab. Select data stores and map them to AUTOSAR variables, such as AUTOSAR-typed per-instance memory or AUTOSAR static memory.

For more information, see “Configure AUTOSAR Per-Instance Memory” on page 4-246 and “Configure AUTOSAR Static Memory” on page 4-251.

The **Data Stores** tab lists each data store that you can map to an AUTOSAR variable. You can:

- Map a Simulink data store by selecting the data store, and then selecting a menu value for an AUTOSAR variable type: `ArTypedPerInstanceMemory`, `StaticMemory`, or `Auto`. To accept software mapping defaults, specify `Auto`.

Source	Mapped To	Path
<ul style="list-style-type: none"> Data Stores (1) <ul style="list-style-type: none"> LowSetPoint 	ArTypedPerInstanceMemory	autosar_bsw_sensor1

- If you select a variable type other than `Auto`, use the Property Inspector to view or modify other code and calibration attributes for the variable.

<input type="checkbox"/> Shared	
<ul style="list-style-type: none"> Design Code <ul style="list-style-type: none"> Mapped To: ArTypedPerInstanceMemory Path: autosar_bsw_sensor1 ShortName: NeedsNVRAMAccess: false SwAddrMethod: Calibration attributes <ul style="list-style-type: none"> SwCalibrationAccess: ReadOnly DisplayFormat: 	

Attribute	Purpose
ShortName	Specify short name for the AUTOSAR variable. If unspecified, <code>arxml</code> export generates a short name.

Attribute	Purpose
Volatile (StaticMemory only)	Specify whether to include C type qualifier <code>volatile</code> in generated code for the AUTOSAR variable. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.
AdditionalNativeTypeQualifier (StaticMemory only)	Specify an AUTOSAR additional native type qualifier to include in generated code for the AUTOSAR variable. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.
NeedsNVRAMAccess (ArTypedPerInstanceMemory only)	Specify whether the AUTOSAR variable needs access to nonvolatile RAM on a processor. Select <code>true</code> to configure the per-instance memory to be a mirror block for a specific NVRAM block.
SwAddrMethod	Select a <code>SwAddrMethod</code> name from the names listed as valid for the AUTOSAR variable. Code generation uses the <code>SwAddrMethod</code> name to group AUTOSAR variables in a memory section for access by measurement and calibration tools. For more information, see “Configure <code>SwAddrMethod</code> ” on page 4-291.
SwCalibrationAccess	Specify how measurement and calibration tools can access the AUTOSAR variable. Valid access values include <code>ReadOnly</code> , <code>ReadWrite</code> , and <code>NotAccessible</code> . For more information, see “Configure <code>SwCalibrationAccess</code> ” on page 4-285.

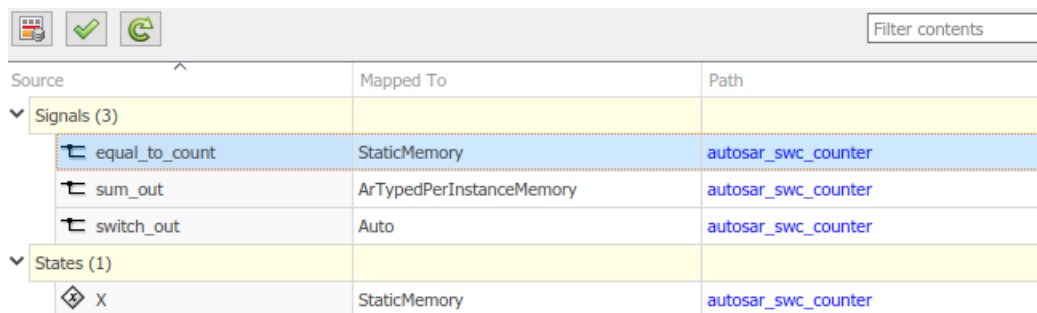
Attribute	Purpose
DisplayFormat	Specify display format for the AUTOSAR variable. AUTOSAR display format specifications control the width and precision display for measurement and calibration data. For more information, see “Configure DisplayFormat” on page 4-287.

Map Block Signals and States to AUTOSAR Variables

On the **Signals/States** tab of the Code Mappings editor, you can map Simulink block signals and states to AUTOSAR variables for AUTOSAR run-time calibration. After creating named or test-pointed Simulink block signals or Simulink state owner blocks in your model, open the Code Mappings editor and select the **Signals/States** tab. Select block signals and states and map them to AUTOSAR variables, such as AUTOSAR-typed per-instance memory or AUTOSAR static memory.

For more information, see “Configure AUTOSAR Per-Instance Memory” on page 4-246 and “Configure AUTOSAR Static Memory” on page 4-251.

The **Signals/States** tab, **Signals** node, lists each named or test-pointed Simulink block signal that you can map to an AUTOSAR variable. You can map a Simulink block signal by selecting the signal and then selecting a menu value for an AUTOSAR variable type: `ArTypedPerInstanceMemory`, `StaticMemory`, or `Auto`. To accept software mapping defaults, specify `Auto`.



The screenshot shows the Code Mappings editor interface. At the top, there are three icons (a document, a checkmark, and a refresh) and a search box labeled "Filter contents". Below the icons is a table with three columns: "Source", "Mapped To", and "Path". The table is organized into two main sections: "Signals (3)" and "States (1)".

Source	Mapped To	Path
<ul style="list-style-type: none"> Signals (3) <ul style="list-style-type: none"> equal_to_count sum_out switch_out 		
<ul style="list-style-type: none"> equal_to_count 	StaticMemory	autosar_swc_counter
<ul style="list-style-type: none"> sum_out 	ArTypedPerInstanceMemory	autosar_swc_counter
<ul style="list-style-type: none"> switch_out 	Auto	autosar_swc_counter
<ul style="list-style-type: none"> States (1) <ul style="list-style-type: none"> X 		
<ul style="list-style-type: none"> X 	StaticMemory	autosar_swc_counter

The **Signals/States** tab, **States** node, lists each configurable Simulink block state that you can map to an AUTOSAR variable. You can map a Simulink block state by selecting

the state and then selecting a menu value for an AUTOSAR variable type: `ArTypedPerInstanceMemory`, `StaticMemory`, or `Auto`. To accept software mapping defaults, specify `Auto`.

In either tab, if you map a signal or state to a variable type other than `Auto`, you can use the Property Inspector to view or modify other code and calibration attributes for the variable.

Code	
Mapped To	StaticMemory
Path	autosar_swc_counter
ShortName	SM_equal_to_count
Volatile	true
AdditionalNativeTypeQualifier	my_qualifier
SwAddrMethod	VAR
Calibration attributes	
SwCalibrationAccess	ReadOnly
DisplayFormat	


Attribute	Purpose
ShortName	Specify short name for the AUTOSAR variable. If unspecified, a <code>rxml</code> export generates a short name. <ul style="list-style-type: none"> For signals, the auto-generated short name can differ from the signal name. For states, the auto-generated short name is based on the state name if one exists. If the state is unnamed, the generated name can differ from the block name.
Volatile (<code>StaticMemory</code> only)	Specify whether to include C type qualifier <code>volatile</code> in generated code for the AUTOSAR variable. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.

Attribute	Purpose
AdditionalNativeTypeQualifier (StaticMemory only)	Specify an AUTOSAR additional native type qualifier to include in generated code for the AUTOSAR variable. For more information, see “Specify C Type Qualifiers for AUTOSAR Static and Constant Memory” on page 4-84.
SwAddrMethod	Select a SwAddrMethod name from the names listed as valid for the AUTOSAR variable. Code generation uses the SwAddrMethod name to group AUTOSAR variables in a memory section for access by measurement and calibration tools. For more information, see “Configure SwAddrMethod” on page 4-291.
SwCalibrationAccess	Specify how measurement and calibration tools can access the AUTOSAR variable. Valid access values include ReadOnly , ReadWrite , and NotAccessible . For more information, see “Configure SwCalibrationAccess” on page 4-285.
DisplayFormat	Specify display format for the AUTOSAR variable. AUTOSAR display format specifications control the width and precision display for measurement and calibration data. For more information, see “Configure DisplayFormat” on page 4-287.

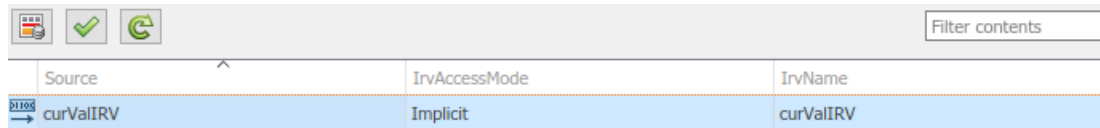
Map Data Transfers to AUTOSAR Inter-Runnable Variables

The **Data Transfers** tab of the Code Mappings editor supports modeling AUTOSAR inter-runnable variables (IRVs) in Simulink. After using the AUTOSAR Dictionary to create AUTOSAR IRVs, which connect runnables and implement aspects of internal behavior in an AUTOSAR component, open the Code Mappings editor. Use the **Data Transfers** tab to map Simulink data transfer lines to AUTOSAR IRVs.

For more information, see “Model AUTOSAR Component Behavior” on page 2-39. For illustrations of how IRVs are used with rate-based and function-call-based runnables, see the example models in “Model AUTOSAR Software Components” on page 2-3.

The **Data Transfers** tab of the Code Mappings editor maps each Simulink data transfer line to an AUTOSAR IRV. Click the **Update** button  to load or update Simulink data transfers in your model.

In the **Data Transfers** tab, you can map a Simulink data transfer line by selecting the signal name and then selecting menu values for an IRV access mode (**Implicit** or **Explicit**) and an AUTOSAR IRV name, among those listed for the AUTOSAR component.




Source	IrvAccessMode	IrvName
curValIRV	Implicit	curValIRV

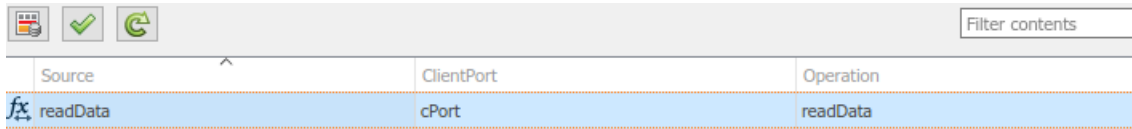
Map Function Callers to AUTOSAR Client-Server Ports and Operations

The **Function Callers** tab of the Code Mappings editor supports modeling the client side of AUTOSAR client-server (C-S) communication in Simulink. After using the AUTOSAR Dictionary to create AUTOSAR client ports, C-S interfaces, and C-S operations in your model, open the Code Mappings editor. Use the **Function Callers** tab to map Simulink function callers to AUTOSAR client ports and AUTOSAR C-S operations.

For more information, see “Configure AUTOSAR Client-Server Communication” on page 4-171.

The **Function Callers** tab of the Code Mappings editor maps each Simulink function caller to an AUTOSAR client port and an AUTOSAR C-S interface operation. Click the **Update** button  to load or update Simulink function callers in the model.

In the **Function Callers** tab, you can map a Simulink function caller by selecting the function caller name and then selecting menu values for an AUTOSAR client port and an AUTOSAR operation, among those listed for the AUTOSAR component.



Source	ClientPort	Operation
readData	cPort	readData

Specify C Type Qualifiers for AUTOSAR Static and Constant Memory

For an AUTOSAR component, you can configure C type qualifiers to customize generated AUTOSAR-compliant C code for AUTOSAR static memory and AUTOSAR constant memory. For example, you can apply C type qualifiers such as `const` or `volatile` to control compiler optimizations.

In an AUTOSAR model, use the Code Mappings editor to configure C type qualifiers for model signals, states, data stores, and parameters that are mapped to AUTOSAR `StaticMemory` or AUTOSAR `ConstantMemory`. Building the model exports type qualifiers to `arxml` files and generates AUTOSAR-compliant C code that uses the type qualifiers.

For example, in the Code Mappings editor, **Signals/States** tab, suppose that you map a signal to `StaticMemory`. Select the signal to display code attributes in the Property Inspector.

Code	
Mapped To	StaticMemory
Path	autosar_swc_counter
ShortName	SM_equal_to_count
Volatile	true
AdditionalNativeTypeQualifier	my_qualifier
SwAddrMethod	VAR
Calibration attributes	
SwCalibrationAccess	ReadOnly
DisplayFormat	

If you set the `Volatile` attribute to `true` and specify `AdditionalNativeTypeQualifier` to be `my_qualifier`:

- Exported `arxml` files define the `AdditionalNativeTypeQualifier`:

```
<ADDITIONAL-NATIVE-TYPE-QUALIFIER>volatile my_qualifier</ADDITIONAL-NATIVE-TYPE-QUALIFIER>
```
- Generated C code uses the C type qualifiers, for example:

```
/* Static Memory for Internal Data */  
volatile my_qualifier boolean SM_equal_to_count;
```

For more information, see “Map Block Signals and States to AUTOSAR Variables” on page 4-80, “Map Data Stores to AUTOSAR Variables” on page 4-77, and “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.

See Also

Related Examples

- “Map Calibration Data for Submodels Referenced from AUTOSAR Component Models” on page 4-86
- “Configure AUTOSAR Elements and Properties” on page 4-8
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332

More About

- “AUTOSAR Component Configuration” on page 4-3

Map Calibration Data for Submodels Referenced from AUTOSAR Component Models

In a Simulink implementation of an AUTOSAR design, model references allow you to organize and manage large or numerous AUTOSAR components hierarchically. You can define an algorithm in a submodel and reference it repeatedly. Referenced models compile independently from the models that use them, which allows modular development, reuse and sharing of algorithms across multiple components and designs, and incremental code generation.

For any model in an AUTOSAR model reference hierarchy, you can configure the model data for run-time calibration. In submodels referenced from AUTOSAR software component models, you can use the Code Mappings editor or equivalent functions to map parameters, data stores, signals, and states. Submodel mapped internal data can be used in memory sections, and is available for software-in-the-loop (SIL) and processor-in-the-loop (PIL) testing from the top model or calibration in the AUTOSAR run-time environment.

In this section...
“Submodel Data Mapping Workflow” on page 4-86
“Map Submodel Parameters to AUTOSAR Component Internal Parameters” on page 4-90
“Map Submodel Data Stores to AUTOSAR Variables” on page 4-92
“Map Submodel Signals and States to AUTOSAR Variables” on page 4-94
“Generate Submodel Data Macros for Verification and Deployment” on page 4-97

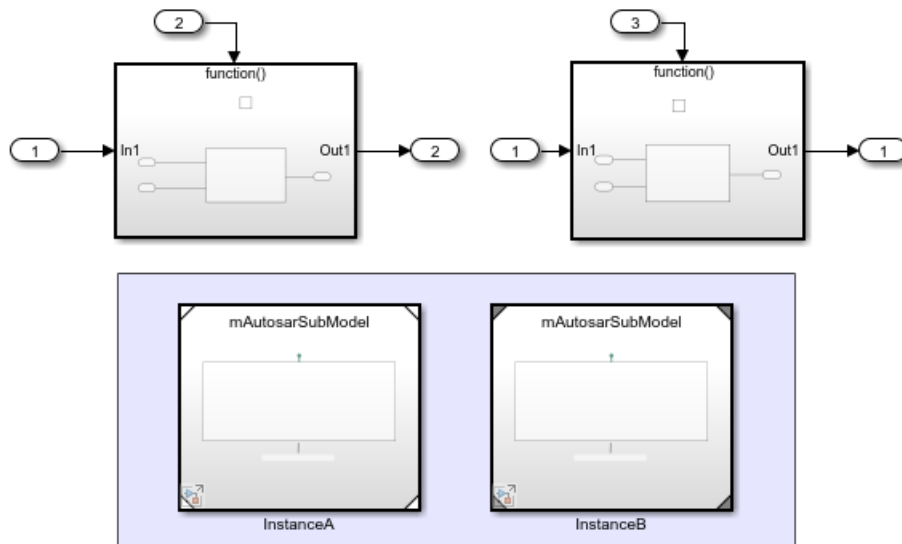
Submodel Data Mapping Workflow

To map Simulink submodel elements to AUTOSAR software component elements:

- Configure the submodel as a model referenced from an AUTOSAR software component model. Use the AUTOSAR Component Quick Start or the AUTOSAR function `autosar.api.create`.
- In the AUTOSAR code perspective, use the Code Mappings editor to configure the submodel internal data.

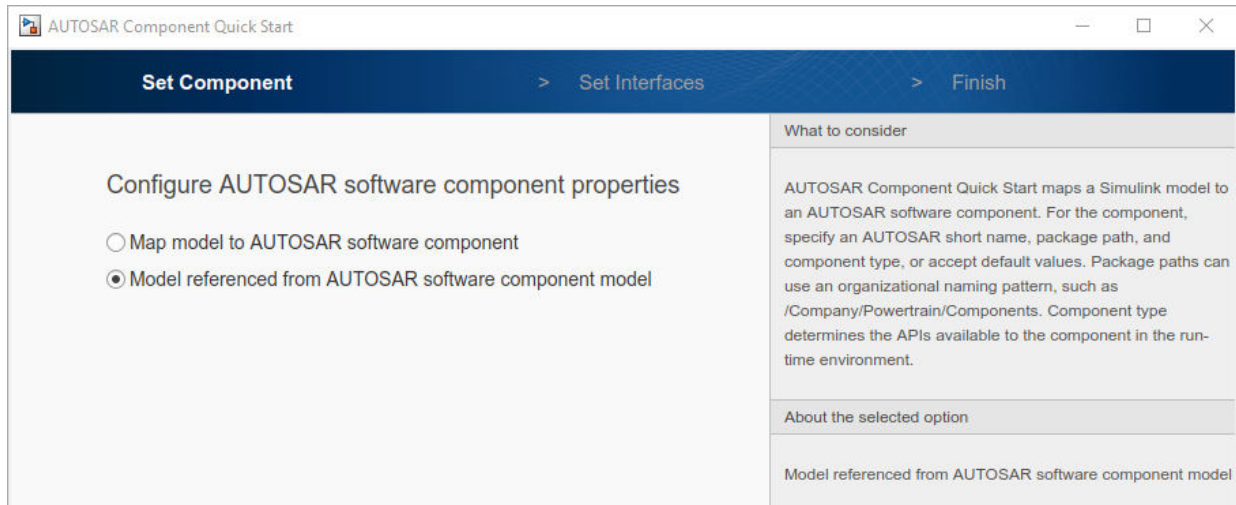
- To generate C code and AUTOSAR XML (arxml) files that support run-time calibration of the submodel internal data, open and build the component model that references the submodel.

For this example, select a model that is referenced from an AUTOSAR software component model. This example uses `mAutosarSubModel`, which is referenced twice in the AUTOSAR component model `mAutosarTopModel`. (You can copy the models from `matlabroot/help/toolbox/autosar/examples` to a working folder.)



Open the submodel standalone, that is, in a separate model window. In the model window, from the **Apps** tab, open the AUTOSAR Component Designer app. If the submodel is mapped, it opens in the AUTOSAR code perspective.

If the submodel is unmapped, the AUTOSAR Component Quick Start opens. Work through the quick-start procedure. In the **Set Component** pane, select **Model referenced from AUTOSAR software component model**



When you complete the quick-start procedure and click **Finish**, the submodel opens in the AUTOSAR code perspective.

In the AUTOSAR code perspective, use the Code Mappings editor to:

- Map individual parameters to `PerInstanceParameters`.
- Map individual signals, states, and data stores to `ArTypedPerInstanceMemorys`.
- After setting the **Mapped To** property for a parameter, signal, state, or data store, use the Property Inspector to set code and calibration attributes.

The screenshot displays the Simulink environment with a submodel named 'mAutosarSubModel'. The main workspace shows a block diagram for 'y = CalculateSum(u1,u2)'. Below the workspace is the 'Code Mappings - Submodel (Referenced from AUTOSAR SW Component model)' window, which has tabs for 'Parameters', 'Data Stores', and 'Signals/States'. The 'Parameters' tab is active, showing a table of mappings.

Source	Mapped To
Model Parameter Arguments (4)	
engine_speed	PerInstanceParameter
max_press	PerInstanceParameter
max_speed	PerInstanceParameter
PressureEstimation	PerInstanceParameter
Model Parameters (0)	

To the right is the 'Property Inspector' for the 'Parameters: engine_speed'. It shows the following details:

NAME	VALUE
Source	engine_speed
Description	Engine Speed
<input checked="" type="checkbox"/> Argument	
> Design	
> Code	
Mapped To	PerInstanceParameter
SwAddrMethod	CALIB_32
> Calibration attributes	
SwCalibrationAccess	ReadOnly
DisplayFormat	%5.1f

If you have Simulink Coder and Embedded Coder software, you can build the component model that references the submodel. When you build, the exported arxml files and generated C code support run-time calibration of the submodel internal data. The arxml files exported for the top model include descriptions of the submodel parameters, signals, states, and data stores, as well as software address methods used in the submodel. The generated C code references the submodel internal data. The model build also generates macros that provide access to the submodel data for SIL and PIL testing and calibration in the AUTOSAR run-time environment. For more information, see “Generate Submodel Data Macros for Verification and Deployment” on page 4-97.

To programmatically configure a submodel as a model referenced from an AUTOSAR software component model, call the AUTOSAR function `autosar.api.create` and

specify the name-value pair argument 'ReferencedFromComponentModel', true. For example:

```
hModel = 'mAutosarSubModel';
open_system(hModel);
autosar.api.create(hModel, 'default', 'ReferencedFromComponentModel', true);
```

To programmatically add shared definitions of software address methods to use with the submodel, call the AUTOSAR importer function `updateModel` and specify the name of an AUTOSAR XML (`arxml`) file containing the shared definitions. For example:

```
ar = arxml.importer('SwAddrMethods.arxml');
updateModel(ar, hModel);
```

Map Submodel Parameters to AUTOSAR Component Internal Parameters

On the **Parameters** tab of the Code Mappings editor, you can map Simulink submodel parameters to AUTOSAR per-instance parameters for AUTOSAR run-time calibration. Examples of model workspace parameters you can map include:

- Simulink parameter objects
- Simulink lookup table objects
- Simulink breakpoint objects

By mapping lookup table and breakpoint objects to AUTOSAR internal calibration parameters, you can model AUTOSAR parameters for integrated and distributed lookups. For more information, see “Configure Lookup Tables for AUTOSAR Measurement and Calibration” on page 4-298.


After creating model workspace parameters in your model, for example, using Model Explorer, open the Code Mappings editor and select the **Parameters** tab. Select Simulink model workspace parameters and map them to AUTOSAR component per-instance parameters.

For more information, see “Configure Model Workspace Parameters as AUTOSAR Per-Instance Parameters” on page 4-261.

The **Parameters** tab lists each Simulink model workspace parameter that you can map to an AUTOSAR parameter. You can:

- Map a parameter by selecting it and then selecting a menu value for an AUTOSAR parameter type: `PerInstanceParameter` or `Auto`. To accept software mapping defaults, specify `Auto`.

For example, here is the **Parameters** tab for submodel `mAutosarSubModel`. AUTOSAR software component model `mAutosarTopModel` contains two instances of `mAutosarSubModel`.

Filter contents	
Source	Mapped To
^ Model Parameter Arguments (4)	
[101] engine_speed [010]	PerInstanceParameter
[101] max_press [010]	PerInstanceParameter
[101] max_speed [010]	PerInstanceParameter
 PressureEstimation	PerInstanceParameter
Model Parameters (0)	

- If you select parameter type `PerInstanceParameter`, use the Property Inspector to view or modify other code and calibration attributes for the parameter.

<input checked="" type="checkbox"/> Argument	
> Design	
> Code	
Mapped To	PerInstanceParameter
SwAddrMethod	CALIB_32
> Calibration attributes	
SwCalibrationAccess	ReadOnly
DisplayFormat	%5.1f

Attribute	Purpose
SwAddrMethod	Select a SwAddrMethod name from the names listed as valid for the AUTOSAR parameter. Code generation uses the SwAddrMethod name to group AUTOSAR parameters in a memory section for access by measurement and calibration tools. For more information, see “Configure SwAddrMethod” on page 4-291.
SwCalibrationAccess	Specify how measurement and calibration tools can access the AUTOSAR parameter. Valid access values include ReadOnly, ReadWrite, and NotAccessible. For more information, see “Configure SwCalibrationAccess” on page 4-285.
DisplayFormat	Specify display format for the AUTOSAR parameter. AUTOSAR display format specifications control the width and precision display for measurement and calibration data. For more information, see “Configure DisplayFormat” on page 4-287.

Map Submodel Data Stores to AUTOSAR Variables


On the **Data Stores** tab of the Code Mappings editor, you can map Simulink submodel data store memory blocks to AUTOSAR-typed per-instance memory elements for AUTOSAR run-time calibration.

After creating data store memory blocks in your model, open the Code Mappings editor and select the **Data Stores** tab. Select data stores and map them to AUTOSAR-typed per-instance memory elements. For more information, see “Configure AUTOSAR Per-Instance Memory” on page 4-246.

The **Data Stores** tab lists each Simulink data store that you can map to an AUTOSAR variable. You can:

- Map a data store by selecting the data store, and then selecting a menu value for an AUTOSAR variable type: `ArTypedPerInstanceMemory` or `Auto`. To accept software mapping defaults, specify `Auto`.

For example, here is the **Data Stores** tab for submodel `mAutosarSubModel`. AUTOSAR software component model `mAutosarTopModel` contains two instances of `mAutosarSubModel`.

Filter contents		
Source	Mapped To	Path
Data Stores (1)		
 DSM_local	ArTypedPerInstanceMemory	mAutosarSubModel/Simulink Function

- If you select variable type `ArTypedPerInstanceMemory`, use the Property Inspector to view or modify other code and calibration attributes for the variable.

<input type="checkbox"/> Shared	
> Design	
Code	
Mapped To	ArTypedPerInstanceMemory
Path	mAutosarSubModel/Simulink Function
ShortName	dsmsig
SwAddrMethod	VAR_INIT_32
Calibration attributes	
SwCalibrationAccess	ReadWrite
DisplayFormat	%5d

Attribute	Purpose
ShortName	Specify short name for the AUTOSAR variable. If unspecified, <code>arxml</code> export generates a short name.

Attribute	Purpose
SwAddrMethod	Select a SwAddrMethod name from the names listed as valid for the AUTOSAR variable. Code generation uses the SwAddrMethod name to group AUTOSAR variables in a memory section for access by measurement and calibration tools. For more information, see “Configure SwAddrMethod” on page 4-291.
SwCalibrationAccess	Specify how measurement and calibration tools can access the AUTOSAR variable. Valid access values include ReadOnly, ReadWrite, and NotAccessible. For more information, see “Configure SwCalibrationAccess” on page 4-285.
DisplayFormat	Specify display format for the AUTOSAR variable. AUTOSAR display format specifications control the width and precision display for measurement and calibration data. For more information, see “Configure DisplayFormat” on page 4-287.

Map Submodel Signals and States to AUTOSAR Variables

On the **Signals/States** tab of the Code Mappings editor, you can map Simulink submodel block signals and states to AUTOSAR-typed per-instance memory elements for AUTOSAR run-time calibration.

After creating named or test-pointed Simulink block signals or Simulink state owner blocks in your model, open the Code Mappings editor and select the **Signals/States** tab. Select block signals and states and map them to AUTOSAR-typed per-instance memory elements. For more information, see “Configure AUTOSAR Per-Instance Memory” on page 4-246.

The **Signals/States** tab lists each named or test-pointed Simulink block signal and each configurable Simulink block state that you can map to an AUTOSAR variable. You can:

- Map a Simulink signal or state by selecting the signal or state, and then selecting a menu value for an AUTOSAR variable type: `ArTypedPerInstanceMemory` or `Auto`. To accept software mapping defaults, specify `Auto`.

For example, here is the **Signals/States** tab for submodel `mAutosarSubModel`. AUTOSAR software component model `mAutosarTopModel` contains two instances of `mAutosarSubModel`.

Filter contents		
Source	Mapped To	Path
▼ Signals (3)		
lutOutSig	ArTypedPerInstanceMemory	mAutosarSubModel/Simulink Function
subSystemOut	ArTypedPerInstanceMemory	mAutosarSubModel/Simulink Function
sumSignal	ArTypedPerInstanceMemory	mAutosarSubModel/Simulink Function
▼ States (1)		
X	ArTypedPerInstanceMemory	mAutosarSubModel/Simulink Function

- If you select variable type `ArTypedPerInstanceMemory`, use the Property Inspector to view or modify other code and calibration attributes for the variable.

▼ Code	
Mapped To	ArTypedPerInstanceMemory
Path	mAutosarSubModel/Simulink Function
ShortName	lutsig
SwAddrMethod	VAR_INIT_32
▼ Calibration attributes	
SwCalibrationAccess	ReadWrite
DisplayFormat	%1d

Attribute	Purpose
ShortName	<p>Specify short name for the AUTOSAR variable. If unspecified, arxml export generates a short name.</p> <ul style="list-style-type: none"> • For signals, the auto-generated short name can differ from the signal name. • For states, the auto-generated short name is based on the state name if one exists. If the state is unnamed, the generated name can differ from the block name.
SwAddrMethod	<p>Select a SwAddrMethod name from the names listed as valid for the AUTOSAR variable. Code generation uses the SwAddrMethod name to group AUTOSAR variables in a memory section for access by measurement and calibration tools. For more information, see “Configure SwAddrMethod” on page 4-291.</p>
SwCalibrationAccess	<p>Specify how measurement and calibration tools can access the AUTOSAR variable. Valid access values include ReadOnly, ReadWrite, and NotAccessible. For more information, see “Configure SwCalibrationAccess” on page 4-285.</p>
DisplayFormat	<p>Specify display format for the AUTOSAR variable. AUTOSAR display format specifications control the width and precision display for measurement and calibration data. For more information, see “Configure DisplayFormat” on page 4-287.</p>

Generate Submodel Data Macros for Verification and Deployment

When you build an AUTOSAR software component model that references a submodel, the exported arxml files and generated C code support run-time calibration of the submodel internal data.

- The arxml files exported for the top model include descriptions of the submodel parameters, signals, states, and data stores, as well as software address methods used in the submodel.
- The generated C code references the submodel internal data.

The model build also generates macros that provide access to the submodel mapped internal data for SIL and PIL testing from the referencing component model, and calibration in the AUTOSAR run-time environment. If an AUTOSAR component model build encompasses a referenced model with mapped internal data, the generated submodel header file references these macros:

- `INCLUDE_RTE_HEADER` — Flag indicating whether to include an RTE component header.
- `RTE_COMPONENT_HEADER` — Name of a header file containing definitions for submodel internal parameters, signals, states, and data stores.

For example, if you build AUTOSAR software component model `mAutosarTopModel`, which contains two instances of `mAutosarSubModel`, the generated file `mAutosarSubModel.h` contains this code.

```
#ifndef INCLUDE_RTE_HEADER
#include RTE_COMPONENT_HEADER
#endif
```

If you run top-model SIL or PIL testing from an AUTOSAR software component model that references a mapped submodel, the SIL or PIL model build automatically picks up the submodel internal data definitions.

When you integrate the generated code into an AUTOSAR run-time environment, you must configure the `INCLUDE_RTE_HEADER` and `RTE_COMPONENT_HEADER` macros to include the submodel internal data definitions.

See Also

Code Mappings Editor | `autosar.api.create`

Related Examples

- “Map AUTOSAR Elements for Code Generation” on page 4-69
- “Configure Model Workspace Parameters as AUTOSAR Per-Instance Parameters” on page 4-261
- “Configure AUTOSAR Per-Instance Memory” on page 4-246

More About

- “AUTOSAR Component Configuration” on page 4-3

Incrementally Update AUTOSAR Mapping After Model Changes

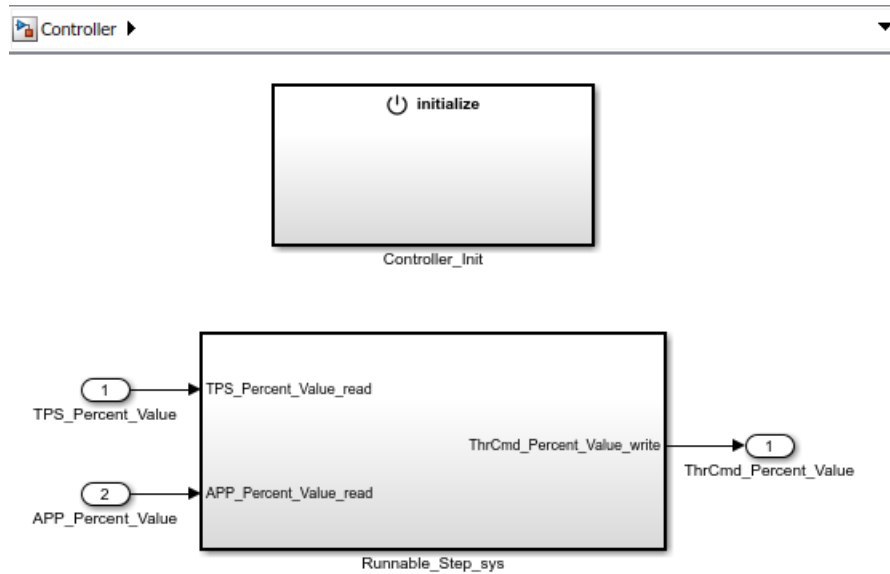
While developing an AUTOSAR software component model, you can use function `autosar.api.create` to incrementally configure and map Simulink elements as you add them to your model. When used with a mapped AUTOSAR model, `autosar.api.create` does not recreate or replace the current Simulink to AUTOSAR mapping. Instead, the function updates the mapping to reflect your model changes. The function:

- Preserves current model configuration and mapping.
- Finds and maps unmapped model elements.
- Updates the AUTOSAR Dictionary for deleted model elements.

In this example, you add inports and outports to a mapped AUTOSAR software component model. Then you use `autosar.api.create` to create and map corresponding AUTOSAR elements with default naming and properties. After the incremental update, you can edit the default naming and properties as you require.

- 1 Open a mapped AUTOSAR software component model. To create a model named `Controller` for this example, use these commands.

```
ar = arxml.importer('ThrottlePositionControlComposition.arxml');
createComponentAsModel(ar, '/Company/Components/Controller',...
    'ModelPeriodicRunnablesAs', 'AtomicSubsystem');
```

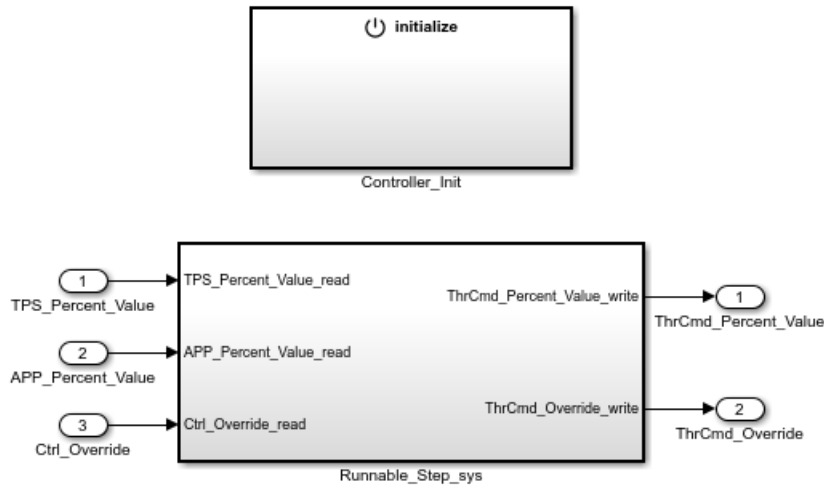


In the Code Mappings editor, **Inports** and **Outports** tabs, here is the initial Simulink to AUTOSAR mapping of Simulink inports and outports in the model.

Source	DataAccessMode	Port	Element
TPS_Percent_Value	ImplicitReceive	TPS_Percent	Value
APP_Percent_Value	ImplicitReceive	APP_Percent	Value

Source	DataAccessMode	Port	Element
ThrCmd_Percent_Value	ImplicitSend	ThrCmd_Percent	Value

- 2 Add an inport and an output to subsystem block Runnable_Step_sts, and a corresponding inport and output inside the subsystem. For example, inside the subsystem, add inport Ctrl_Override_read and output ThrCommand_Override_write. At the top level, add inport Ctrl_Override and output ThrCommand_Override. Connect the inports and outputs.



- 3 To configure and map the added inports and outports, call the `autosar.api.create` function. Use either of these forms.

```
autosar.api.create('Controller', 'incremental');
autosar.api.create('Controller');
```

For more information about function syntax and behavior, see `autosar.api.create`.

- 4 In the Code Mappings editor, **Inports** and **Outports** tabs, here is the updated Simulink to AUTOSAR mapping of Simulink inports and outports in the model. Notice that the added inport and outport are each mapped to an AUTOSAR port and data element, which the function created in the AUTOSAR Dictionary. The function also created the S-R interfaces that own each data element.

Source	DataAccessMode	Port	Element
TPS_Percent_Value	ImplicitReceive	TPS_Percent	Value
APP_Percent_Value	ImplicitReceive	APP_Percent	Value
Ctrl_Override	ImplicitReceive	Ctrl_Override	Ctrl_Override

Source	DataAccessMode	Port	Element
ThrCmd_Percent_Value	ImplicitSend	ThrCmd_Percent	Value
ThrCmd_Override	ImplicitSend	ThrCmd_Override	ThrCmd_Override

- 5 The function provided default naming and properties for the AUTOSAR ports, S-R interfaces, and data elements created in the AUTOSAR Dictionary. You can edit the naming and properties to correspond with peer elements or match your design requirements. For example, you can rename the created data elements to `Value` to match the other S-R interface data elements in the model.

Name	SwCalibrationAccess	DisplayFormat	SwAddrMethod
Value	ReadOnly		<None>

See Also

`autosar.api.create`

More About

- “AUTOSAR Component Configuration” on page 4-3

Design and Simulate AUTOSAR Components and Generate Code

Develop AUTOSAR components by implementing behavior algorithms, simulating components and compositions, and generating component code.

Begin with Simulink Representation of AUTOSAR Components

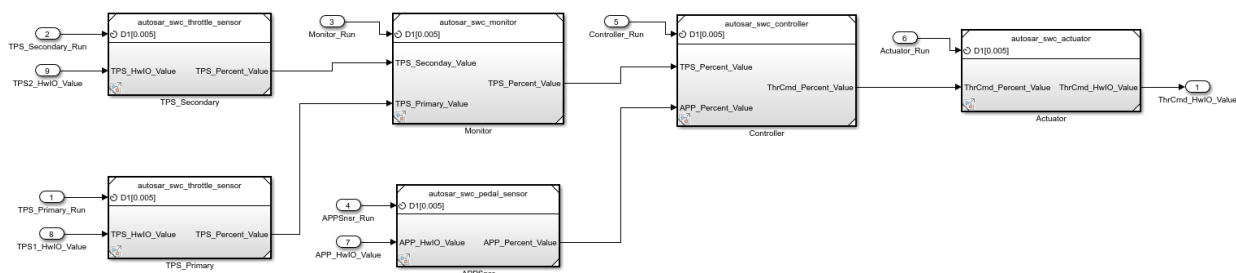
To develop AUTOSAR components in Simulink®, you first create a Simulink representation of an AUTOSAR software component. AUTOSAR component creation can start from an arxml component description or an existing Simulink design.

- To import an AUTOSAR software component description from arxml files and create an initial Simulink model representation, see example “Import AUTOSAR Component to Simulink” on page 3-24 or example “Import AUTOSAR Composition to Simulink” on page 7-2.
- To create an initial model representation of an AUTOSAR software component in Simulink, see “Create AUTOSAR Software Component in Simulink” on page 3-2.

This example uses a Simulink representation of an AUTOSAR software composition named `autosar_composition`, which models a throttle position control system. The composition contains six interconnected AUTOSAR software components -- four sensor/actuator components and two application components.

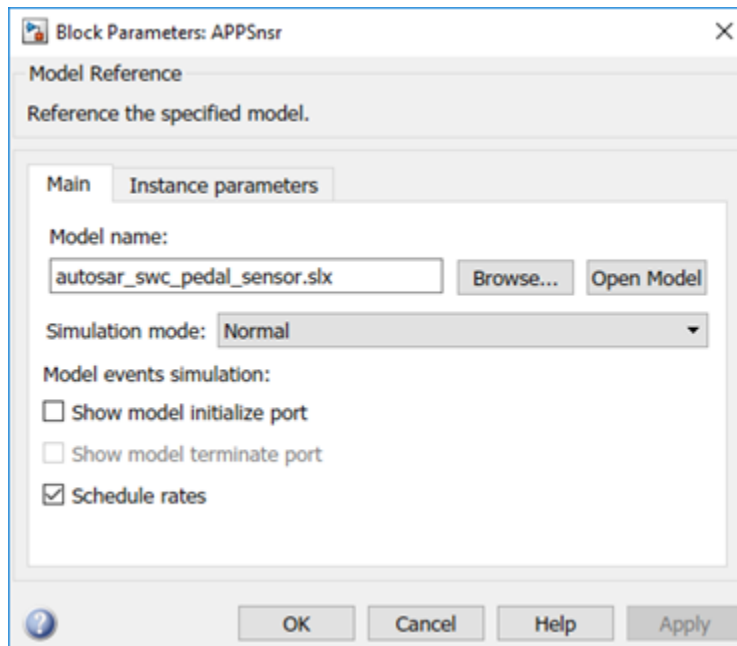
Open the composition model `autosar_composition`.

```
open_system('autosar_composition');
```



Signal lines between component models represent AUTOSAR assembly connectors. Signal lines between component models and data inports and outports represent AUTOSAR delegation connectors.

In a composition model, component models can be rate-based, function-call based, or a mix of both. This composition contains rate-based component models. In each component model, atomic subsystems model AUTOSAR periodic runnables. To allow rate-based runnable tasks to be scheduled on the same basis as exported functions, the component models use the Model block option **Schedule rates**. This option displays model periodic event ports for rate-based models.



Functional Overview of Throttle Position Control Composition

The objective of the composition model `autosar_composition` is to control an automotive throttle based on input from an accelerator pedal and feedback from the throttle. Inside the composition, a controller component takes input values from an accelerator pedal position (APP) sensor and two throttle position sensors (TPSs). The controller then translates the values into input values for a throttle actuator. The throttle actuator generates a hardware command that adjusts the throttle position.

The composition model has root inports for an accelerator pedal sensor and two throttle sensors, and a root outport for a command to throttle hardware. The composition requires sensor input values to arrive already normalized to analog/digital converter (ADC) range.

The composition components are three sensors, one monitor, one controller, and one actuator.

- Sensor component model `autosar_swc_pedal_sensor` takes an APP sensor HWIO value from a composition inport and converts it to an APP sensor percent value.
- Primary and secondary instances of sensor component model `autosar_swc_throttle_sensor` take TPS HWIO values from composition inports and convert them to TPS percent values.
- Application component model `autosar_swc_monitor` decides which TPS signal to pass through to the controller.
- Application component model `autosar_swc_controller` takes the APP sensor percent value from the pedal sensor and the TPS percent value provided by the TPS monitor. Based on these values, the controller calculates a throttle command percent value to provide to the throttle actuator.
- Actuator component model `autosar_swc_actuator` takes the throttle command percent value provided by the controller and converts it to a throttle command HWIO value.

Develop AUTOSAR Component Algorithms

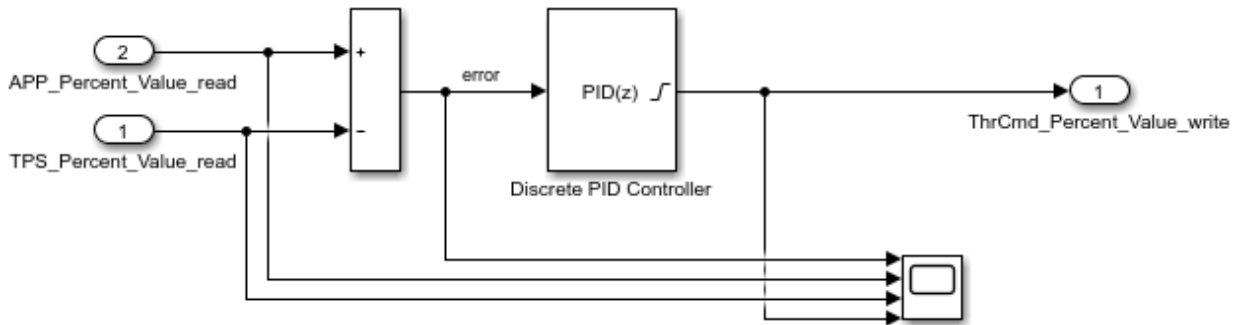
After creating initial Simulink representations of one or more AUTOSAR software components, you develop the components by refining the AUTOSAR configuration and creating algorithmic model content.

To develop AUTOSAR component algorithms, open each component and provide Simulink content that implements the component behavior. For example, consider the `autosar_swc_controller` component model in the `autosar_composition` model. When first imported or created in Simulink, the initial representation of the `autosar_swc_controller` component likely contained an initial stub implementation of the controller behavior:



Component model `autosar_swc_controller` provides this implementation of the throttle position controller behavior. The component takes as inputs an APP sensor percent value from a pedal position sensor and a TPS percent value provided by a throttle

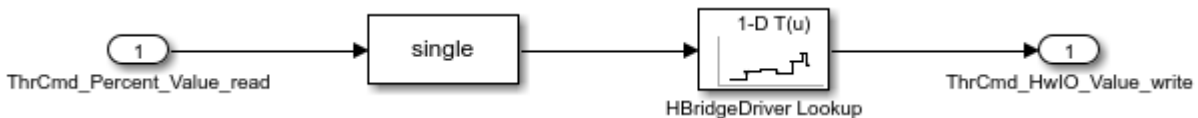
position sensor monitor. Based on these values, the controller calculates the *error*, which is the difference between where the automobile driver wants the throttle, based on the pedal sensor, and the current throttle position. A Discrete PID Controller block uses the error value to calculate a throttle command percent value to provide to a throttle actuator. A scope displays the error value and the Discrete PID Controller block output value over time.



The sensor and actuator component models in the `autosar_composition` model use lookup tables to implement their value conversions. For example, consider the `autosar_sw_c_actuator` component model. When first imported or created in Simulink, the initial representation of the `autosar_sw_c_actuator` component likely contained an initial stub implementation of the actuator behavior.



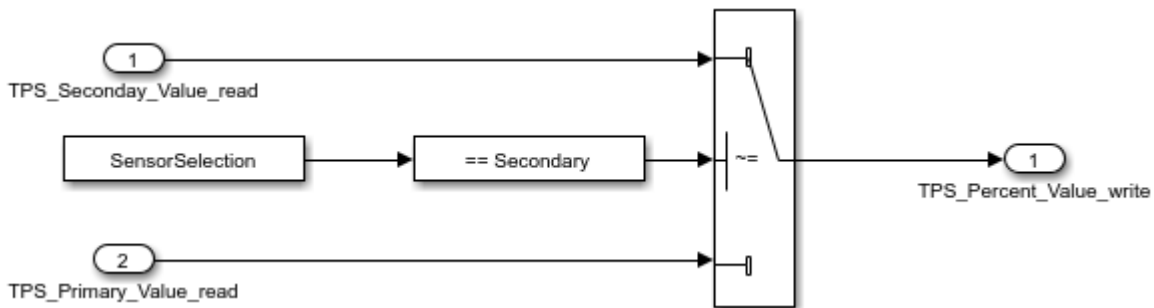
Component model `autosar_sw_c_actuator` provides this implementation of the throttle position actuator behavior. The component takes the throttle command percent value provided by the controller and converts it to a throttle command HWIO value. A hardware bridge command lookup table generates the output value.



The monitor component model in the `autosar_composition` model implements logic for selecting which TPS signal to provide to the controller component. When first imported or created in Simulink, the initial representation of the `autosar_sw_c_monitor` component likely contained an initial stub implementation of the monitor behavior.



Component model `autosar_swc_monitor` provides this implementation of the throttle position monitor behavior. The component takes TPS percent values from primary and secondary throttle position sensors and decides which TPS signal to pass through to the controller. A Switch block determines which value is passed through, based on sensor selection logic.



Simulate AUTOSAR Components and Composition

As you develop AUTOSAR components, you can simulate component models individually or as a group in a containing composition.

Simulate the implemented Controller component model.

```
open_system('autosar_swc_controller');
simOutComponent = sim('autosar_swc_controller');
close_system('autosar_swc_controller');
```

Simulate the `autosar_composition` model.

```
simOutComposition = sim('autosar_composition');
```

Generate AUTOSAR Component Code (Embedded Coder)

As you develop each AUTOSAR component, if you have Simulink Coder and Embedded Coder software, you can generate `arxml` component description files and algorithmic C code for testing in Simulink or integration into an AUTOSAR run-time environment.

For example, to build the implemented `autosar_sw_controller` component model, open the model. Press **Ctrl+B** or enter the MATLAB command `rtwbuild('autosar_sw_controller')`.

The model build exports `arxml` descriptions, generates AUTOSAR-compliant C code, and opens an HTML code generation report describing the generated files. In the report, you can examine the generated files and click hyperlinks to navigate between generated code and source blocks in the component model.

Alternatives for AUTOSAR System-Level Simulation

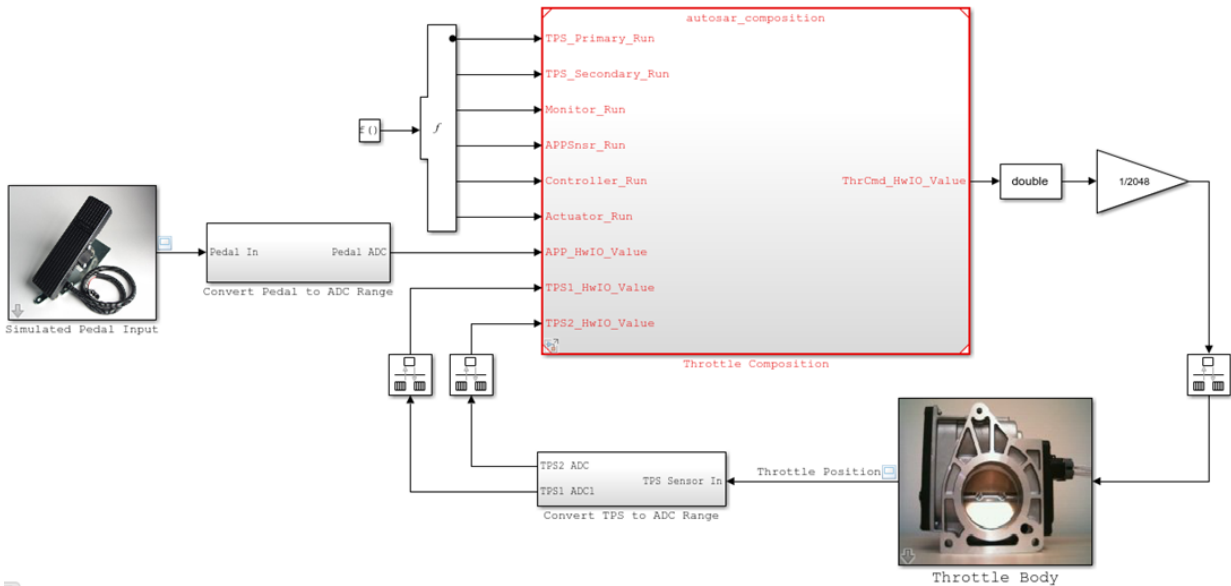
After you develop AUTOSAR components and compositions, you can test groups of components that belong together in a system-level simulation. You can:

- Combine components in a composition for simulation.
- Create a test harness with components, a scheduler, a plant model, and potentially Basic Software service components and callers. Use the test harness to perform an open-loop or closed-loop system simulation.

For an example of open-loop simulation that uses Simulink Test, see “Testing AUTOSAR Compositions” (Simulink Test). This example performs back-to-back testing for an AUTOSAR composition model.

For an example of a closed-loop simulation, open example model `autosar_system`. This model provides a system-level test harness for the AUTOSAR composition model `autosar_composition`.

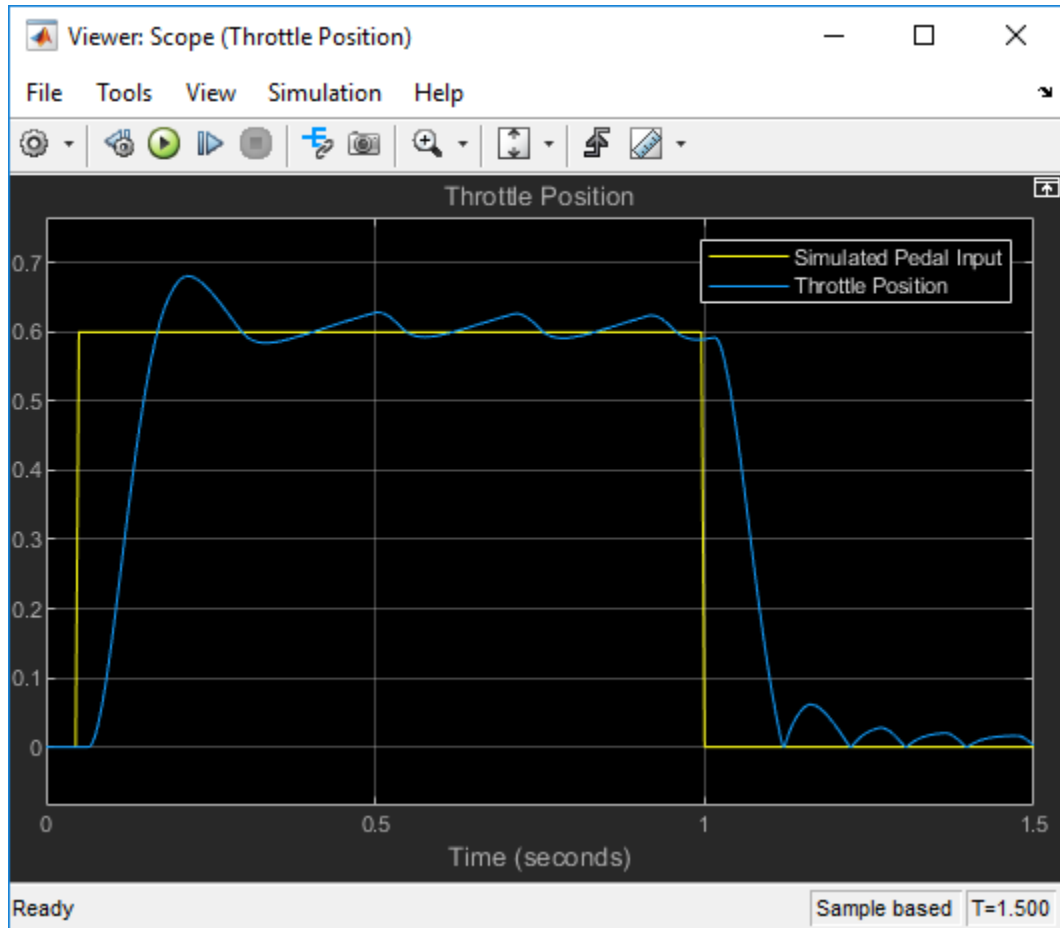
```
open_system('autosar_system');
```



The objective of the system-level model `autosar_system` is performing system-level simulation of the plant and controller portions of the automotive throttle position control system. The system-level model combines the composition model `autosar_composition` with block representations of the physical accelerator pedal and throttle devices in a closed-loop system. The model takes output values from the pedal and throttle device blocks, converts the values to analog/digital converter (ADC) range, and provides the values as inputs to the composition. The system model also takes the throttle command HWIO value generated by the composition and converts it to an acceptable input value for the throttle device block. A system-level throttle position scope displays the accelerator pedal sensor input value against the throttle position sensor input value over time.

If you simulate the system-level model, the throttle position scope indicates how well the throttle-position control algorithms in the throttle composition model are tracking the accelerator pedal input. You can modify the system to improve the composition behavior. For example, you can modify component algorithms to bring the accelerator pedal and throttle position values closer in alignment or you can change a sensor source.

```
simOutSystem = sim('autosar_system');
```



Related Links

- "Import AUTOSAR Component to Simulink" on page 3-24
- "Import AUTOSAR Composition to Simulink" on page 7-2
- "Create AUTOSAR Software Component in Simulink" on page 3-2
- "Component Development"
- "Testing AUTOSAR Compositions" (Simulink Test)

Configure AUTOSAR Packages

In Simulink, you can modify the hierarchical AUTOSAR package structure, as defined by the AUTOSAR standard, that Embedded Coder exports to `arxml` code.

In this section...

“AR-PACKAGE Structure” on page 4-111

“Configure AUTOSAR Packages and Paths” on page 4-113

“Control AUTOSAR Elements Affected by Package Path Modifications” on page 4-116

“Export AUTOSAR Packages” on page 4-117

“AR-PACKAGE Location in Exported ARXML Files” on page 4-119

AR-PACKAGE Structure

The AUTOSAR standard defines AUTOSAR packages (AR-PACKAGES). AR-PACKAGES contain groups of AUTOSAR elements and reside in a hierarchical AR-PACKAGE structure. In an AUTOSAR authoring tool (AAT) or in Simulink, you can configure an AR-PACKAGE structure to:

- Conform to an organizational or standardized AR-PACKAGE structure.
- Establish a namespace for elements in a package.
- Provide a basis for relative references to elements.

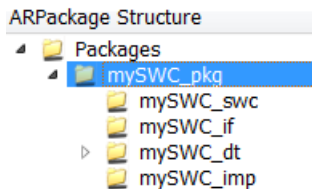
The `arxml` importer imports AR-PACKAGES, their elements, and their paths into Simulink. The model configuration preserves the packages for subsequent export to `arxml` code. In general, the software preserves AUTOSAR packages across round-trips between an AAT and Simulink.

If your AUTOSAR component originated in Simulink, at component creation, the AUTOSAR component builder creates an initial default AR-PACKAGE structure, containing the following packages.

- Software components (including calibration components)
- Data types
- Port interfaces
- Internal behavior (schema 3.x or earlier)

- Implementation

For example, suppose that you start with a simple Simulink model, such as `rtwdemo_counter`. Rename it to `mySWC`. Configure the model for AUTOSAR code generation. (For example, open the Embedded Coder Quick Start and select AUTOSAR code generation.) When you build the model, its initial AR-PACKAGE structure resembles the following figure.



After component creation, you can use the **XML Options** view in the AUTOSAR Dictionary to specify additional AR-PACKAGES. (See “Configure AUTOSAR XML Options” on page 4-63 or “Configure AUTOSAR Adaptive XML Options” on page 6-38.) Each AR-PACKAGE represents an AUTOSAR element category. During code generation, the `arxml` exporter generates a package if any elements of its category exist in the model. For each package, you specify a path, which defines its location in the AR-PACKAGE structure.

Using XML options, you can configure AUTOSAR packages for the following categories of AUTOSAR elements:

- Application data types (schema 4.x)
- Software base types (schema 4.x)
- Data type mapping sets (schema 4.x)
- Constants and values
- Physical data constraints (referenced by application data types or data prototypes)
- System constants (schema 4.x)
- Software address methods
- Mode declaration groups
- Computation methods
- Units and unit groups (schema 4.x)
- Software record layouts (for application data types of category CURVE, MAP, CUBOID, or COM_AXIS)

- Internal data constraints (referenced by implementation data types)

Note

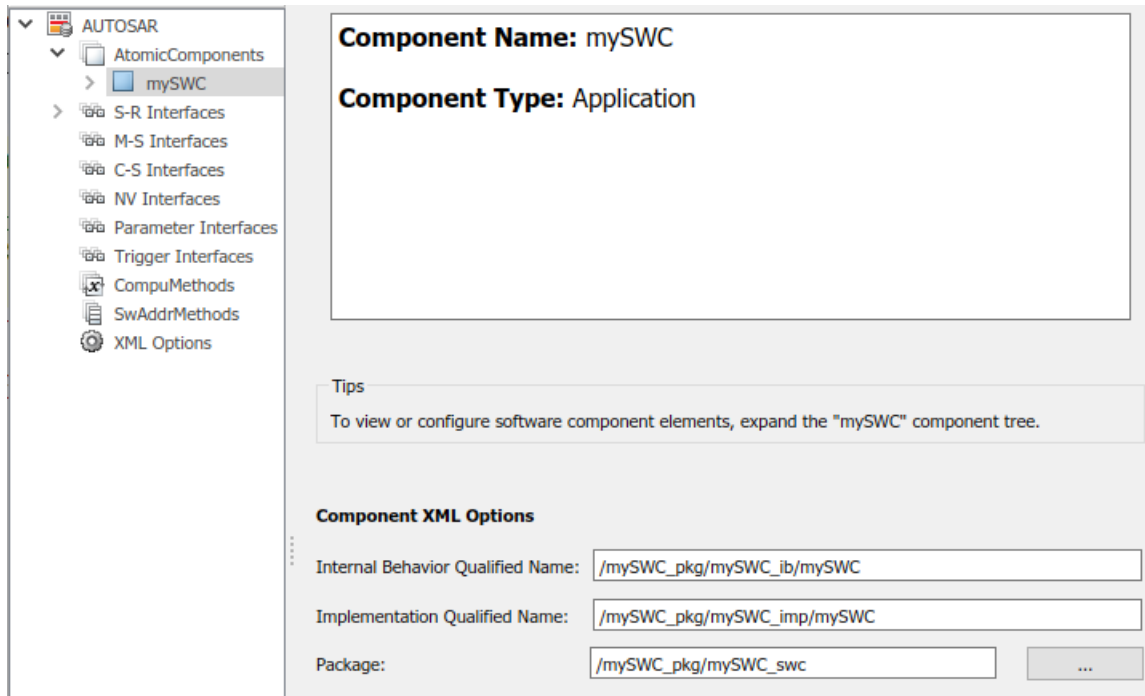
- For packages that you define in XML options, the arxml exporter generates a package only if the model contains an element of the package category. For example, the exporter generates a software address method package only if the model contains a software address method element.
 - If your component uses schema 4.x, you can specify separate packages for the listed schema 4.x elements, for example, application data types. Schema 4.x implementation data types are aggregated in the main data types package.
-

The AR-PACKAGE structure is logically distinct from the single-file or modular-file partitioning that you can select for arxml export, using the XML option **Exported XML file packaging**. For more information about AUTOSAR package export, see “AR-PACKAGE Location in Exported ARXML Files” on page 4-119.

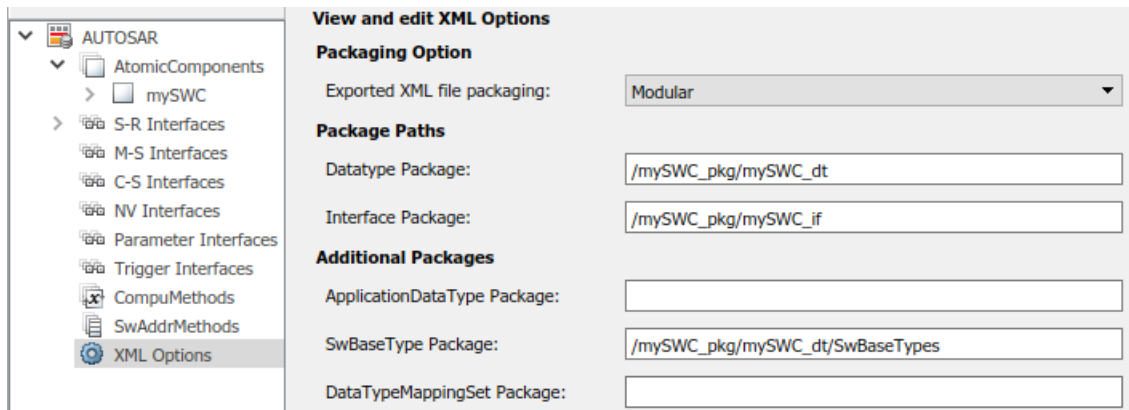
Configure AUTOSAR Packages and Paths

If you import an AR-PACKAGE structure into Simulink, the arxml importer preserves package-element relationships and package paths defined in the arxml code. Also, the importer populates packaging properties in the component and **XML Options** views in the AUTOSAR Dictionary. If the arxml code does not assign AUTOSAR elements to packages based on category, the importer uses heuristics to determine an optimal category association for a package. However, a maximum of one package can be associated with a category.

Suppose that you start with a non-AUTOSAR Simulink model and configure the model for AUTOSAR code generation. (For example, open the Embedded Coder Quick Start and select AUTOSAR code generation.) The software creates an initial default AR-PACKAGE structure. After component creation, the component view in the AUTOSAR Dictionary displays **Component XML Options**, including package paths for the component, internal behavior, and implementation.



The **XML Options** view displays paths for AUTOSAR data type and interface packages, and additional packages.



Using the **Additional Packages** subpane, you can populate path fields for additional packages or leave them empty. If you leave a package field empty, and if the model contains packageable elements of that category, the arxml exporter uses internal rules to calculate the package path. The application of internal rules is backward-compatible with earlier releases. The following table lists the XML option packaging properties with their rule-based default package paths.

Property Name	Package Paths Based on Internal Rules
InternalBehaviorQualifiedName	<i>modelname_pkg/modelname_ib/modelname</i>
ImplementationQualifiedName	<i>modelname_pkg/modelname_imp/modelname</i>
ComponentQualifiedName	<i>modelname_pkg/modelname_swc/modelname</i> (dialog box displays the component path without the short name)
DataTypePackage	<i>modelname_pkg/modelname_dt</i>
InterfacePackage	<i>modelname_pkg/modelname_if</i>
ApplicationDataTypePackage	<i>DataTypePackage/ApplDataTypes</i>
SwBaseTypePackage	<i>DataTypePackage/SwBaseTypes</i>
DataTypeMappingPackage	<i>DataTypePackage/DataTypeMappings</i>
ConstantSpecificationPackage	<i>DataTypePackage/Ground</i>
DataConstraintPackage	<i>ApplicationDataTypePackage/DataConstrs</i>
SystemConstantPackage	<i>DataTypePackage/SystemConstants</i>
SwAddressMethodPackage	<i>DataTypePackage/SwAddrMethods</i>
ModeDeclarationGroupPackage	<i>DataTypePackage</i>
CompuMethodPackage	<i>DataTypePackage</i>
UnitPackage	<i>DataTypePackage</i>
SwRecordLayoutPackage	<i>ApplicationDataTypePackage/RecordLayouts</i>
InternalDataConstraintPackage	<i>DataTypePackage/DataConstrs</i>

To set a packaging property in the MATLAB Command Window or in a script, use an AUTOSAR property set function call similar to the following:

```
hModel = 'autosar_sw_counter';
open_system(hModel);
arProps=autosar.api.getAUTOSARProperties(hModel);
set(arProps,'XmlOptions','ApplicationDataTypePackage','/Company/Powertrain/DataTypes/ADTs');
get(arProps,'XmlOptions','ApplicationDataTypePackage')
```

For a sample script, see “Configure AUTOSAR XML Export” on page 4-361.

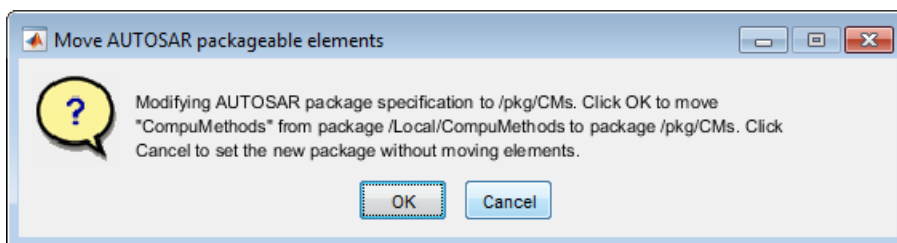
For an example of configuring and exporting AUTOSAR packages, see “Export AUTOSAR Packages” on page 4-117.

Control AUTOSAR Elements Affected by Package Path Modifications

If you modify an AUTOSAR package path, and if packageable elements of that category are affected, you can:

- Move the elements from the existing package to the new package.
- Set the new package path without moving the elements.

If you modify a package path in the AUTOSAR Dictionary, and if packageable elements of that category are affected, a dialog box opens. For example, if you modify the XML option **CompuMethod Package** from path value `/Local/CompuMethods` to `/pkg/CMs`, the software opens the following dialog box.



To move CompuMethod elements to the new package, click **OK**. To set the new package path without moving the elements, click **Cancel**.

If you programmatically modify a package path, you can use the `MoveElements` property to specify handling of affected elements. The property can be set to `All` (the default), `None`, or `Alert`. If you specify `Alert`, and if packageable elements are affected, the software opens the dialog box with **OK** and **Cancel** buttons.

For example, the following code sets a new CompuMethod package path without moving existing CompuMethod elements to the new package.

```
arProps = autosar.api.getAUTOSARProperties('cmSpeed');  
set(arProps, 'XmlOptions', 'CompuMethodPackage', '/pkg/CMs', 'MoveElements', 'None');
```

Export AUTOSAR Packages

This example shows how to configure and export AUTOSAR packages for an AUTOSAR software component that originated in Simulink.

- 1 Open a model that you configured for the AUTOSAR system target file and that models an AUTOSAR software component. This example uses the example model `autosar_swc_expfcns`.
- 2 Open the AUTOSAR Dictionary and select **XML Options**. Here are initial settings for some of the AUTOSAR package parameters.

View and edit XML Options

Packaging Option

Exported XML file packaging:

Package Paths

Datatype Package:

Interface Package:

Additional Packages

ApplicationDataType Package:

SwBaseType Package:

DataTypeMappingSet Package:

ConstantSpecification Package:

In this example, **Exported XML file packaging** is set to `Single file`, which generates a single, unified `arxml` file. If you prefer multiple, modular `arxml` files, change the setting to `Modular`.

- 3 Configure packages for one or more AUTOSAR elements that your model exports to `arxml` code. For each package, enter a path to define its location in the AR-PACKAGE structure. Click **Apply**.

The example model exports multiple AUTOSAR constant specifications. This example sets the **ConstantSpecification Package** parameter to `/pkg/misc/MyGround`. (This value overrides the rule-based default, `/pkg/dt/Ground`.)

View and edit XML Options

Packaging Option

Exported XML file packaging:

Package Paths

Datatype Package:

Interface Package:

Additional Packages

ApplicationDataType Package:

SwBaseType Package:

DataTypeMappingSet Package:

ConstantSpecification Package:

- 4 Generate code for the model.
- 5 Open the generated file `modelName.arxml`. (If you set **Exported XML file packaging** to Modular, open the generated file `modelName_component.arxml`.)
- 6 Search the XML code for the packages that you configured, for example, using the text AR-PACKAGE or an element name. For the example model, searching `autosar_swc_expfncs.arxml` for the text MyGround finds the constant specification package and many references to it. Here is a sample code excerpt.

```

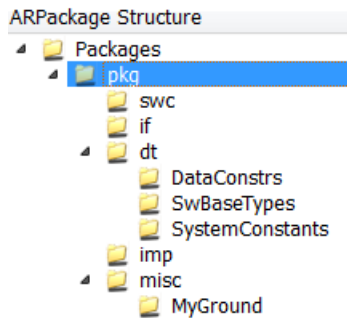
<AR-PACKAGE UUID="95f4dcf1-66ea-5f72-cd27-34f4eb36ad65">
  <SHORT-NAME>MyGround</SHORT-NAME>
  <ELEMENTS>
    <CONSTANT-SPECIFICATION UUID="be03b363-5267-5a11-531f-22a443475036">
      <SHORT-NAME>DefaultInitValue_Double</SHORT-NAME>
      <VALUE-SPEC>
        <NUMERICAL-VALUE-SPECIFICATION>
          <SHORT-LABEL>DefaultInitValue_Double</SHORT-LABEL>
          <VALUE>0</VALUE>
        </NUMERICAL-VALUE-SPECIFICATION>
      </VALUE-SPEC>
    </CONSTANT-SPECIFICATION>
    <CONSTANT-SPECIFICATION UUID="f1220406-2ece-568f-f709-693cc6b12b8a">
      <SHORT-NAME>DefaultInitValu_036fab392deee624</SHORT-NAME>
      <VALUE-SPEC>
        <ARRAY-VALUE-SPECIFICATION>
          <SHORT-LABEL>DefaultInitValu_036fab392deee624</SHORT-LABEL>
          <ELEMENTS>
            <CONSTANT-REFERENCE>
              <SHORT-LABEL>DefaultInitValu_d172891e92bde674</SHORT-LABEL>
              <CONSTANT-REF DEST="CONSTANT-SPECIFICATION"/>/pkg/misc/MyGround/DefaultInitValue_Double</CONSTANT-REF>
            </CONSTANT-REFERENCE>
            <CONSTANT-REFERENCE>
              <SHORT-LABEL>DefaultInitValu_2d898f9704c2f030</SHORT-LABEL>
              <CONSTANT-REF DEST="CONSTANT-SPECIFICATION"/>/pkg/misc/MyGround/DefaultInitValue_Double</CONSTANT-REF>
            </CONSTANT-REFERENCE>
          </ELEMENTS>
        </ARRAY-VALUE-SPECIFICATION>
      </VALUE-SPEC>
    </CONSTANT-SPECIFICATION>
  </ELEMENTS>
</AR-PACKAGE>

```

AR-PACKAGE Location in Exported ARXML Files

Grouping AUTOSAR elements into AUTOSAR packages (AR-PACKAGES) is logically distinct from the arxml output file packaging that the AUTOSAR configuration parameter **Exported XML file packaging** controls. Whether you set **Exported XML file packaging** to Single file or Modular, arxml export preserves the configured AR-PACKAGE structure.

Suppose that you configure the example model `autosar_swc_multirunnables` with the following AR-PACKAGE structure. (See the steps in “Export AUTOSAR Packages” on page 4-117). In this configuration, the specified path of the constant specification package, `/pkg/misc/myGround`, overrides the rule-based default, `/pkg/dt/Ground`.



If you export this AR-PACKAGE structure into a single file (**Exported XML file packaging** is set to **Single file**), the exported arxml code preserves the configured AR-PACKAGE structure.

autosar_swc_expcns.arxml:

```

<AR-PACKAGES>
  <AR-PACKAGE UUID="...">
    <SHORT-NAME>pkg</SHORT-NAME>
    ...
    <SHORT-NAME>swc</SHORT-NAME>
    ...
    <SHORT-NAME>if</SHORT-NAME>
    ...
    <SHORT-NAME>dt</SHORT-NAME>
    ...
    <SHORT-NAME>SwBaseTypes</SHORT-NAME>
    ...
    <SHORT-NAME>misc</SHORT-NAME>
    ...
    <SHORT-NAME>MyGround</SHORT-NAME>
    ...
    <SHORT-NAME>imp</SHORT-NAME>
    ...
  </AR-PACKAGE>
</AR-PACKAGES>
    
```

If you export the same AR-PACKAGE structure into multiple files (**Exported XML file packaging** is set to **Modular**), the exported arxml code preserves the configured AR-PACKAGE structure, distributed across multiple files.

The exporter maps packages to arxml files based on package path, not on package content or element category. For example, the exporter maps the data-type-oriented package, /pkg/misc/myGround, to the component file, autosar_swc_exps_component.arxml, based on the package path. To group the

package with other data-type-oriented packages, both in the AR-PACKAGE structure and in a rxml output, specify a package path beginning with /pkg/dt/.

autosar_swc_expfncs_component.arxml:

```
<AR-PACKAGES>
  <AR-PACKAGE UUID="...">
    <SHORT-NAME>pkg</SHORT-NAME>
    ...
    <SHORT-NAME>swc</SHORT-NAME>
    ...
    <SHORT-NAME>misc</SHORT-NAME>
    ...
    <SHORT-NAME>MyGround</SHORT-NAME>
    ...
  </AR-PACKAGE>
</AR-PACKAGES>
```

autosar_swc_expfncs_interface.arxml:

```
<AR-PACKAGES>
  <AR-PACKAGE UUID="...">
    <SHORT-NAME>pkg</SHORT-NAME>
    ...
    <SHORT-NAME>if</SHORT-NAME>
    ...
  </AR-PACKAGE>
</AR-PACKAGES>
```

autosar_swc_expfncs_datatype.arxml:

```
<AR-PACKAGES>
  <AR-PACKAGE UUID="...">
    <SHORT-NAME>pkg</SHORT-NAME>
    ...
    <SHORT-NAME>dt</SHORT-NAME>
    ...
    <SHORT-NAME>SwBaseTypes</SHORT-NAME>
    ...
  </AR-PACKAGE>
</AR-PACKAGES>
```

autosar_swc_expfncs_implementation.arxml:

```
<AR-PACKAGES>
  <AR-PACKAGE UUID="...">
    <SHORT-NAME>pkg</SHORT-NAME>
    ...
    <SHORT-NAME>imp</SHORT-NAME>
    ...
  </AR-PACKAGE>
</AR-PACKAGES>
```

See Also

Related Examples

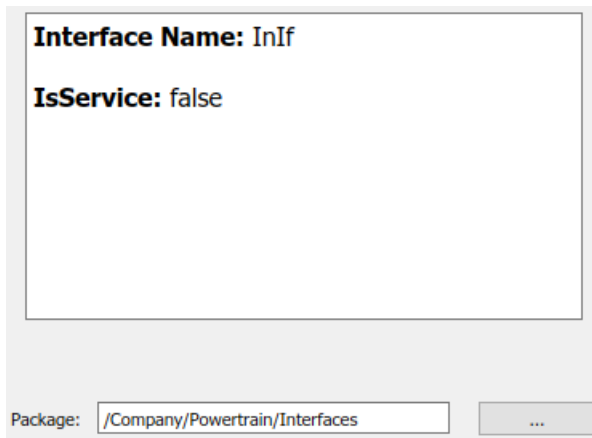
- “Import AUTOSAR Software Component” on page 3-19
- “Import AUTOSAR Adaptive Software Descriptions” on page 6-15
- “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123
- “Configure AUTOSAR XML Options” on page 4-63
- “Configure AUTOSAR Adaptive XML Options” on page 6-38
- “Configure AUTOSAR XML Export” on page 4-361
- “Configure AUTOSAR Code Generation” on page 5-8
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

More About

- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod

As part of configuring an AUTOSAR component, interface, CompuMethod, or SwAddrMethod, you specify the AUTOSAR package (AR-PACKAGE) to be generated for individual components, interfaces, CompuMethods, or SwAddrMethods in your configuration. For example, here is the AUTOSAR Dictionary view for an individual interface.



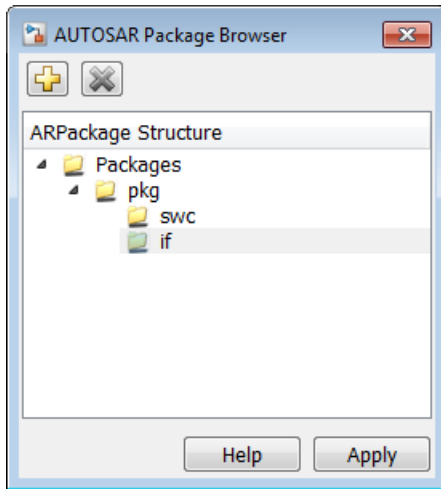
The screenshot shows a configuration window for an interface. It contains the following text:


Interface Name: InIf

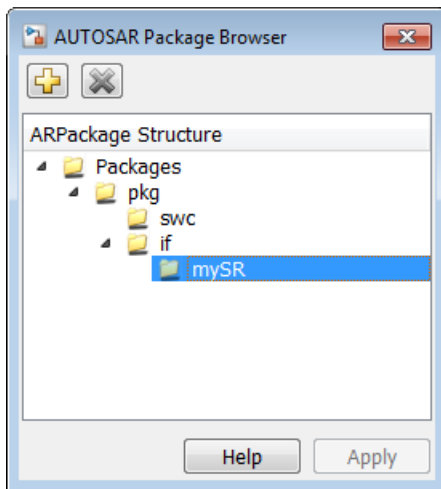
IsService: false

At the bottom, there is a **Package:** field with the text `/Company/Powertrain/Interfaces` and a button with three dots (`...`) to its right.

You can enter a package path in the **Package** parameter field, or use the AUTOSAR Package Browser to select a package. To open the browser, click the button to the right of the **Package** field. The AUTOSAR Package Browser opens.



In the browser, you can select an existing package, or create and select a new package. To create a new package, select the containing folder for the new package and click the **Add** button . For example, to add a new interface package, select the `if` folder and click the **Add** button. Then select the new subpackage and edit its name.



When you apply your changes in the browser, the interface **Package** parameter value is updated with your selection.

Package: `/pkg/if/mySR`

For more information about AR-PACKAGEs, see “Configure AUTOSAR Packages” on page 4-111.

See Also

Related Examples

- “Configure AUTOSAR Elements and Properties” on page 4-8
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332

More About

- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Sender-Receiver Communication

In AUTOSAR port-based sender-receiver (S-R) communication, AUTOSAR software components read and write data to other components or services. To implement S-R communication, AUTOSAR software components define provide and require ports that send and receive data.

In Simulink, you can create AUTOSAR S-R interfaces and ports, and map Simulink inports and outports to AUTOSAR ports. You model AUTOSAR provide and require ports with Simulink root-level outports and inports, as described in “Sender-Receiver Interface” on page 2-29.


For queued sender-receiver communication, see “Configure AUTOSAR Queued Sender-Receiver Communication” on page 4-145.

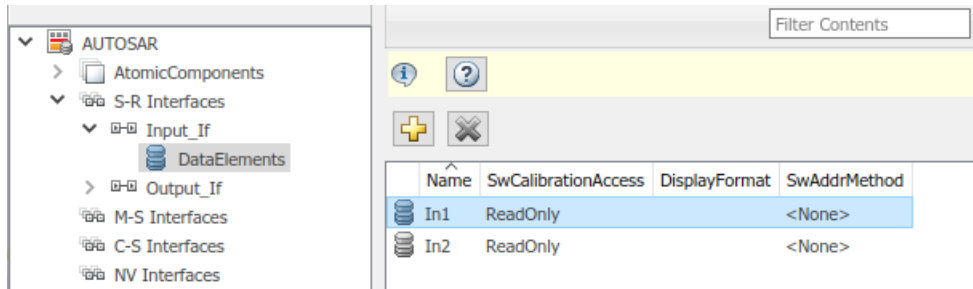
In this section...

- “Configure AUTOSAR Sender-Receiver Interface” on page 4-126
- “Configure AUTOSAR Provide-Require Port” on page 4-128
- “Configure AUTOSAR Receiver Port for IsUpdated Service” on page 4-130
- “Configure AUTOSAR Sender-Receiver Data Invalidation” on page 4-132
- “Configure AUTOSAR S-R Interface Port for End-To-End Protection” on page 4-136
- “Configure AUTOSAR Receiver Port for DataReceiveErrorEvent” on page 4-138
- “Configure AUTOSAR Sender-Receiver Port ComSpecs” on page 4-141

Configure AUTOSAR Sender-Receiver Interface

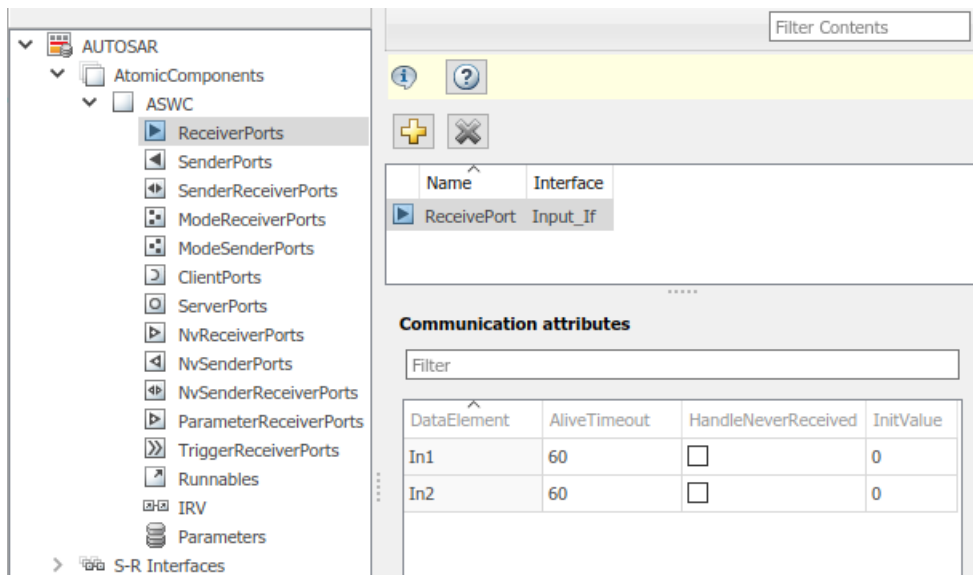
To create an S-R interface and ports in Simulink:

- 1 Open the AUTOSAR Dictionary and select **S-R Interfaces**. Click the **Add** button  to create a new AUTOSAR S-R data interface. Specify its name and the number of associated S-R data elements.
- 2 Select and expand the new S-R interface. Select **DataElements**, and modify the AUTOSAR data element attributes.



- 3 In the AUTOSAR Dictionary, expand the **AtomicComponents** node and select an AUTOSAR component. Expand the component.
- 4 Select and use the **ReceiverPorts**, **SenderPorts**, and **SenderReceiverPorts** views to add AUTOSAR S-R ports that you want to associate with the new S-R interface. For each new S-R port, select the S-R interface you created.

Optionally, examine the communication attributes for each S-R port and modify where required. For more information, see “Configure AUTOSAR Sender-Receiver Port ComSpecs” on page 4-141.




- Open the Code Mappings editor. Select and use the **Inports** and **Outports** tabs to map Simulink inports and outports to AUTOSAR S-R ports. For each inport or output, select an AUTOSAR port, data element, and data access mode.

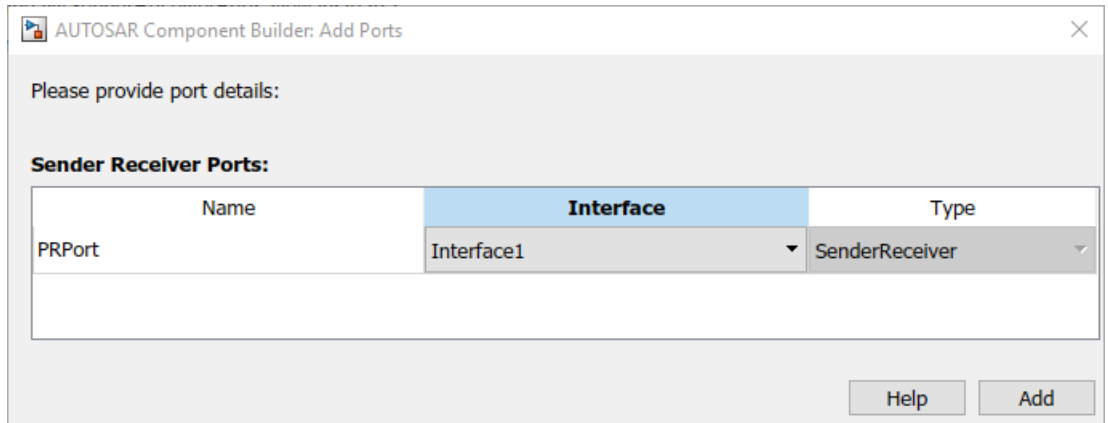
Source	DataAccessMode	Port	Element
In1_1s	ImplicitReceive	ReceivePort	In1
In2_2s	ImplicitReceive	ReceivePort	In2

Configure AUTOSAR Provide-Require Port

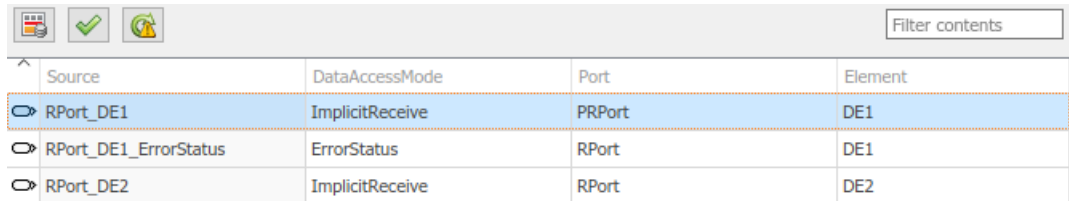
AUTOSAR Release 4.1 introduced the AUTOSAR provide-require port (PRPort). Modeling an AUTOSAR PRPort involves using a Simulink inport and output pair with matching data type, dimension, and signal type. You can associate a PRPort with a sender-receiver (S-R) interface or a nonvolatile (NV) data interface.

To configure an AUTOSAR PRPort for S-R communication in Simulink:

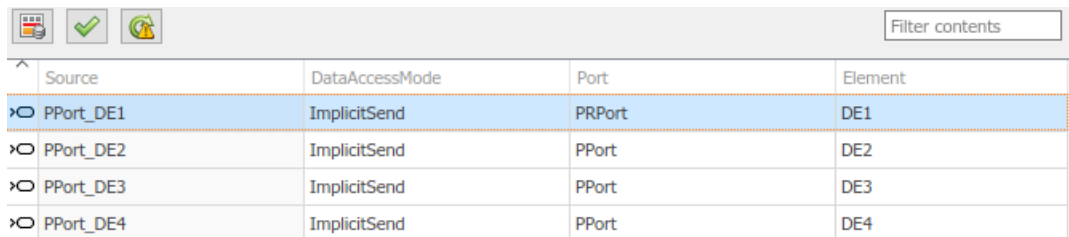
- Open a model that is configured for AUTOSAR, and in which a runnable has an inport and an outport suitable for pairing into an AUTOSAR PRPort. In this example, the RPort_DE1 inport and PPort_DE1 outport both use data type `int8`, port dimension 1, and signal type `real`.
- Open the AUTOSAR Dictionary and navigate to the **SenderReceiverPorts** view. (To configure a PRPort for NV communication, use the **NvSenderReceiverPorts** view instead.)
- To add a sender-receiver port, click the **Add** button . In the Add Ports dialog box, specify **Name** as PRPort and select an **Interface** from the list of available S-R interfaces. Click **Add**.




- Open the Code Mappings editor and select the **Inports** tab. To map a Simulink inport to the AUTOSAR sender-receiver port you created, select the inport, set **Port** to the value PRPort, and set **Element** to a data element that the inport and outport will share.



- Select the **Outports** tab. To map a Simulink outport to the AUTOSAR sender-receiver port you created, select the outport, set **Port** to the value PRPort, and set **Element** to the same data element selected in the previous step.



- Click the **Validate** button  to validate the updated AUTOSAR component configuration. If errors are reported, address them and then retry validation. A

common error flagged by validation is mismatched properties between the inport and outlet that are mapped to the AUTOSAR PRPort.

Alternatively, you can programmatically add and map a PRPort port using AUTOSAR property and map functions. The following example adds an AUTOSAR PRPort (sender-receiver port) and then maps it to a Simulink inport and outlet pair.

```
hModel = 'my_autosar_expfncs';
open_system(hModel)
arProps = autosar.api.getAUTOSARProperties(hModel);
swcPath = find(arProps,[], 'AtomicComponent')

swcPath =
    'ASWC'

add(arProps, 'ASWC', 'SenderReceiverPorts', 'PRPort', 'Interface', 'Interface1')
prportPath = find(arProps,[], 'DataSenderReceiverPort')

prportPath =
    'ASWC/PRPort'

slMap = autosar.api.getSimulinkMapping(hModel);
mapInport(slMap, 'RPort_DE1', 'PRPort', 'DE1', 'ImplicitReceive')
mapOutlet(slMap, 'PPort_DE1', 'PRPort', 'DE1', 'ImplicitSend')
[arPortName, arDataElementName, arDataAccessMode] = getOutlet(slMap, 'PPort_DE1')

arPortName =
    PRPort

arDataElementName =
    DE1

arDataAccessMode =
    ImplicitSend
```

Configure AUTOSAR Receiver Port for IsUpdated Service

AUTOSAR defines quality-of-service attributes, such as `ErrorStatus` and `IsUpdated`, for sender-receiver interfaces. The `IsUpdated` attribute allows an AUTOSAR explicit receiver to detect whether a receiver port data element has received data since the last read occurred. When data is idle, the receiver can save computational resources.

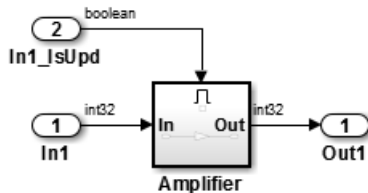
For the sender, the AUTOSAR Runtime Environment (RTE) sets the status of an update flag, indicating whether the data element has been written. The receiver calls the `Rte_IsUpdated_Port_Element` API, which reads the update flag and returns a value indicating whether the data element has been updated since the last read.

In Simulink, you can:

- Import an AUTOSAR receiver port for which `IsUpdated` service is configured.
- Configure an AUTOSAR receiver port for `IsUpdated` service.
- Generate C and axml code for an AUTOSAR receiver port for which `IsUpdated` service is configured.


To model `IsUpdated` service in Simulink, you pair an inport that is configured for `ExplicitReceive` data access with a new inport configured for `IsUpdated` data access. To configure an AUTOSAR receiver port for `IsUpdated` service:

- 1 Open a model for which an AUTOSAR sender-receiver interface is configured.
- 2 Identify the inport that corresponds to the AUTOSAR receiver port for which `IsUpdated` service is required. Create a second inport, set its data type to `boolean`, and connect it to the same block. For example:



- 3 Open the Code Mappings editor. Select the **Inports** tab. In the inports view, configure the mapping properties for both inports.
 - a If the data inport is not already configured, set **DataAccessMode** to `ExplicitReceive`. Select **Port** and **Element** values that map the inport to the AUTOSAR receiver port and data element for which `IsUpdated` service is required.
 - b For the quality-of-service inport, set **DataAccessMode** to `IsUpdated`. Select **Port** and **Element** values that exactly match the data inport.

Source	DataAccessMode	Port	Element
In1	ExplicitReceive	Input	DE1
In1_IsUpd	IsUpdated	Input	DE1

- 4 To validate the AUTOSAR component configuration, click the **Validate** button .
- 5 Build the model and inspect the generated code. The generated C code contains an `Rte_IsUpdated` API call.

```

if (Rte_IsUpdated_Input_DE1()) {
    ...
    Rte_Read_Input_DE1(&tmp);
    ...
}

```

The exported axml code contains the ENABLE-UPDATE setting `true` for the AUTOSAR receiver port.

```

<R-PORT-PROTOTYPE UUID="...">
  <SHORT-NAME>Input</SHORT-NAME>
  <REQUIRED-COM-SPECS>
    <NONQUEUED-RECEIVER-COM-SPEC>
      <DATA-ELEMENT-REF DEST="VARIABLE-DATA-PROTOTYPE">/pkg/if/Input/DE1
      </DATA-ELEMENT-REF>
      ...
      <ENABLE-UPDATE>true</ENABLE-UPDATE>
      ...
    </NONQUEUED-RECEIVER-COM-SPEC>
  </REQUIRED-COM-SPECS>
  ...
</R-PORT-PROTOTYPE>

```

Configure AUTOSAR Sender-Receiver Data Invalidation

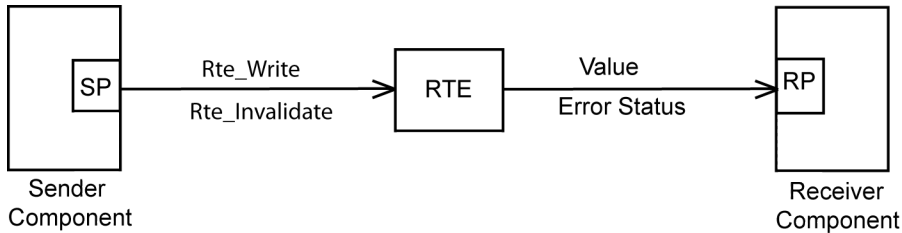
The AUTOSAR standard defines an invalidation mechanism for AUTOSAR data elements used in sender-receiver (S-R) communication. A sender component can notify a downstream receiver component that data in a sender port is invalid. Each S-R data element can have an invalidation policy. In Simulink, you can:

- Import AUTOSAR sender-receiver data elements for which an invalidation policy is configured.
- Use a Signal Invalidation block to model sender-receiver data invalidation for simulation and code generation. Using block parameters, you can specify a signal invalidation policy and an initial value for an S-R data element.
- Generate C code and axml descriptions for AUTOSAR sender-receiver data elements for which an invalidation policy is configured.

For each S-R data element, you can set the Signal Invalidation block parameter **Signal invalidation policy** to `Keep`, `Replace`, or `DontInvalidate`. If an input data value is invalid (invalidation control flag is `true`), the resulting action is determined by the value of **Signal invalidation policy**:

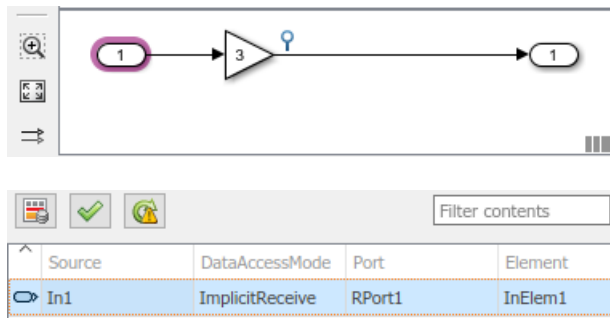
- `Keep` - Replace the input data value with the last valid signal value.
- `Replace` - Replace the input data value with an **Initial value** parameter.

- DontInvalidate - Do not replace the input data value.



To configure an invalidation policy for an AUTOSAR S-R data element in Simulink:

- 1 Open a model for which an AUTOSAR sender-receiver interface is configured. For example, suppose that:
 - A Simulink output named **Out** is mapped to AUTOSAR sender port **PPort** and data element **OutElem**. In the AUTOSAR Dictionary, AUTOSAR sender port **PPort** selects S-R interface **Out**, which contains the data element **OutElem**.
 - A Simulink inport named **In1** is mapped to AUTOSAR receiver port **RPort1** and data element **InElem1**. In the AUTOSAR Dictionary, AUTOSAR receiver port **RPort1** selects S-R interface **In1**, which contains the data element **InElem1**. In the Code Mappings editor, **Inports** tab, here is the mapping for inport **In1**.

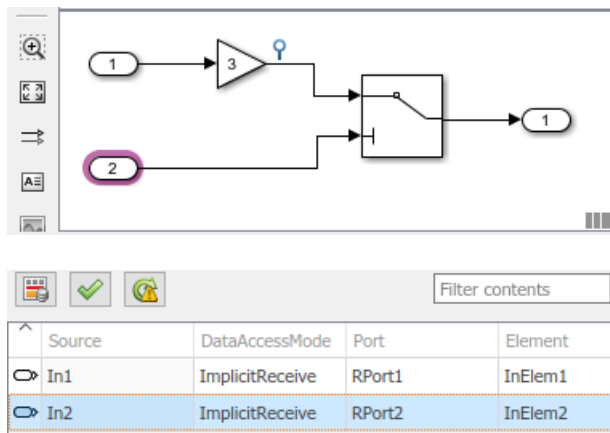


- 2 Add a Signal Invalidation block to the model.
 - a The block must be connected directly to a root output block. Connect the block to root output **Out**.
 - b Connect the first block input, a data value, to the data path from root inport **In1**.
 - c For the second block input, an invalidation control flag, add a root inport named **In2** to the model. Set its data type to scalar **boolean**. Map the new inport to a

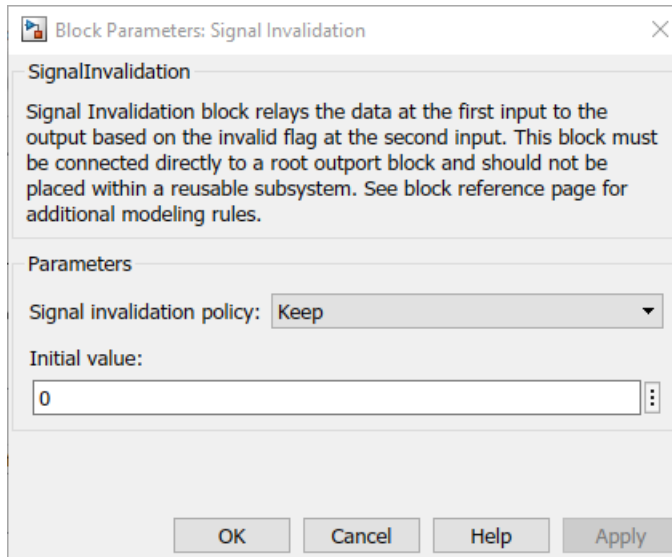
second AUTOSAR sender port. If a second AUTOSAR sender port does not exist, use the AUTOSAR Dictionary to create the AUTOSAR port, S-R interface, and data element.

In this example, Simulink input In2 is mapped to AUTOSAR receiver port RPort2 and data element InElem2. In the AUTOSAR Dictionary, AUTOSAR receiver port RPort2 selects S-R interface In2, which contains the data element InElem2.

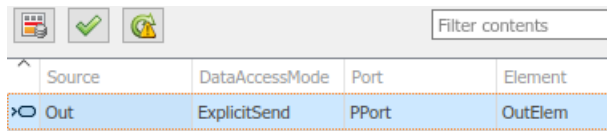
Connect the second block input to root input In2.




- 3 View the Signal Invalidation block parameters, for example, in the Property Inspector or the block parameters dialog box. Examine the **Signal invalidation policy** and **Initial value** attributes. For more information, see the Signal Invalidation block reference page.



- 4 Open the Code Mappings editor and select the **Outports** tab. For the root outport Out, verify that the AUTOSAR data access mode is set to ExplicitSend or EndToEndWrite.



- 5 To validate the AUTOSAR component configuration, open the Code Mappings editor and click the **Validate** button .
- 6 Build the model and inspect the generated code. When the signal is valid, the generated C code calls `Rte_Write_Port_Element`. When the signal is invalid, the C code calls `Rte_Invalidate_Port_Element`.

```

/* SignalInvalidation: '<Root>/Signal Invalidation' incorporates:
 * Inport: '<Root>/In2'
 */
if (!Rte_IRead_Runnable_Step_RPort2_InElem2()) {
  /* Outport: '<Root>/Out' */
  (void) Rte_Write_PPort_OutElem(mSignalInvalidation_B.Gain);
} else {
  Rte_Invalidate_PPort_OutElem();
}

```

The exported `arxml` code contains the invalidation setting for the data element.

```
<INVALIDATION-POLICY>
  <DATA-ELEMENT-REF DEST="VARIABLE-DATA-PROTOTYPE">/pkg/if/Out/OutElem</DATA-ELEMENT-REF>
  <HANDLE-INVALID>KEEP</HANDLE-INVALID>
</INVALIDATION-POLICY>
```

Configure AUTOSAR S-R Interface Port for End-To-End Protection

AUTOSAR end-to-end (E2E) protection for sender and receiver ports is based on the E2E library. E2E is a C library that you use to transmit data securely between AUTOSAR components. End-to-end protection adds additional information to an outbound data packet. The component receiving the packet can then verify independently that the received data packet matches the sent packet. Potentially, the receiving component can detect errors and take action.

For easier integration of AUTOSAR generated code with AUTOSAR E2E solutions, Embedded Coder supports AUTOSAR E2E protection. In Simulink, you can:

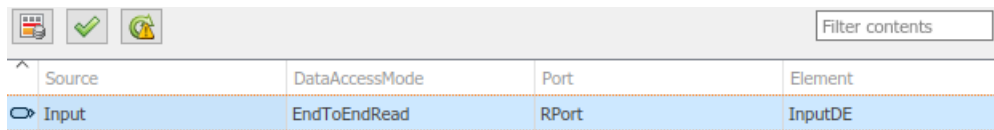
- Import AUTOSAR sender port and receiver ports for which E2E protection is configured.
- Configure an AUTOSAR sender or receiver port for E2E protection.
- Generate C and `arxml` code for AUTOSAR sender and receiver ports for which E2E protection is configured.

You should configure E2E protection for AUTOSAR sender and receiver ports that use explicit write and read data access modes. When you change the data access mode of an AUTOSAR port from explicit write to end-to-end write, or from explicit read to end-to-end read:

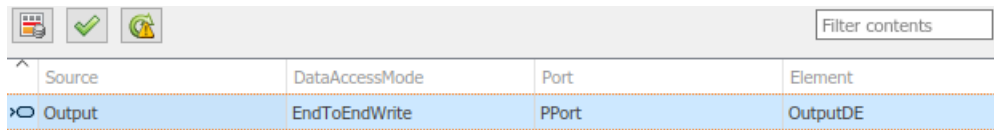
- Simulation behavior is unaffected.
- Code generation is similar to explicit write and read, with these differences:
 - E2E initialization wrapper API calls appear in C initialization code.
 - E2E protection wrapper API calls appear in C step code.
 - When combined with an error status inport, end-to-end read returns `uint32` rather than `uint8`.
 - For receiver and sender COM-SPECs, the `arxml` exporter generates property `USES-END-TO-END-PROTECTION` with value `true`.

To configure an AUTOSAR sender or receiver port for E2E protection:


- 1 Open a model for which an AUTOSAR sender-receiver interface is configured.
- 2 Open the Code Mappings editor. Navigate to the Simulink inport or output that models the AUTOSAR receiver or sender port for which you want to configure E2E protection. Select the port.
- 3 Set the AUTOSAR data access mode to `EndToEndRead` (inport) or `EndToEndWrite` (output).



Source	DataAccessMode	Port	Element
Input	EndToEndRead	RPort	InputDE



Source	DataAccessMode	Port	Element
Output	EndToEndWrite	PPort	OutputDE

- 4 To validate the AUTOSAR component configuration, click the **Validate** button .
- 5 Build the model and inspect the generated code. The generated C code contains E2E API calls.

```
void Runnable_Step(void)
{
    ...
    /* Inport: '<Root>/Input' */
    E2EPW_Read_RPort_InputDE(...);
    ...
    /* Output: '<Root>/Output'... */
    (void) E2EPW_Write_PPort_OutputDE(...);
    ...
}
...
void Runnable_Init(void)
{
    ...
    /* End-to-End (E2E) initialization */
    E2EPW_ReadInit_RPort_InputDE();
    E2EPW_WriteInit_PPort_OutputDE();
    ...
}
```

The exported `arxml` code contains the E2E settings for the AUTOSAR receiver and sender ports.

```

<NONQUEUED-RECEIVER-COM-SPEC>
...
  <USES-END-TO-END-PROTECTION>true</USES-END-TO-END-PROTECTION>
...
<NONQUEUED-SENDER-COM-SPEC>
...
  <USES-END-TO-END-PROTECTION>true</USES-END-TO-END-PROTECTION>
...

```

Configure AUTOSAR Receiver Port for DataReceiveErrorEvent

In AUTOSAR sender-receiver communication between software components, the Runtime Environment (RTE) raises a `DataReceiveErrorEvent` when the communication layer reports an error in data reception by the receiver component. For example, the event can indicate that the sender component failed to reply within an `AliveTimeout` limit, or that the sender component sent invalid data.

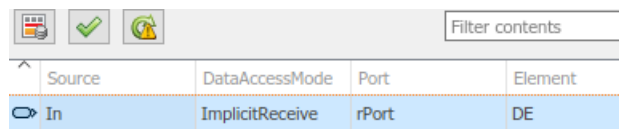
Embedded Coder supports creating `DataReceiveErrorEvents` in AUTOSAR receiver components. In Simulink, you can:

- Import an AUTOSAR `DataReceiveErrorEvent` definition.
- Define a `DataReceiveErrorEvent`.
- Generate arxml code for AUTOSAR receiver ports for which a `DataReceiveErrorEvent` is configured.

You should configure a `DataReceiveErrorEvent` for an AUTOSAR receiver port that uses `ImplicitReceive`, `ExplicitReceive`, or `EndToEndRead` data access mode.


To configure an AUTOSAR receiver port for a `DataReceiveErrorEvent`:

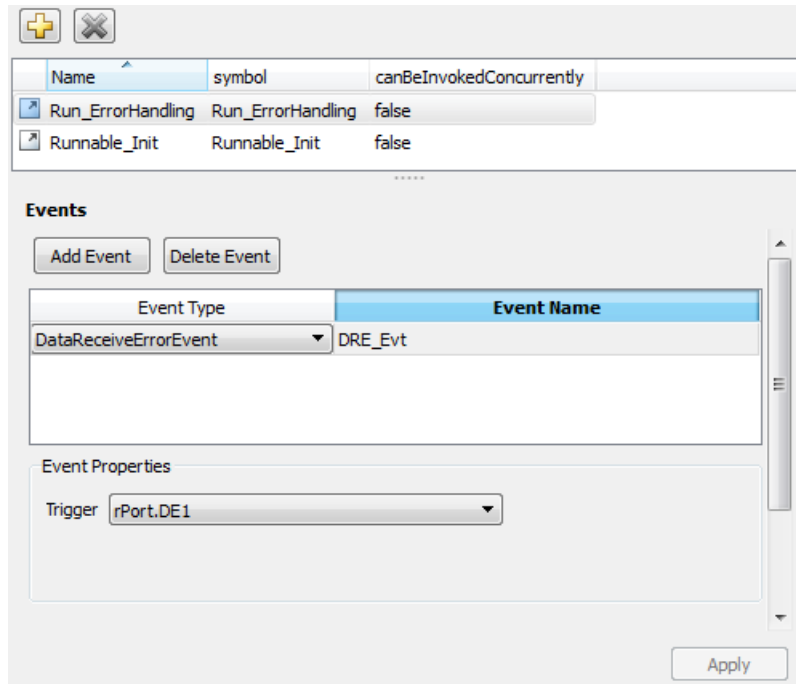
- 1 Open a model for which the receiver side of an AUTOSAR sender-receiver interface is configured.
- 2 Open the Code Mappings editor. Select the **Inports** tab. Select the data inport that is mapped to the AUTOSAR receiver port for which you want to configure a `DataReceiveErrorEvent`. Set its AUTOSAR data access mode to `ImplicitReceive`, `ExplicitReceive`, or `EndToEndRead`. Here are two examples, without and with a coupled `ErrorStatus` port.



Source	DataAccessMode	Port	Element
In	ImplicitReceive	rPort	DE

Source	DataAccessMode	Port	Element
In	ImplicitReceive	rPort	DE1
In(ErrorStatus)	ErrorStatus	rPort	DE1
In1	ImplicitReceive	rPort1	DE2

- 3 Open the AUTOSAR Dictionary. Expand the **AtomicComponents** node. Expand the receiver component and select **Runnables**.
- 4 In the runnables view, create a runnable to handle `DataReceiveErrorEvents`.
 - a Click the **Add** button  to add a runnable entry.
 - b Select the new runnable entry to configure its name and other properties.
 - c Go to the **Events** pane, and configure a `DataReceiveErrorEvent` for the runnable. Click **Add Event**, select type `DataReceiveErrorEvent`, and enter an event name.
 - d Under **Event Properties**, select the trigger for the event. The selected trigger value indicates the AUTOSAR receiver port and the data element for which the runnable is handling `DataReceiveErrorEvents`.



Alternatively, you can programmatically create a `DataReceiveErrorEvent`.

```
arProps = autosar.api.getAUTOSARProperties(mdName);
add(arProps, ibQName, 'Events', 'DRE_Evt', ...
    'Category', 'DataReceiveErrorEvent', 'Trigger', 'rPort.DE1', ...
    'StartOnEvent', runnableQName);
```

- 5 Build the model and inspect the generated code. The exported `arxml` code defines the error-handling runnable and its triggering event.

```
<EVENTS>
  <DATA-RECEIVE-ERROR-EVENT UUID="...">
    <SHORT-NAME>DRE_Evt</SHORT-NAME>
    <START-ON-EVENT-REF DEST="RUNNABLE-ENTITY">
      /Root/mDemoModel_sw/ReceivingASWC/IB/Run_ErrorHandling</START-ON-EVENT-REF>
    <DATA-IREF>
      <CONTEXT-R-PORT-REF DEST="R-PORT-PROTOTYPE">
        /Root/mDemoModel_sw/ReceivingASWC/rPort</CONTEXT-R-PORT-REF>
      <TARGET-DATA-ELEMENT-REF DEST="VARIABLE-DATA-PROTOTYPE">
        /Root/Interfaces/In/DE</TARGET-DATA-ELEMENT-REF>
    </DATA-IREF>
  </DATA-RECEIVE-ERROR-EVENT>
</EVENTS>
...
```

```

<RUNNABLES>
  ...
  <RUNNABLE-ENTITY UUID="...">
    <SHORT-NAME>Run_ErrorHandling</SHORT-NAME>
    <MINIMUM-START-INTERVAL>0</MINIMUM-START-INTERVAL>
    <CAN-BE-INVOKED-CONCURRENTLY>false</CAN-BE-INVOKED-CONCURRENTLY>
    ...
    <SYMBOL>Run_ErrorHandling</SYMBOL>
  </RUNNABLE-ENTITY>
</RUNNABLES>

```

Configure AUTOSAR Sender-Receiver Port ComSpecs

In AUTOSAR software components, a sender or receiver port optionally can specify a communication specification (ComSpec). ComSpecs describe additional communication requirements for port data.

To model AUTOSAR sender and receiver ComSpecs in Simulink, you can:

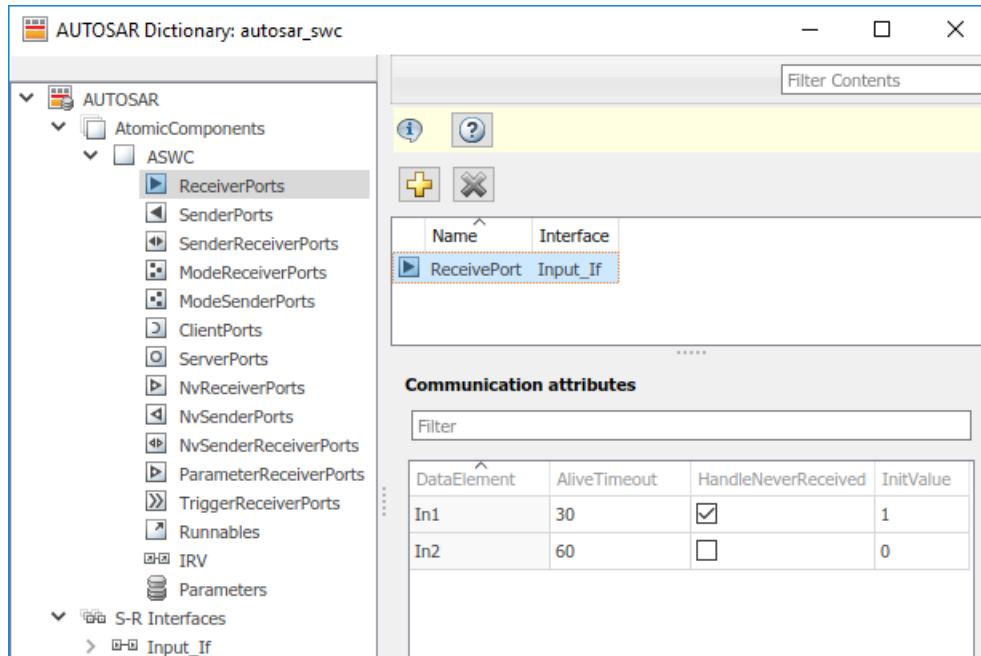
- Import sender and receiver ComSpecs from axml files
- Create sender and receiver ComSpecs in Simulink
- For nonqueued sender and receiver ports, modify ComSpec attribute `InitValue`
- For nonqueued receiver ports, modify ComSpec attributes `AliveTimeout` and `HandleNeverReceived`
- Export ComSpecs to axml files

For example, if you create an AUTOSAR receiver port in Simulink, you use the Code Mappings editor to map a Simulink inport to the AUTOSAR receiver port and an S-R data element. You can then select the port and specify its ComSpec attributes.

The screenshot displays the AUTOSAR development environment. The main window shows a component diagram for 'autosar_sw'. At the top, there is an 'Initialize' block with an 'Event Listener' and an 'Integrator' component. Below this, the 'Runnable_Initialize' block contains two sub-components: 'Runnable_1s' and 'Runnable_2s'. 'Runnable_1s' has an input port 'In1_1s' (circled in red) and is connected to an 'SS1' block. 'Runnable_2s' has an input port 'In2_2s' (circled in green) and is connected to an 'Integrator' block. The 'Integrator' block has a 'K Ts' and 'z-1' block. The 'SS1' block has two output ports, 'Out1' and 'Out2', which are connected to ports '1' and '2' respectively. The 'Property Inspector' on the right shows the properties for the 'In1_1s' port. The 'Code' section shows the 'DataAccessMode' as 'ImplicitReceive', the 'Port' as 'ReceivePort', and the 'Element' as 'In1'. The 'Communication attributes' section shows 'AliveTimeout' as 30, 'HandleNeverReceived' as true, and 'InitValue' as 1. The 'Code Mappings - AUTOSAR SW Component' table at the bottom shows the mapping between the source ports and the component ports.

Source	DataAccessMode	Port	Element
In1_1s	ImplicitReceive	ReceivePort	In1
In2_2s	ImplicitReceive	ReceivePort	In2

If you import or create an AUTOSAR receiver port, you can use the AUTOSAR Dictionary to view and edit the ComSpec attributes of the mapped S-R data elements in the AUTOSAR port.



To programmatically modify ComSpec attributes of an AUTOSAR nonqueued sender or receiver port, use the AUTOSAR property function `set`. For example:

```
hModel = 'autosar_swc';
open_system(hModel);
arProps = autosar.api.getAUTOSARProperties(hModel);

% Find ComSpec path
portPath = find(arProps, [], 'DataReceiverPort', 'PathType', 'FullyQualified');
ifPath = find(arProps, [], 'SenderReceiverInterface', 'Name', 'Input_If', 'PathType', 'FullyQualified');
dataElementPath = find(arProps, ifPath{1}, 'FlowData', 'Name', 'In1', 'PathType', 'FullyQualified');
infoPath = find(arProps, portPath{1}, 'PortInfo', ...
    'PathType', 'FullyQualified', 'DataElements', dataElementPath{1});
comSpecPath = find(arProps, infoPath{1}, 'PortComSpec', 'PathType', 'FullyQualified');

% Set ComSpec attributes
set(arProps, comSpecPath{1}, 'AliveTimeout', 30, 'HandleNeverReceived', true, 'InitValue', 1);
get(arProps, comSpecPath{1}, 'AliveTimeout')
get(arProps, comSpecPath{1}, 'HandleNeverReceived')
get(arProps, comSpecPath{1}, 'InitValue')
```

When you generate code for an AUTOSAR model that specifies ComSpec attributes, the exported arxml port descriptions include the ComSpec attribute values.

```
<PORTS>
  <R-PORT-PROTOTYPE UUID="...">
```

```
<SHORT-NAME>ReceivePort</SHORT-NAME>
<REQUIRED-COM-SPECS>
  <NONQUEUED-RECEIVER-COM-SPEC>
    <DATA-ELEMENT-REF DEST="VARIABLE-DATA-PROTOTYPE">
      /Company/Powertrain/Interfaces/Input_If/In1
    </DATA-ELEMENT-REF>
  ...
  <ALIVE-TIMEOUT>30</ALIVE-TIMEOUT>
  <HANDLE-NEVER-RECEIVED>true</HANDLE-NEVER-RECEIVED>
  ...
  <INIT-VALUE>
    <CONSTANT-REFERENCE>
      <SHORT-LABEL>DefaultInitValue_Double_1</SHORT-LABEL>
      <CONSTANT-REF DEST="CONSTANT-SPECIFICATION">
        /Company/Powertrain/Constants/DefaultInitValue_Double_1
      </CONSTANT-REF>
    </CONSTANT-REFERENCE>
  </INIT-VALUE>
  </NONQUEUED-RECEIVER-COM-SPEC>
</REQUIRED-COM-SPECS>
</R-PORT-PROTOTYPE>
</PORTS>
...
<CONSTANT-SPECIFICATION UUID="...">
  <SHORT-NAME>DefaultInitValue_Double_1</SHORT-NAME>
  <VALUE-SPEC>
    <NUMERICAL-VALUE-SPECIFICATION>
      <SHORT-LABEL>DefaultInitValue_Double_1</SHORT-LABEL>
      <VALUE>1</VALUE>
    </NUMERICAL-VALUE-SPECIFICATION>
  </VALUE-SPEC>
</CONSTANT-SPECIFICATION>
```

See Also

Signal Invalidation

Related Examples

- “Model AUTOSAR Communication” on page 2-28
- “Import AUTOSAR Software Component” on page 3-19
- “Configure AUTOSAR Code Generation” on page 5-8

More About

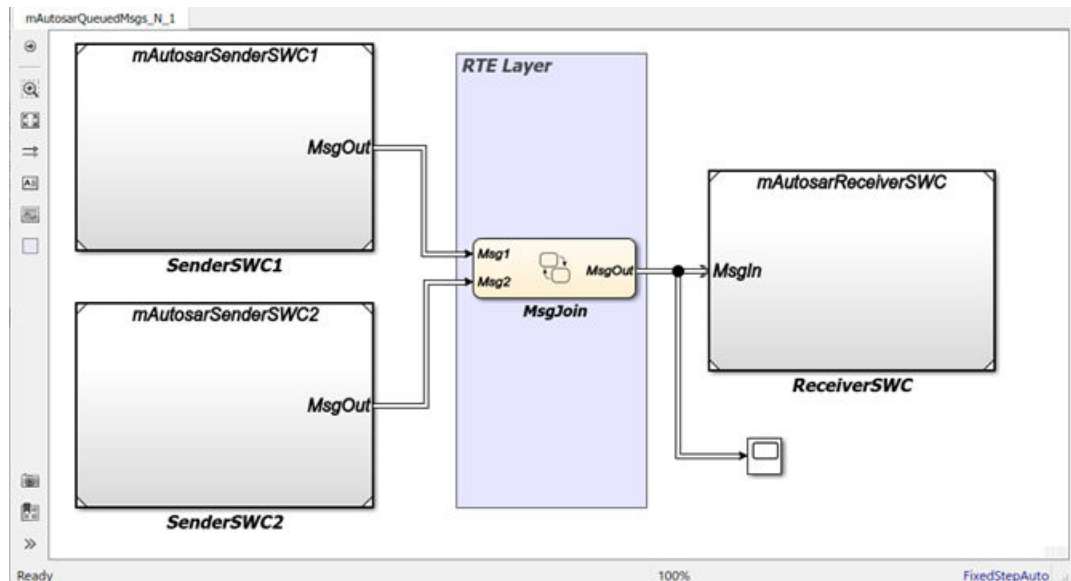
- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Queued Sender-Receiver Communication

In AUTOSAR queued communication, data sent by an AUTOSAR sender software component is added to a queue provided by the AUTOSAR Runtime Environment (RTE). Newly received data does not overwrite existing unread data. Later, a receiver software component reads the data from the queue.

In Simulink, you can use Stateflow[®] messages to model sending and receiving AUTOSAR data using a queue. You can handle errors that occur when the queue is empty or full. You can specify the size of the queue.

You can simulate AUTOSAR queued sender-receiver (S-R) communication between component models, for example, in a composition-level simulation. Data senders and receivers can run at different rates. Multiple data senders can communicate with a single data receiver.



To get started, you can import components with queued sender and receiver ports from a xml files into Simulink, or use Simulink to create queued sender and receiver ports.

In this section...

“Simulink Workflow for Modeling AUTOSAR Queued Send and Receive” on page 4-146

“Configure AUTOSAR Sender and Receiver Components for Queued Communication” on page 4-147

“Implement AUTOSAR Queued Send and Receive Messaging” on page 4-150

“Configure Simulation of AUTOSAR Queued Sender-Receiver Communication” on page 4-156

“Simulate N-to-1 AUTOSAR Queued Sender-Receiver Communication” on page 4-157

“Simulate Event-Driven AUTOSAR Queued Sender-Receiver Communication” on page 4-160

“Determine When a Queue Overflows” on page 4-167

Simulink Workflow for Modeling AUTOSAR Queued Send and Receive

Here is the general workflow for modeling AUTOSAR queued sender and receiver components in Simulink.

- 1** Configure one or more models as AUTOSAR queued sender components, and one model as an AUTOSAR queued receiver component. For each component model, use the AUTOSAR Dictionary and the Code Mappings editor to:
 - a** Create an S-R data interface and its data elements.
 - b** Create a sender or receiver port.
 - c** Map the sender or receiver port to a Simulink outputport for sending or inputport for receiving. Set the AUTOSAR data access mode to `QueuedExplicitSend` or `QueuedExplicitReceive`.

For example, see “Configure AUTOSAR Sender and Receiver Components for Queued Communication” on page 4-147.

- 2** To implement AUTOSAR queued sender or receiver component behavior, use Stateflow messages. Follow the general procedure described in “Model an Assembly Line Feeder” (Stateflow). Create a chart, add message states, implement state entry actions, specify state transition conditions or events, and define data to store state variables. Finally, connect the chart message-line inputs and outputs to Simulink root inputports and outputports.

For more information, see “Implement AUTOSAR Queued Send and Receive Messaging” on page 4-150.


- 3 When you build an AUTOSAR queued sender or receiver component model:
 - Generated C code contains calls to AUTOSAR `Rte_Send_<port>_<DataElement>` or `Rte_Receive_<port>_<DataElement>` APIs. The generated code handles the status of the message send and receive calls.
 - Exported arxml files contain descriptions for queued sender-receiver communication. The generated ComSpec for a queued port includes the port type and the queue length (based on Simulink message property `QueueCapacity`). In the `SwDataDefProps` generated for the queued port data element, `SwImplPolicy` is set to `Queued`.
- 4 To simulate AUTOSAR queued sender-receiver communication in Simulink, create a containing composition, system, or harness model. Include the queued sender and receiver components as referenced models.
 - If you have one sender component and one receiver component, you potentially can connect the models directly. For example, see the 1-to-1 composition model used in “Configure Simulation of AUTOSAR Queued Sender-Receiver Communication” on page 4-156.
 - If you are simulating N-to-1 or event-driven messaging, you provide additional logic between sender and receiver component models. For example, see “Simulate N-to-1 AUTOSAR Queued Sender-Receiver Communication” on page 4-157 and “Simulate Event-Driven AUTOSAR Queued Sender-Receiver Communication” on page 4-160.

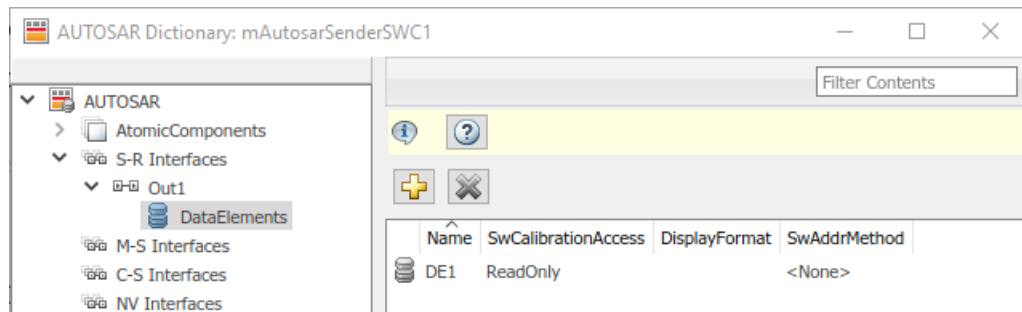
Configure AUTOSAR Sender and Receiver Components for Queued Communication

This example configures AUTOSAR queued sender and receiver components in Simulink. The example uses two models in the folder `matlabroot/help/toolbox/autosar/examples` (open). If you copy the files to a working folder, collocate the models. To see these models connected for simulation, see “Configure Simulation of AUTOSAR Queued Sender-Receiver Communication” on page 4-156.

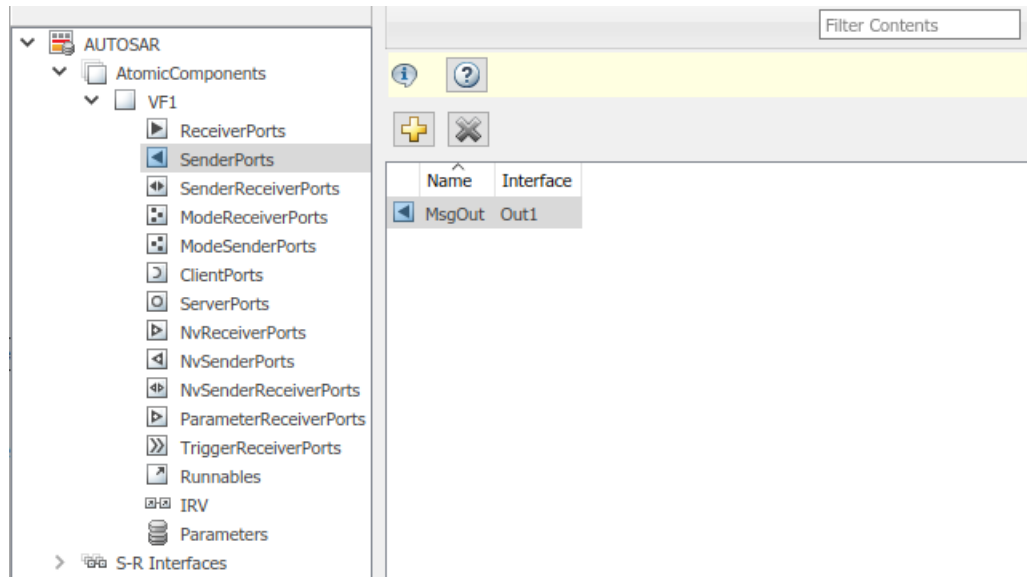
- `mAutosarSenderSWC1.slx`
- `mAutosarReceiverSWC.slx`

Open an AUTOSAR model that you want to configure as a queued sender or receiver component. To create an S-R data interface and a queued sender or receiver port:

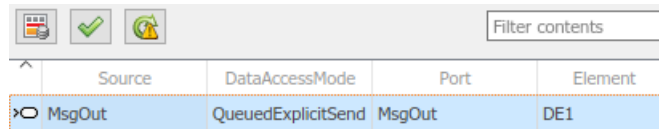
- 1 Open the AUTOSAR Dictionary.
- 2 Select **S-R Interfaces**. To create an S-R data interface, click the **Add** button . Specify its name and the number of associated S-R data elements. This example uses one data element in both the sender and receiver components.
- 3 Select and expand the new S-R interface. Select **DataElements** and modify the data element attributes. Here is data element DE1 for the sender component.



- 4 Expand the **AtomicComponents** node and select an AUTOSAR component. Expand the component.
- 5 Select the **SenderPorts** or **ReceiverPorts** view and use it to add the sender or receiver port you require. For each S-R port, select the S-R interface you created. For the sender component, here is sender port MsgOut, which uses S-R interface Out1.



- 6 Open the Code Mappings editor. Select the **Inports** or **Outports** tab and use it to map a Simulink inport or outport to an AUTOSAR queued S-R port. For each inport or outport, select an AUTOSAR port, data element, and data access mode. Set the AUTOSAR data access mode to `QueuedExplicitSend` or `QueuedExplicitReceive`. In the sender component, here is Simulink outport `MsgOut`, which is mapped to AUTOSAR sender port `MsgOut` and data element `DE1`, with data access mode `QueuedExplicitSend`.



When you build an AUTOSAR queued sender or receiver component model:

- Generated C code contains calls to AUTOSAR `Rte_Send_<port>_<DataElement>` or `Rte_Receive_<port>_<DataElement>` APIs. The generated code handles the status of the message send and receive calls.
- Exported `arxml` files contain descriptions for queued sender-receiver communication. The generated `ComSpec` for a queued port includes the port type and the queue length.

(based on Simulink message property `QueueCapacity`). In the `SwDataDefProps` generated for the queued port data element, `SwImplPolicy` is set to `Queued`.

To implement the messaging behavior of an AUTOSAR queued sender or receiver component, use Stateflow messages. See “Implement AUTOSAR Queued Send and Receive Messaging” on page 4-150.

Implement AUTOSAR Queued Send and Receive Messaging

To implement AUTOSAR queued sender or receiver component behavior, this example uses Stateflow messages. To create a Stateflow chart, follow the general procedure described in “Model an Assembly Line Feeder” (Stateflow).

- 1 Add a chart to the AUTOSAR queued sender or receiver component model. Name the chart.
- 2 Open the chart and add message-related states.
- 3 For each state, add entry actions. Supported message keywords include:
 - `send(M)` -- Send message M.
 - `receive(M)` -- Receive message M.
 - `isvalid(M)` -- Check if message M is valid (popped and not discarded).
 - `discard(M)` -- Explicitly discard message M. Messages are implicitly discarded on state exit after a message receive operation completes.
- 4 Add state transition lines and specify transition conditions or events on those lines.
 - Use conditions when you want to transition based on a conditional statement or a change of input value from a Simulink block. For more information, see “Transition Action Types” (Stateflow).
 - Use events when you want to transition based on a Simulink triggered or function-call input event. For more information, see “Synchronize Model Components by Broadcasting Events” (Stateflow).
- 5 Define data that stores state variables.
- 6 Connect the chart message-line inputs and outputs to Simulink root inports and outports.

For more information, see “Messages” (Stateflow).

In the context of a Stateflow chart, you can modify message properties, such as data type and queue capacity. (For a list of properties, see “Set Properties for a Message”

(Stateflow).) You can access message properties in the Property Inspector, a Message properties dialog box, or Model Explorer. To view or modify message properties with the Property Inspector:

- 1 Open a chart that uses messages.
- 2 In the **Modeling** tab, open **Symbols Pane** and **Property Inspector**.
- 3 In the Symbols view, select a message. The Property Inspector displays panes for **Message Data Properties** and **Advanced** properties.

If the chart is in a receiver component, the Property Inspector also displays **Message Queue Properties**. To configure the receiver component to use external AUTOSAR RTE message queues, make sure that property **Use internal queue** is cleared.

4

The Property Inspector window shows the following configuration for the 'Msg' message:

- Message Data Properties:**
 - Scope: Input
 - Port: 1
 - Size: 1
 - Type: dType
- Message Queue Properties:**
 - Use internal queue
- Advanced:** (Expanded)

The Symbols pane displays the following table:

TYPE	NAME	VALUE	PORT
	Msg		1
	leftTurnReqs	0	
	rightTurnReqs	0	

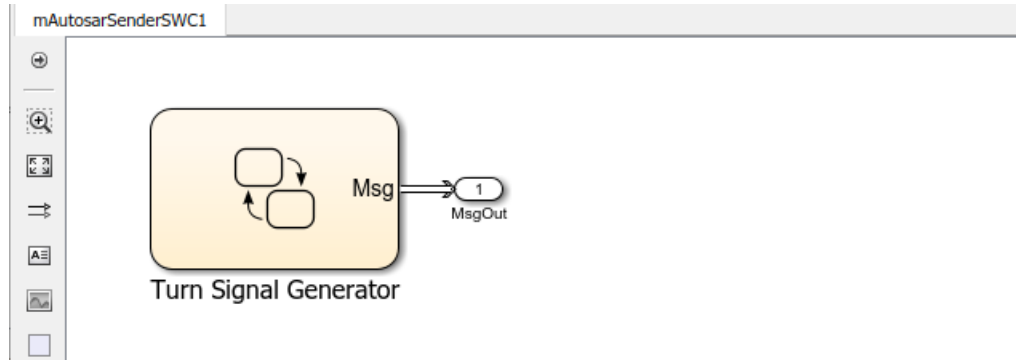
By default, message data type and queue capacity values are inherited from the Stateflow message to which a Simulink root port is attached. Message data can use these Simulink

parameter data types: `int` types, `uint` types, floating-point types, `boolean`, `Enum`, or `Bus (struct)`.

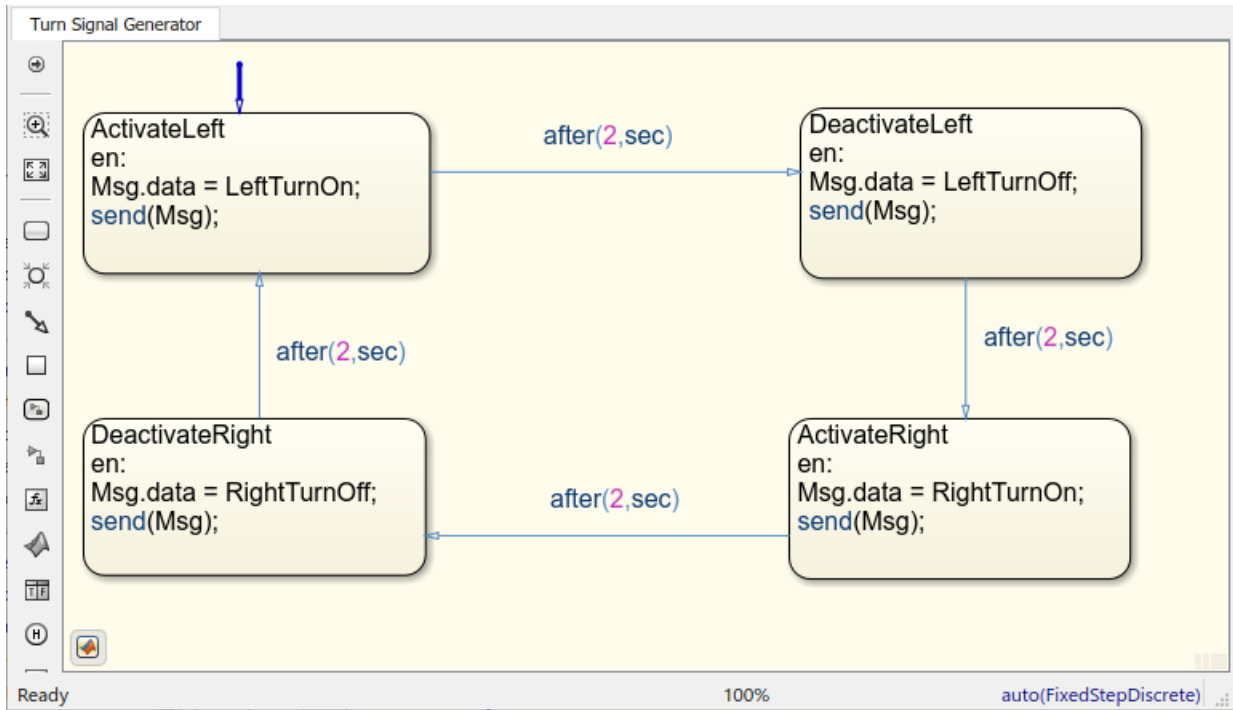
If you use imported bus or enumeration data types in Stateflow charts, typedefs are required for simulation. To generate typedefs automatically, select the Simulink configuration option **Generate typedefs for imported bus and enumeration types**. Otherwise, use Simulink configuration parameter **Simulation Target > Custom Code > Header file** to include header files with the definitions.

For sample implementations of queued sender and receiver components in a 1-to-1 configuration, see the example component models used in both “Configure AUTOSAR Sender and Receiver Components for Queued Communication” on page 4-147 and “Configure Simulation of AUTOSAR Queued Sender-Receiver Communication” on page 4-156. Models `mAutosarSenderSWC1.slx` and `mAutosarReceiverSWC.slx` are located in the folder `matlabroot/help/toolbox/autosar/examples` (open).

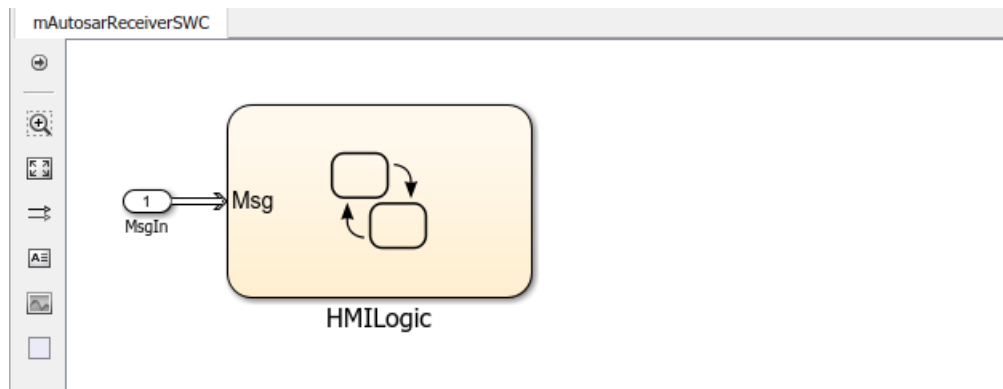
Here is the top level of AUTOSAR queued sender component `mAutosarSenderSWC1`, which contains Stateflow chart `Turn Signal Generator`. The chart message-line output is connected to Simulink root output `MsgOut`.



Here is the logic implemented in the `Turn Signal Generator` chart. The chart has four states - `ActivateLeft`, `DeactivateLeft`, `ActivateRight`, and `DeactivateRight`. Each state contains entry actions that assign a value to message data and send a message. (See “Communicate with Stateflow Charts by Sending Messages” (Stateflow).) Periodic timing drives the message output.



Here is the top level of AUTOSAR queued receiver component `mAutosarReceiverSWC`, which contains Stateflow chart `HMILogic`. The chart message-line input is connected to Simulink root inport `MsgIn`.



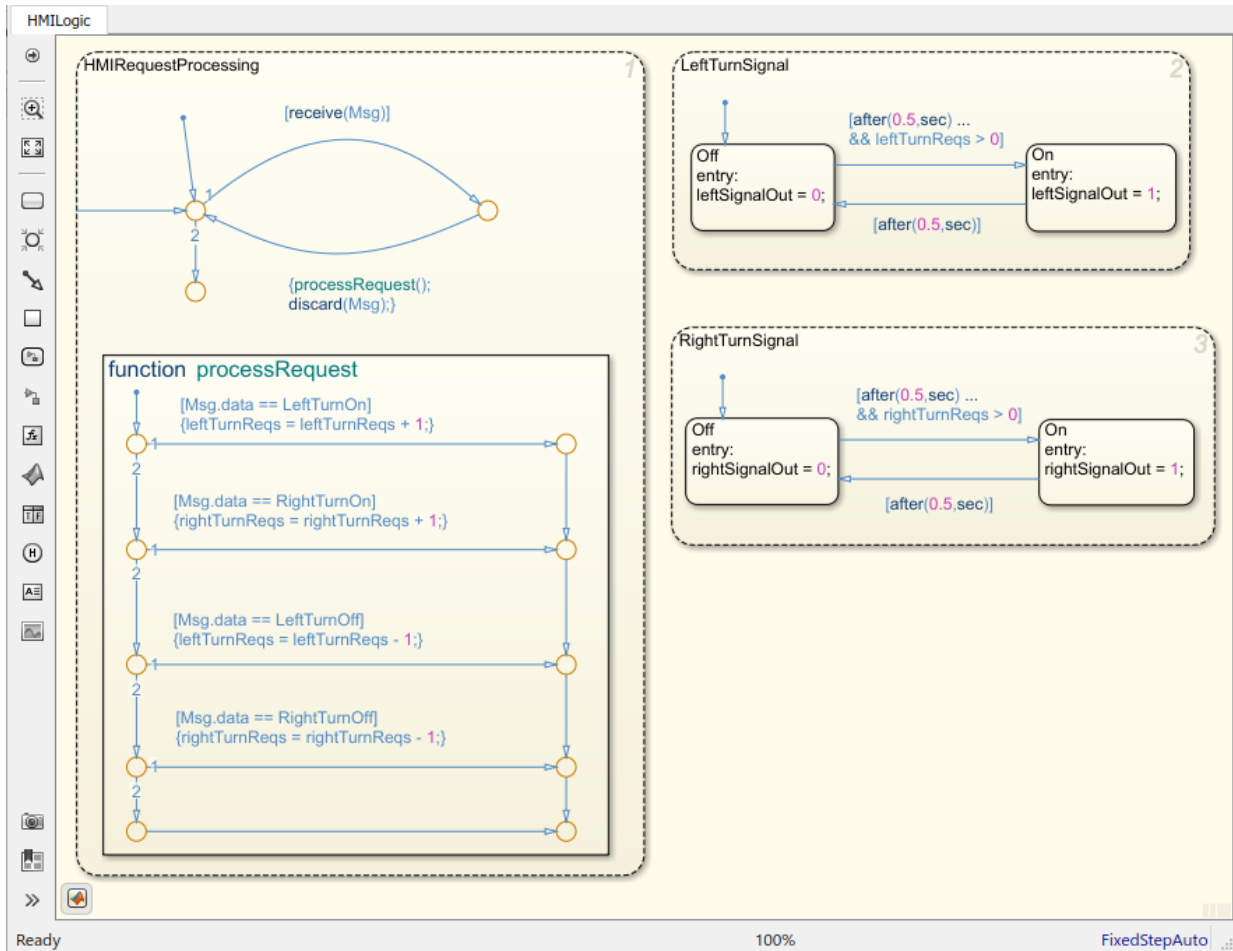
To receive a message, queued receiver logic uses `receive(M)`:

- If a valid message `M` exists, `receive(M)` returns true.
- If a valid message does not exist, the chart removes a message from its associated queue, and `receive(M)` returns true. If `receive(M)` removes a message from the queue, the length of the queue drops by one.
- If message `M` is invalid, and another message could not be removed from the queue, `receive(M)` returns false.

You can place `receive` on a transition (for example, `[receive(M)]`). Or, within a state, use an `if` condition (for example, `if(receive(M))`). For more information, see “Communicate with Stateflow Charts by Sending Messages” (Stateflow).

Here is the logic implemented in the `HMILogic` chart. `HMILogic` contains states `HMIRequestProcessing`, `LeftTurnSignal`, and `RightTurnSignal`.

- `HMIRequestProcessing` receives a message from the message queue, calls a function to process the message, and then discards the message. The `processRequest` function tests the received message data for values potentially set by the message sender -- `LeftTurnOn`, `RightTurnOn`, `LeftTurnOff`, or `RightTurnOff`. Based on the value received, the function increments or decrements a request counter variable, either `leftTurnReqs` or `rightTurnReqs`. Periodic timing drives the message input.
- `LeftTurnSignal` and `RightTurnSignal` each contain states `Off` and `On`. They transition from `Off` to `On` based on the value of request counter `leftTurnReqs` or `rightTurnReqs` and a time interval. When the request counter is greater than zero, the charts set a variable, either `leftSignalOut` or `rightSignalOut`, to 1. After a time interval, they transition back to the `Off` state and set `leftSignalOut` or `rightSignalOut` to 0.



For sample implementations of queued sender and receiver components in an N-to-1 configuration, see the example models used in “Simulate N-to-1 AUTOSAR Queued Sender-Receiver Communication” on page 4-157.

For sample implementations of event-driven queued messaging, see the example models used in “Simulate Event-Driven AUTOSAR Queued Sender-Receiver Communication” on page 4-160.

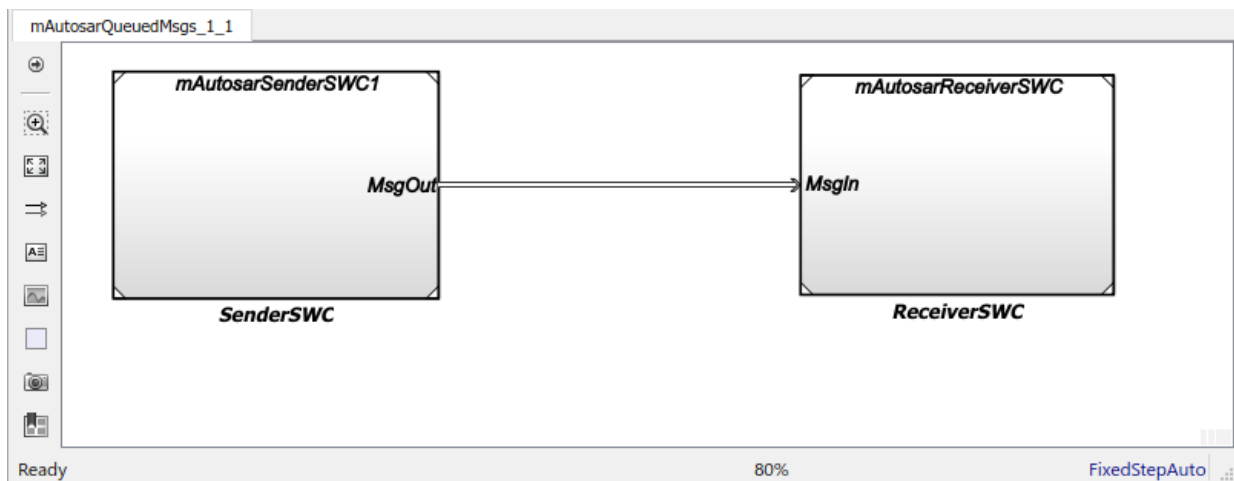
Configure Simulation of AUTOSAR Queued Sender-Receiver Communication

To simulate AUTOSAR queued sender-receiver communication in Simulink, create a containing composition, system, or harness model. Include the queued sender and receiver components as referenced models.

- If you have one sender component and one receiver component, you potentially can connect the models directly. This example directly connects sender and receiver component models.
- If you are simulating N-to-1 or event-driven messaging, you provide additional logic between sender and receiver component models. For example, see “Simulate N-to-1 AUTOSAR Queued Sender-Receiver Communication” on page 4-157 and “Simulate Event-Driven AUTOSAR Queued Sender-Receiver Communication” on page 4-160.

Here is a composition-level model that contains queued sender and receiver component models and implements 1-to-1 communication. Periodic timing drives the messaging. This example uses three models in the folder *matlabroot/help/toolbox/autosar/examples* (open). If you copy the files to a working folder, collocate the models.

- *mAutosarQueuedMsgs_1_1.slx* (top model)
- *mAutosarSenderSWC1.slx*
- *mAutosarReceiverSWC.slx*



Models `mAutosarSenderSWC1` and `mAutosarReceiverSWC` are the same sender and receiver components configured in “Configure AUTOSAR Sender and Receiver Components for Queued Communication” on page 4-147 and implemented in “Implement AUTOSAR Queued Send and Receive Messaging” on page 4-150. Composition-level model `mAutosarQueuedMsgs_1_1` includes them as referenced models and connects sender component port `MsgOut` to receiver component port `MsgIn`.

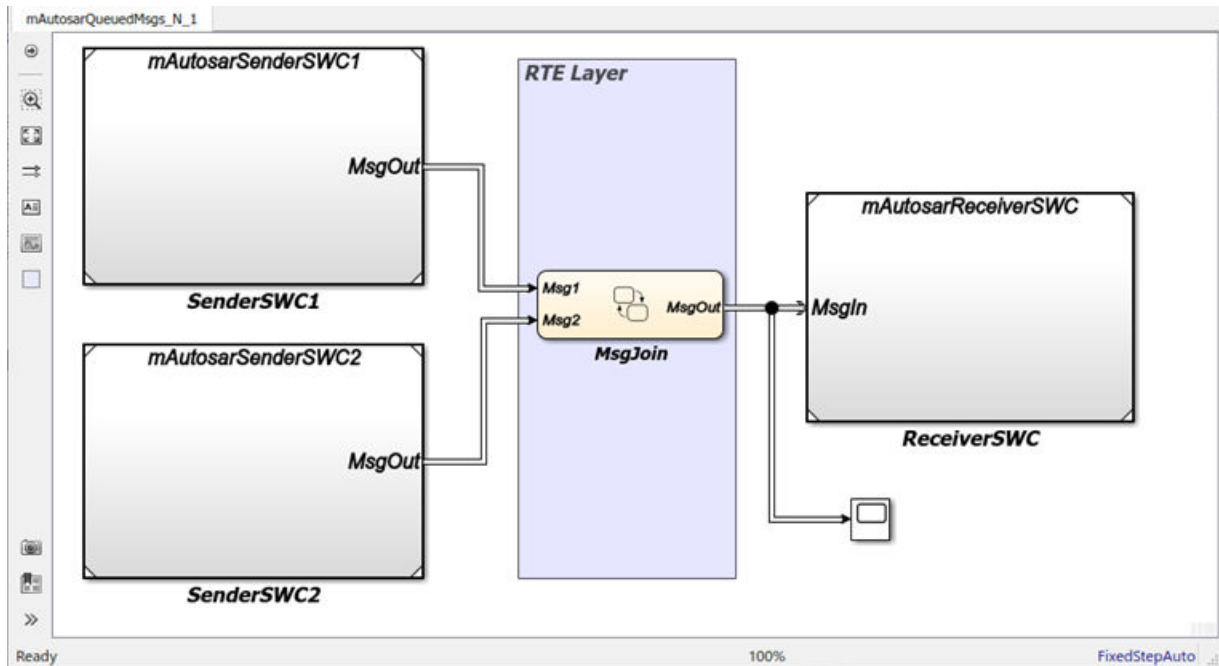
The top model `mAutosarQueuedMsgs_1_1` is for simulation only. You can generate AUTOSAR C code and arxml files for the sender and receiver component models, but not for the containing composition-level model.

Similarly, you can run software-in-the-loop (SIL) simulation for the sender and receiver component models, but not for the composition-level model.

Simulate N-to-1 AUTOSAR Queued Sender-Receiver Communication

Here is a composition-level model that contains two sender and one receiver component models, and implements N-to-1 communication. Periodic timing drives the messaging. This example extends the 1-to-1 example by adding a second sender model and providing flow logic between the senders and receiver. This example uses four models in the folder `matlabroot/help/toolbox/autosar/examples` (open). If you copy the files to a working folder, collocate the models.

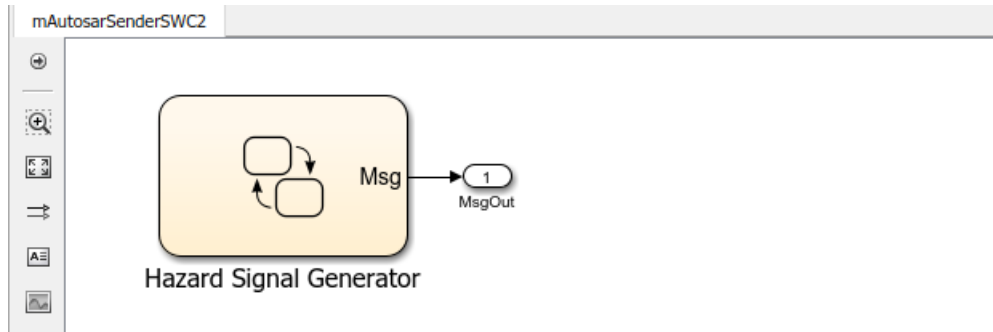
- `mAutosarQueuedMsgs_N_1.slx` (top model)
- `mAutosarSenderSWC1.slx`
- `mAutosarSenderSWC2.slx`
- `mAutosarReceiverSWC.slx`



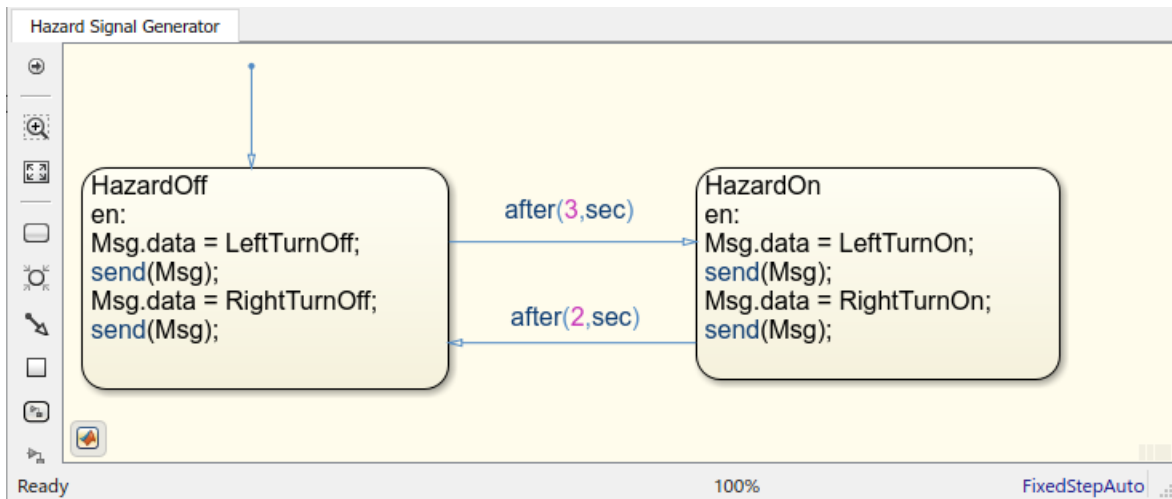
Composition-level model `mAutosarQueuedMsgs_N_1` includes two sender components and a receiver component as referenced models. It connects the sender component `MsgOut` ports to intermediate `MsgJoin` processing logic, which in turn connects to a receiver component `MsgIn` port.

Models `mAutosarSenderSWC1` and `mAutosarReceiverSWC` are the same sender and receiver components configured in “Configure AUTOSAR Sender and Receiver Components for Queued Communication” on page 4-147 and implemented in “Implement AUTOSAR Queued Send and Receive Messaging” on page 4-150. The second sender component, `mAutosarSenderSWC2`, is similar to `mAutosarSenderSWC1`, but implements a second type of message input for the receiver to process.

Here is the top level of AUTOSAR queued sender component `mAutosarSenderSWC2`, which contains Stateflow chart Hazard Signal Generator. The chart message-line output is connected to Simulink root outputport `MsgOut`.



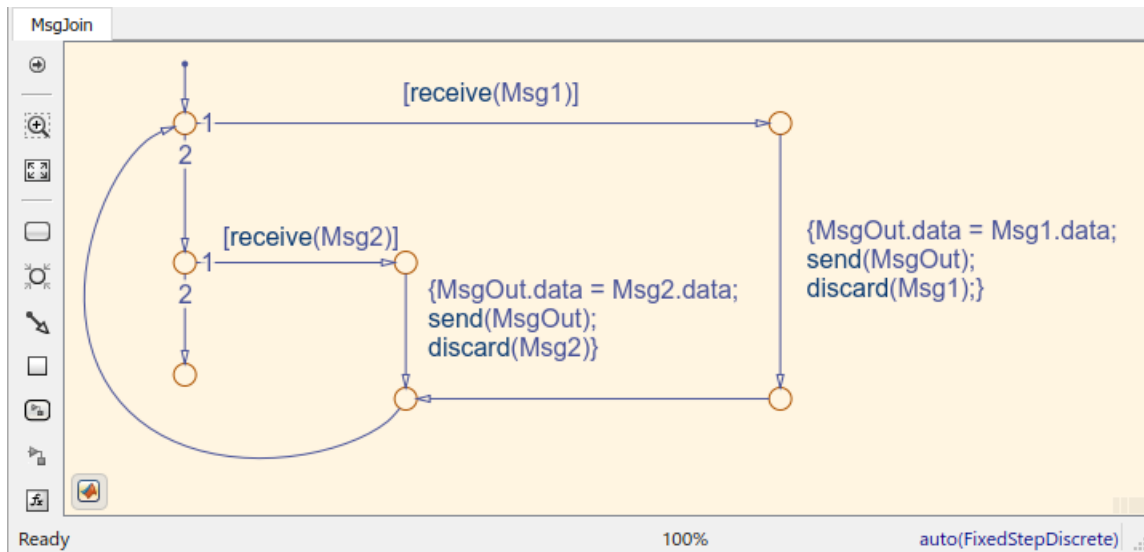
Here is the logic implemented in the Hazard Signal Generator chart. The chart has two states - HazardOff and HazardOn. Each state contains entry actions that assign values to message data and send messages. (See "Communicate with Stateflow Charts by Sending Messages" (Stateflow).) Periodic timing drives the message output.



Here is the MsgJoin chart located between the sender and receiver components.



Here is the logic implemented in the `MsgJoin` chart. The chart receives queued messages from both sender components and outputs them, one at a time, to the receiver component. Messages from the first sender component, `mAutosarSenderSWC1.slx`, are processed first. For each message received, the chart copies the received message data to the outbound message, sends the data, and discards the received message. (See “Communicate with Stateflow Charts by Sending Messages” (Stateflow).)



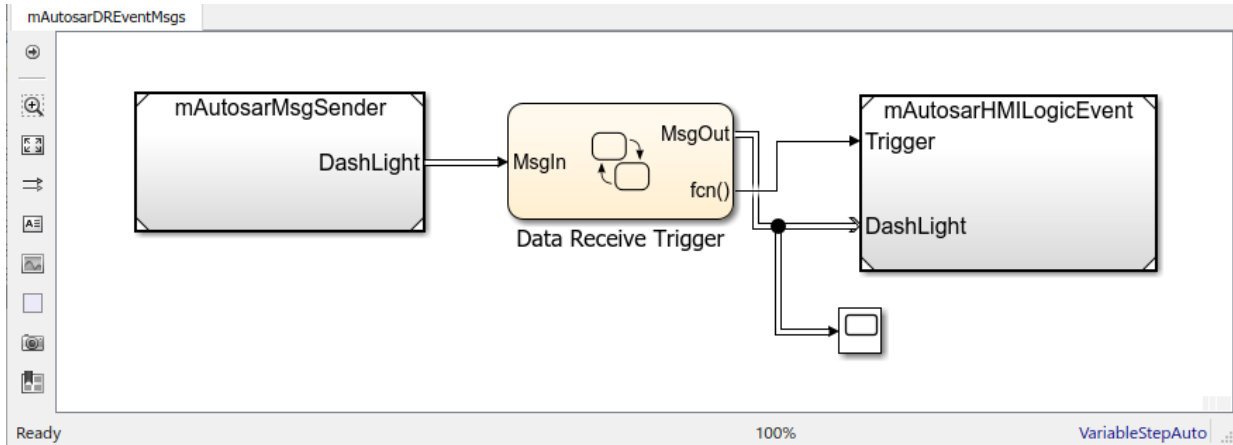
The top model `mAutosarQueuedMsgs_N_1` is for simulation only. You can generate AUTOSAR C code and arxml files for the referenced sender and receiver component models, but not for the containing composition-level model.

Similarly, you can run software-in-the-loop (SIL) simulation for the sender and receiver component models, but not for the composition-level model.

Simulate Event-Driven AUTOSAR Queued Sender-Receiver Communication

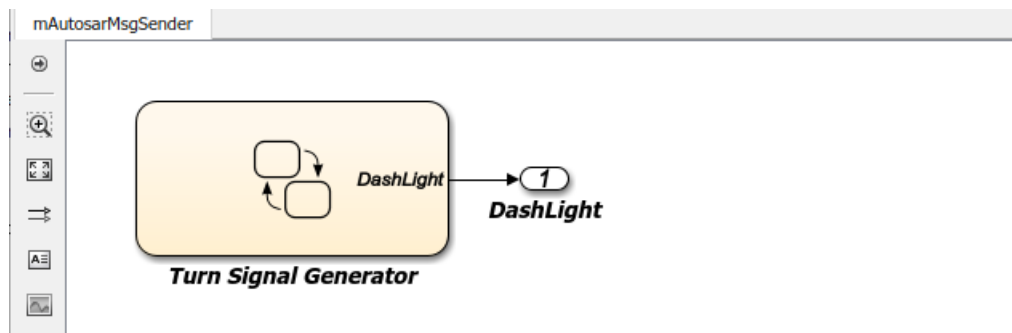
Here is a composition-level model in which a Simulink function-call input event activates receiver component processing of a queued message. This example uses three models in the folder `matlabroot/help/toolbox/autosar/examples` (open). If you copy the files to a working folder, collocate the models.

- mAutosarDREventMsgs.slx (top model)
- mAutosarMsgSender.slx
- mAutosarHMILogicEvent.slx

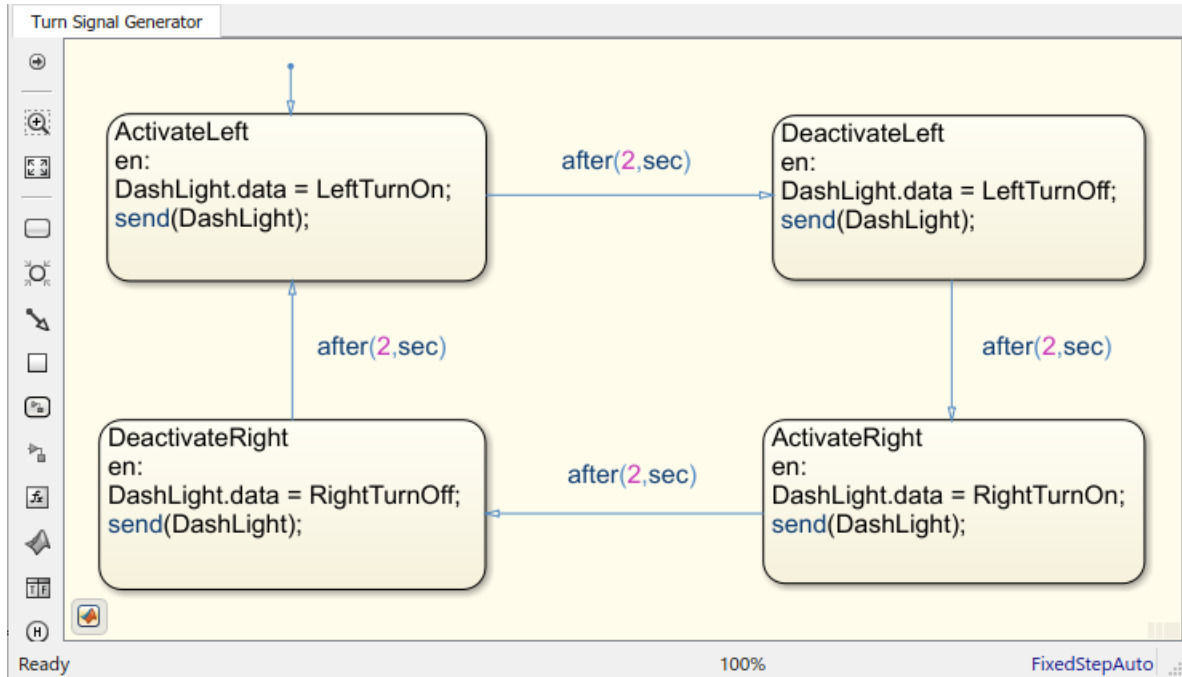


Composition-level model mAutosarDREventMsgs includes a sender component and a receiver component as referenced models. It connects the sender message port DashLight to intermediate Data Receive Trigger logic, which in turn connects to receiver message port MsgIn and function trigger port Trigger.

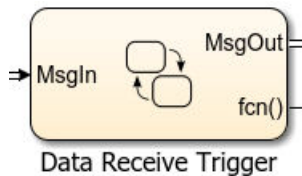
Here is the top level of AUTOSAR queued sender component mAutosarMsgSender, which contains Stateflow chart Turn Signal Generator. The chart message-line output is connected to Simulink root outputport DashLight. (This sender component is similar to component mAutosarSenderSWC1 in the 1-to-1 and N-to-1 simulation examples.)



Here is the logic implemented in the Turn Signal Generator chart. The chart has four states - ActivateLeft, DeactivateLeft, ActivateRight, and DeactivateRight. Each state contains entry actions that assign a value to message data and send a message. (See “Communicate with Stateflow Charts by Sending Messages” (Stateflow).) Periodic timing drives the message output.



Here is the Data Receiver Trigger chart located between the sender and receiver components.

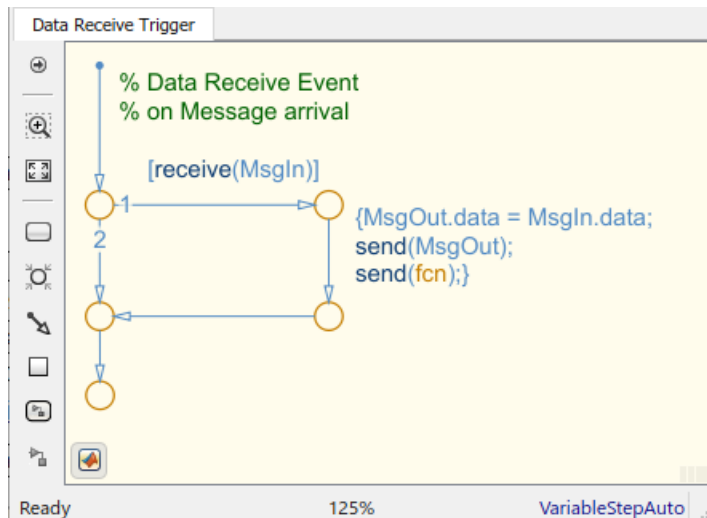


To receive a message, queued receiver logic uses receive(M):

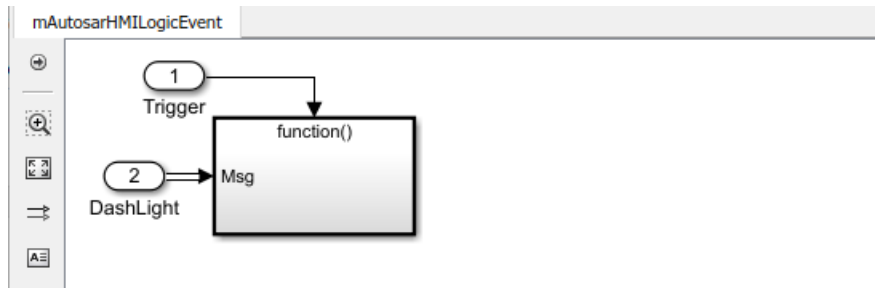
- If a valid message M exists, `receive(M)` returns true.
- If a valid message does not exist, the chart removes a message from its associated queue, and `receive(M)` returns true. If `receive(M)` removes a message from the queue, the length of the queue drops by one.
- If message M is invalid, and another message could not be removed from the queue, `receive(M)` returns false.

You can place `receive` on a transition (for example, `[receive(M)]`). Or, within a state, use an `if` condition (for example, `if(receive(M))`). For more information, see “Communicate with Stateflow Charts by Sending Messages” (Stateflow).

Here is the logic implemented in the `Data Receiver Trigger` chart. The chart receives queued messages from the sender component. For each message received, the chart copies the received message data to the outbound message, sends the data, and sends a function-call event. (See “Communicate with Stateflow Charts by Sending Messages” (Stateflow).)

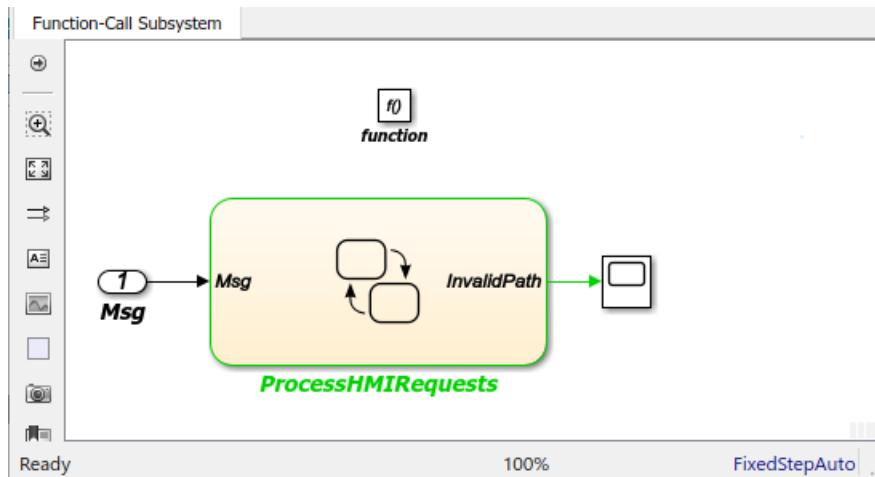


Here is the top level of AUTOSAR queued receiver component `mAutosarHMILogicEvent`, which contains a Simulink function-call subsystem. The subsystem inports are a function-call trigger and message receiver port `DashLight`, which is configured for AUTOSAR data access mode `QueuedExplicitReceive`.



The function-call subsystem contains Stateflow chart `ProcessHMIRRequests` and a Trigger Port block. The chart message-line input is connected to Simulink root inport `Msg`. A scope is configured to display the value of an `InvalidPath` variable.

The Trigger Port block is configured for a function-call trigger and triggered sample time. Function-call input events sent from the Data Receiver Trigger chart in the top model activate the chart.

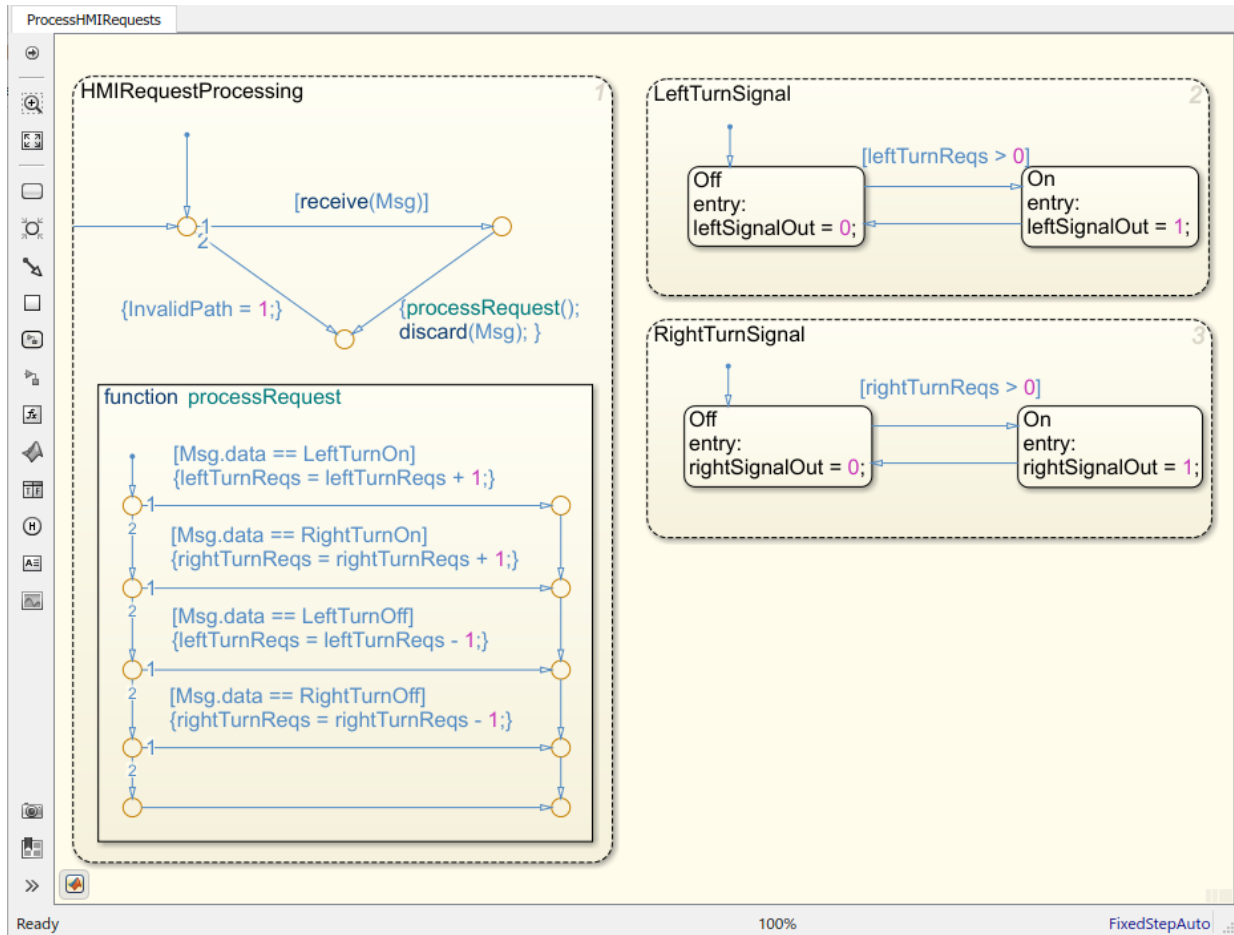


Here is the logic implemented in the `ProcessHMIRRequests` chart. `ProcessHMIRRequests` contains states `HMIRequestProcessing`, `LeftTurnSignal`, and `RightTurnSignal`. (This receiver chart is similar to chart `HMILogic` in the 1-to-1 and N-to-1 simulation examples.)

- `HMIRequestProcessing` receives a message from the message queue, calls a function to process the message, and then discards the message. The

`processRequest` function tests the received message data for values potentially set by the message sender -- `LeftTurnOn`, `RightTurnOn`, `LeftTurnOff`, or `RightTurnOff`. Based on the value received, the function increments or decrements a request counter variable, either `leftTurnReqs` or `rightTurnReqs`. Function-call input events drive the message input. If the chart is incorrectly activated, the `InvalidPath` variable is set to 1.

- `LeftTurnSignal` and `RightTurnSignal` each contain states `Off` and `On`. They transition from `Off` to `On` based on the value of request counter `leftTurnReqs` or `rightTurnReqs`. When the request counter is greater than zero, the charts set a variable, either `leftSignalOut` or `rightSignalOut`, to 1. Then they transition back to the `Off` state and set `leftSignalOut` or `rightSignalOut` to 0.



The top model `mAutosarDREventMsgs` is for simulation only. You can generate AUTOSAR C code and arxml files for the referenced sender and receiver component models, but not for the containing composition-level model.

Similarly, you can run software-in-the-loop (SIL) simulation for the sender and receiver component models, but not for the composition-level model.

Determine When a Queue Overflows

To check whether a message is lost because it was sent to a queue that was already full, use the Stateflow `overflowed` operator:

```
overflowed(message_name)
```

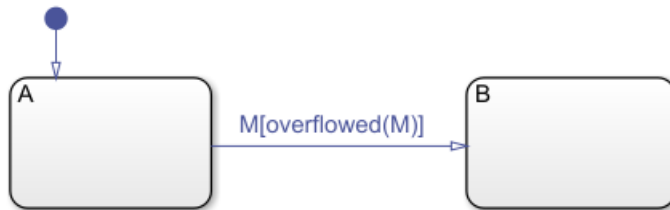
In each time step, the value of this operator is set when a chart adds a message to, or removes a message from, a queue. It is invalid to use the `overflowed` operator before sending or retrieving a message in the same time step.

By default, when a message queue overflows, simulation stops with an error. To prevent a run-time error and allow the `overflowed` operator to dynamically react to dropped messages, set the value of the **Queue Overflow Diagnostic** property to `Warning` or `None`. For more information, see “Queue Overflow Diagnostic” (Stateflow).

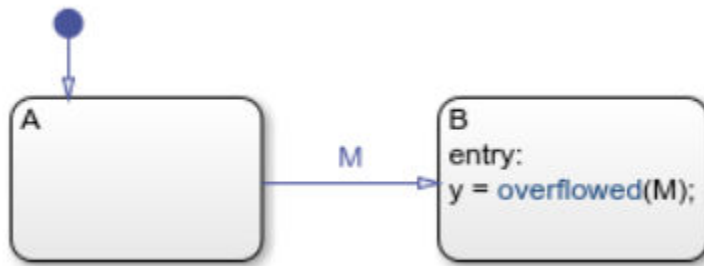
Check for Input Message Overflow

To check the overflow status of an input message queue, first remove a message from the queue. You can:

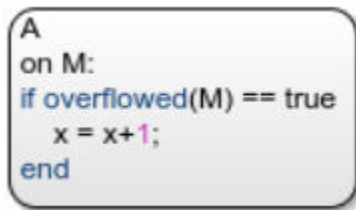
- Guard a transition with the message and the `overflowed` operator.



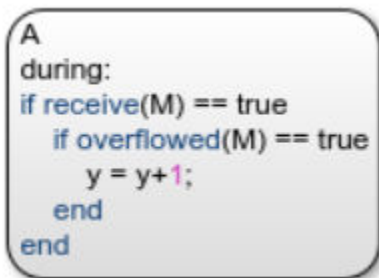
- Guard a transition with the message and call the `overflowed` operator in the entry action of the destination state.



- Guard a state on action with the message and call the `overflowed` operator in the action.



- In a state action, use the `receive` operator followed by the `overflowed` operator.



Calling the `overflowed` operator before retrieving an input message in the same time step results in a run-time error.

Check for Output Message Overflow

To check the overflow status of an output message queue, first add a message to the queue. You can:

- Use the `send` operator followed by the `overflowed` operator.

```
A
entry:
M.data = 3;
send(M);
if overflowed(M) == true
  x = x+1;
end
```

- Use the `forward` operator followed by the `overflowed` operator.

```
A
on M1:
forward(M1, M);
if overflowed(M) == true
  x = x+1;
end
```

Calling the `overflowed` operator before sending or forwarding an output message in the same time step results in a run-time error.

Check for Local Message Overflow

To check the overflow status of a local message queue, either add a message to the queue or remove a message from the queue before calling the `overflowed` operator. Calling the `overflowed` operator before sending or retrieving a local message in the same time step results in a run-time error.

See Also

`overflowed`

Related Examples

- “Model an Assembly Line Feeder” (Stateflow)

More About

- “Messages” (Stateflow)
- “AUTOSAR Communication”
- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Client-Server Communication

In Simulink, you can model AUTOSAR client-server communication for simulation and code generation. For information about the Simulink blocks you use and the high-level workflow, see “Client-Server Interface” on page 2-30.

To model AUTOSAR servers and clients, you can do either or both of the following:

- Import AUTOSAR servers and clients from a `arxml` code into a model.
- Configure AUTOSAR servers and clients from Simulink blocks.

This topic provides examples of AUTOSAR server and client configuration that start from Simulink blocks.

In this section...

“Configure AUTOSAR Server” on page 4-171

“Configure AUTOSAR Client” on page 4-181

“Configure AUTOSAR Client-Server Error Handling” on page 4-190

“Concurrency Constraints for AUTOSAR Server Runnables” on page 4-195

“Configure and Map AUTOSAR Server and Client Programmatically” on page 4-197

Configure AUTOSAR Server

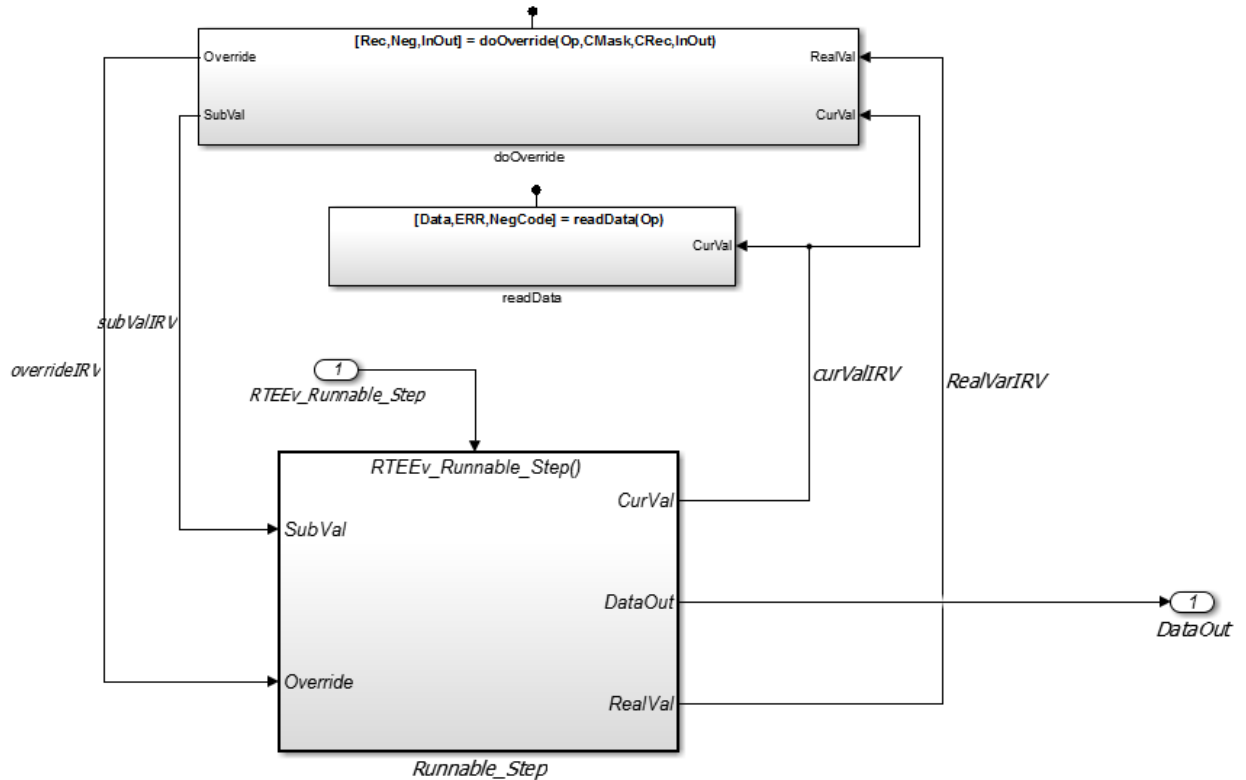
This example shows how to configure a Simulink Function block as an AUTOSAR server. The example uses these files in the folder `matlabroot/help/toolbox/autosar/examples` (open):

- `mControllerWithInterface_server.slx`
- `ExampleApplicationErrorType.m`

If you copy the files to a working folder, collocate the MATLAB file with the model file.

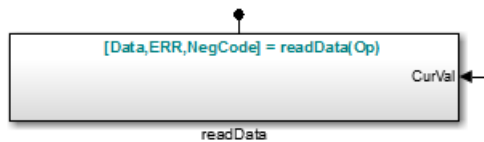
- 1 Open a model in which you want to create and configure an AUTOSAR server, or open the example model `mControllerWithInterface_server.slx`.
- 2 Add a Simulink Function block to the model. In the Simulink Library Browser, the Simulink Function block is in **User-Defined Functions**.

The example model provides two Simulink Function blocks, doOverride and readData.



- 3 Configure the Simulink Function block to implement a server function. Configure a function prototype and implement the server function algorithm.

In the example model, the contents of the Simulink Function block named readData implement a server function named readData.

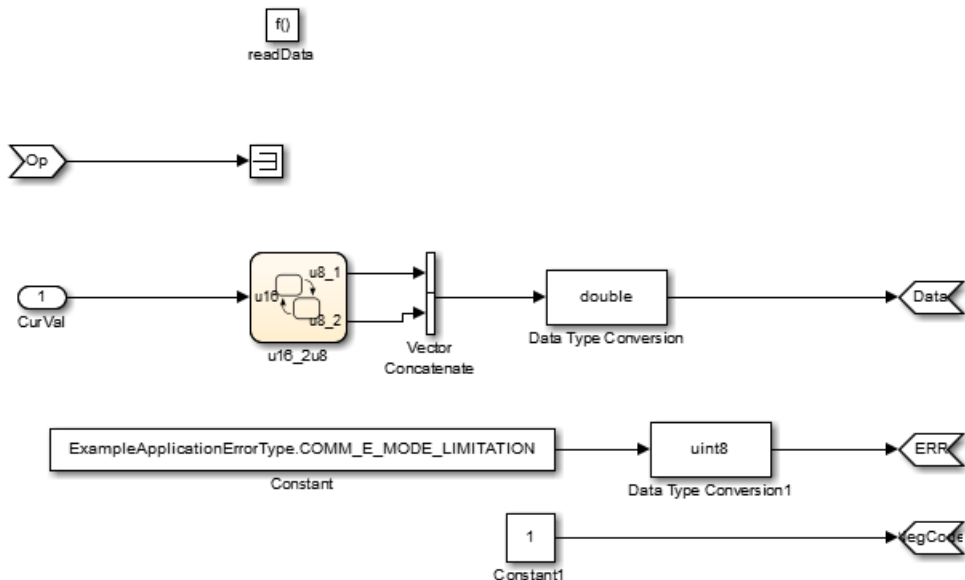


The contents include:

- Trigger block `readData`, representing a trigger port for the server function. In the Trigger block properties, **Trigger type** is set to `Function call`. Also, the option **Treat as Simulink function** is selected.
- Argument Inport block `Op` and Argument Outport blocks `Data`, `ERR`, and `NegCode`, corresponding to the function prototype `[Data,ERR,NegCode]=readData(Op)`.

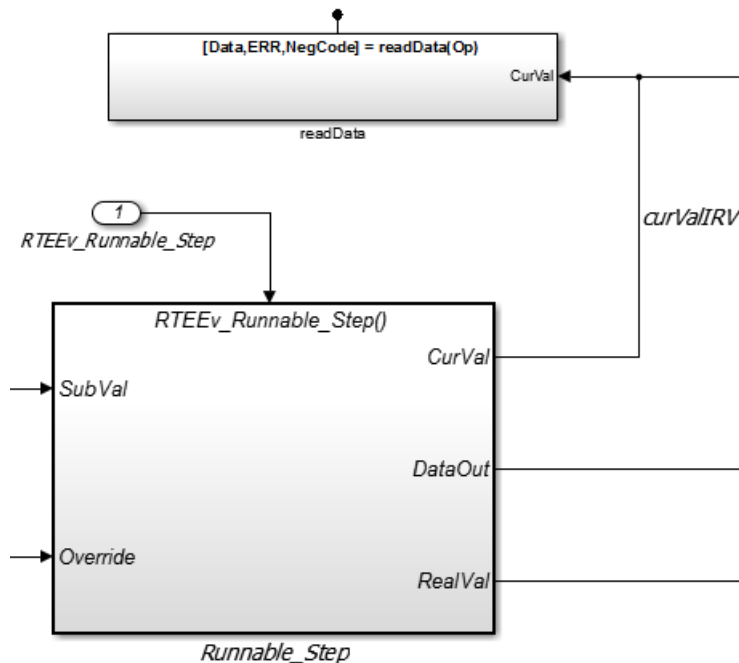
Note When configuring server function arguments, you must specify signal data type, port dimensions, and signal type on the **Signal Attributes** tab of the inport and outport blocks. The AUTOSAR configuration fails validation if signal attributes are absent for server function arguments.

- Blocks implementing the `readData` function algorithm. In this example, a few simple blocks provide `Data`, `ERR`, and `NegCode` output values with minimal manipulation. A Constant block represents the value of an application error defined for the server function. The value of `Op` passed by the caller is ignored. In a real-world application, the algorithm could perform a more complex manipulation, for example, selecting an execution path based on the passed value of `Op`, producing output data required by the application, and checking for error conditions.



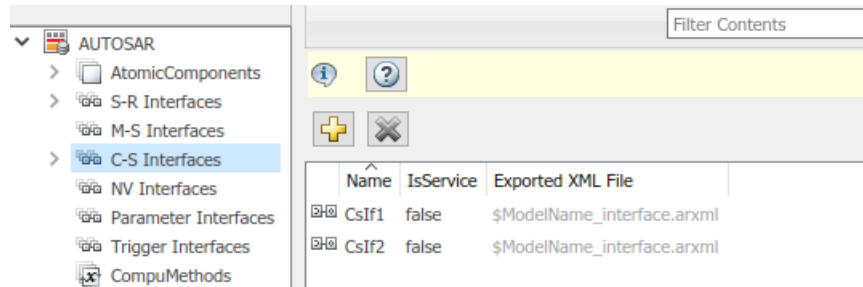
- 4 When the server function is working in Simulink, set up the Simulink Function block in a model configured for AUTOSAR. For example, configure the current model for AUTOSAR or copy the block into an AUTOSAR model.

The example model is an AUTOSAR model, into which the Simulink Function block `readData` has been copied. In place of a meaningful `Op` input value for the `readData` function, Simulink data transfer line `CurVal` provides an input value that is used in the function algorithm.




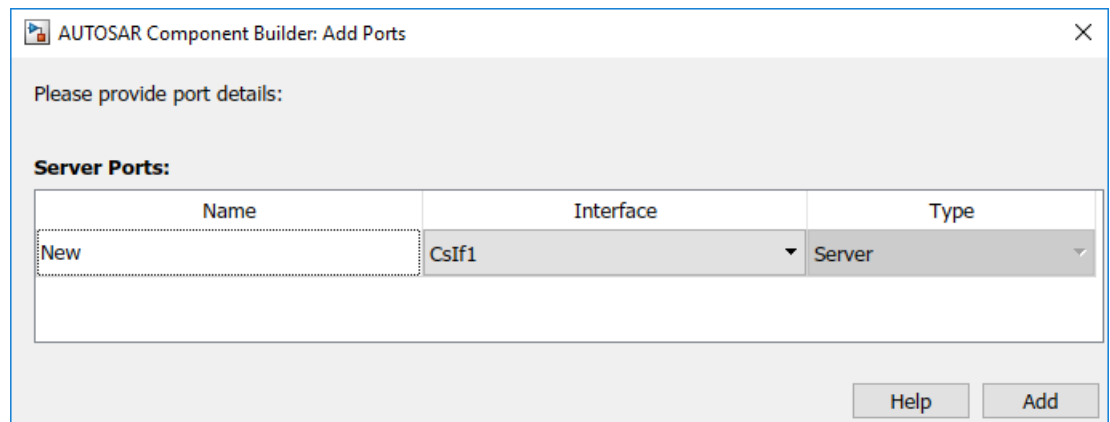
- 5 The required elements to configure an AUTOSAR server, in the general order they are created, are:
 - AUTOSAR client-server (C-S) interface
 - One or more AUTOSAR operations for which the C-S interface handles client requests
 - AUTOSAR server port to receive client requests for a server operation
 - For each server operation, an AUTOSAR server runnable to execute client requests

Open the AUTOSAR Dictionary. To view AUTOSAR C-S interfaces in the model, go to the **C-S Interfaces** view. The example model already contains client-server interfaces.



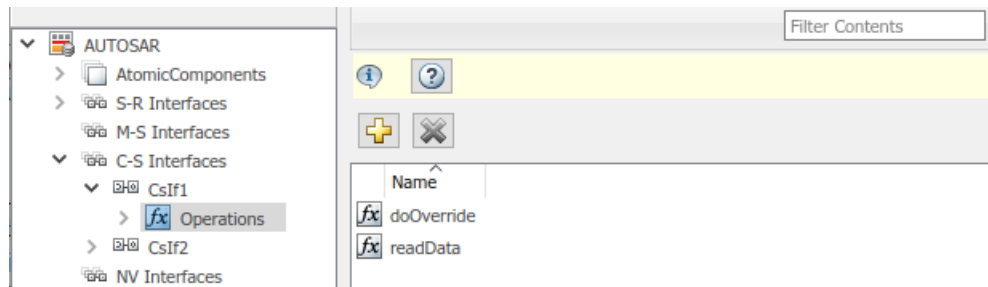
If a C-S interface does not yet exist in your model, create one.

- a In the C-S interfaces view, click the **Add** button . This action opens the Add Interfaces dialog box.
- b In the dialog box, name the new C-S Interface, and specify the number of operations you intend to associate with the interface. Leave other parameters at their defaults. Click **Add**. The new interface appears in the C-S interfaces view.




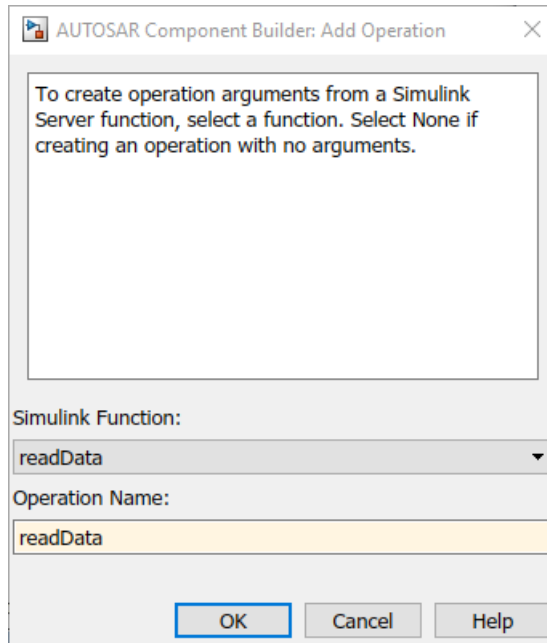
- 6 Under **C-S Interfaces**, create one or more AUTOSAR server operations for which the C-S interface handles client requests. Each operation corresponds to a Simulink server function in the model.

Expand **C-S Interfaces** and expand the individual C-S interface to which you want to add a server operation. (In the example model, expand CsIf1.) To view operations for the interface, select **Operations**. The example model already contains AUTOSAR server operations named doOverride and readData.

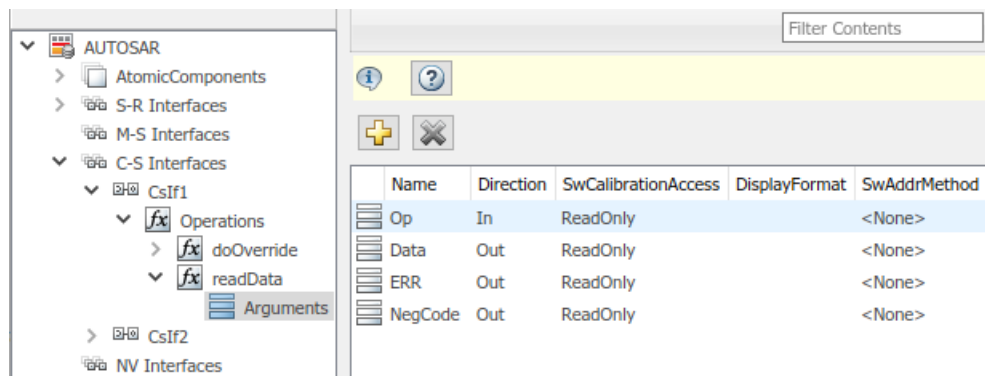


If a server operation does not yet exist in your model, create one. (If your C-S interface contains a placeholder operation named `Operation1`, you can safely delete it.)

- a** In the operations view, click the **Add** button . This action opens the Add Operation dialog box.
- b** In the dialog box, enter the **Operation Name**. Specify the name of the corresponding Simulink server function.
- c** If the corresponding Simulink server function has arguments, select the function in the **Simulink Function** list. This action causes AUTOSAR operation arguments to be automatically created based on the Simulink server function arguments. Click **OK**. The operation and its arguments appear in the operations view.

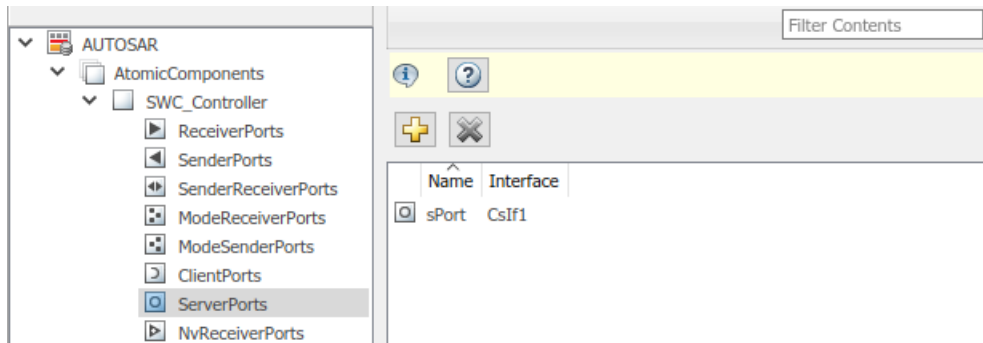


- 7 Examine the arguments listed for the AUTOSAR server operation. Expand **Operations**, expand the individual operation (for example, `readData`), and select **Arguments**. The listed arguments correspond to the Simulink server function prototype.




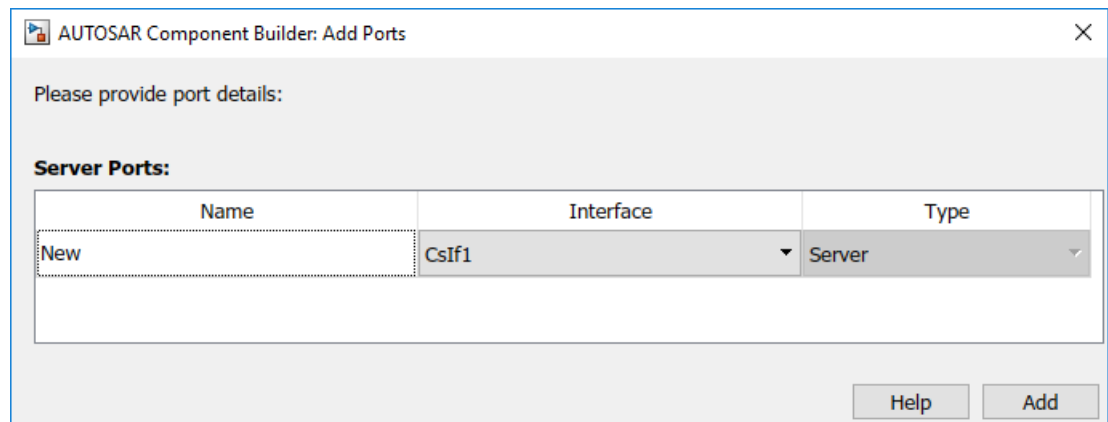
- 8 To view AUTOSAR server ports in the model, go to the server ports view. Expand **AtomicComponents**, expand the individual component that you are configuring, and

select **ServerPorts**. The example model already contains an AUTOSAR server port named sPort.



If a server port does not yet exist in your model, create one.


- a In the server ports view, click the **Add** button . This action opens the Add Ports dialog box.
- b In the dialog box, name the new server port, and select the C-S interface for which you configured a server operation. Click **Add**. The new port appears in the server ports view.

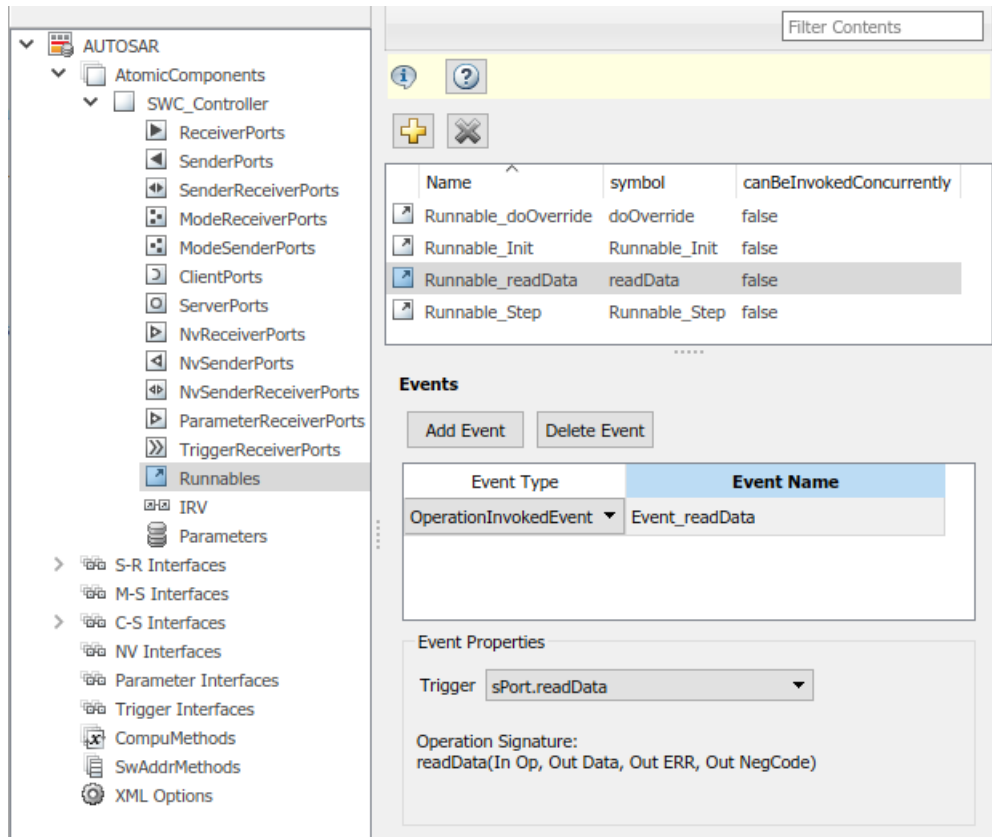


- 9 For each AUTOSAR server operation, configure an AUTOSAR server runnable to execute client requests. To view AUTOSAR runnables in the model, select

Runnables. The example model already contains a server runnable for `readData`, named `Runnable_readData`.

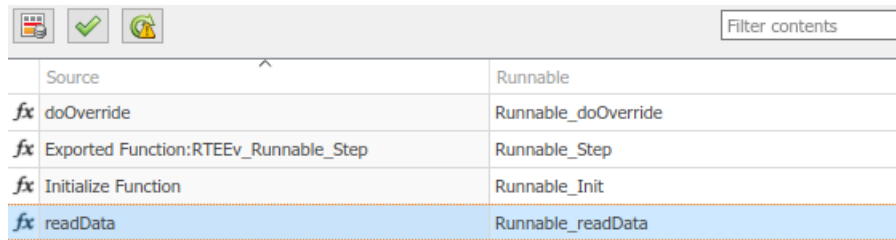
If a suitable server runnable does not yet exist in your model, create one.

- a** In the runnables view, click the **Add** button . This action adds a table entry for a new runnable.
- b** Select the new runnable and configure its name and symbol. The **symbol** name specified for the runnable must match the Simulink server function name. (In the example model, the **symbol** name for `Runnable_readData` is the function name `readData`.)
- c** Create an operation-invoked event to trigger the server runnable. (The example model defines event `event_readData` for server runnable `Runnable_readData`.)
 - i** Under **Events**, click **Add Event**. Select the new event.
 - ii** For **Event Type**, select `OperationInvokedEvent`.
 - iii** Enter the **Event Name**.
 - iv** Under **Event Properties**, select a **Trigger** value that corresponds to the server port and C-S operation previously created for the server function. (In the example model, the **Trigger** value selected for `Runnable_readData` is `sPort.readData`, combining server port `sPort` with operation `readData`.) Click **Apply**.




This step completes the configuration of an AUTOSAR server in the AUTOSAR Dictionary view of the configuration.

- 10 Switch to the Code Mappings editor view of the configuration and map the Simulink server function to the AUTOSAR server runnable.
 - a Open the Code Mappings editor. Select the **Functions** tab.
 - b Select the Simulink server function. To map the function to an AUTOSAR runnable, click on the **Runnable** field and select the corresponding runnable from the list of available server runnables. In the example model, the Simulink function `readData` is mapped to AUTOSAR runnable `Runnable_readData`.



Source	Runnable
<i>fx</i> doOverride	Runnable_doOverride
<i>fx</i> Exported Function:RTEv_Runnable_Step	Runnable_Step
<i>fx</i> Initialize Function	Runnable_Init
<i>fx</i> readData	Runnable_readData

- 11 To validate the AUTOSAR component configuration, click the **Validate** button . If errors are reported, fix the errors, and retry validation. Repeat until validation succeeds.
- 12 Generate C and arxml code for the model.

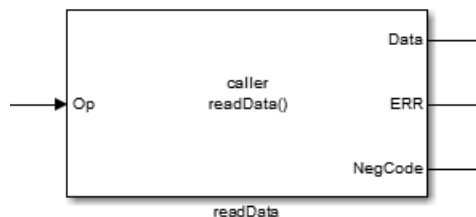
After you configure an AUTOSAR server, configure a corresponding AUTOSAR client invocation, as described in “Configure AUTOSAR Client” on page 4-181.

Configure AUTOSAR Client

After you configure an AUTOSAR server, as described in “Configure AUTOSAR Server” on page 4-171, configure a corresponding AUTOSAR client invocation. This example shows how to configure a Function Caller block as an AUTOSAR client invocation. The example uses the file `matlabroot/help/toolbox/autosar/examples/mControllerWithInterface_client.slx`.

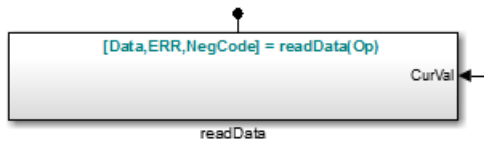
- 1 Open a model in which you want to create and configure an AUTOSAR client, or open the example model `mControllerWithInterface_client.slx`.
- 2 Add a Function Caller block to the model. In the Simulink Library Browser, the Function Caller block is in **User-Defined Functions**.

The example model provides a Simulink Function block named `readData`, which is located inside `Runnable3_Subsystem`.

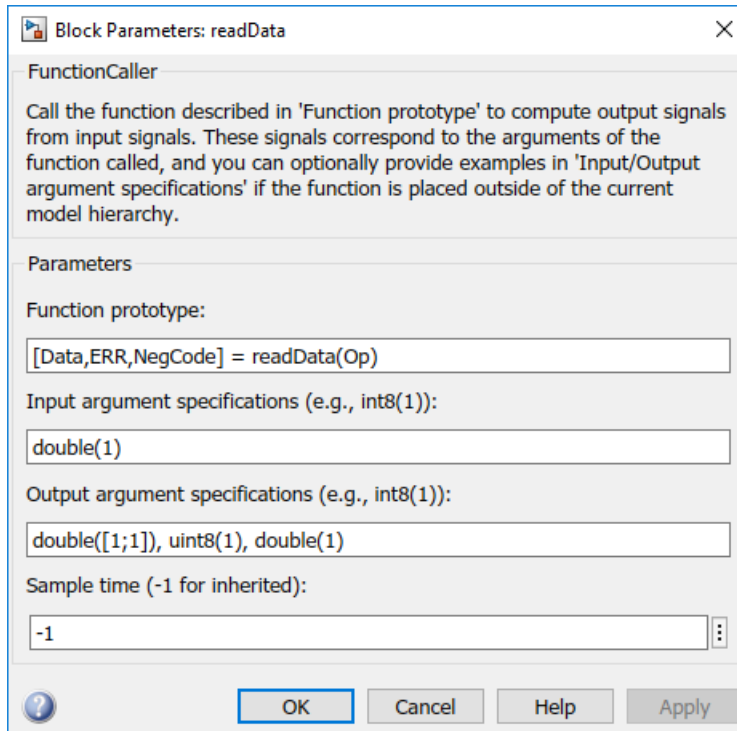


- 3 Configure the Function Caller block to call a corresponding Simulink Function block. Double-click the block to open it, and edit the block parameters to specify the server function prototype.

In the example model, the `readData` Function Caller parameters specify a function prototype for the `readData` server function used in the AUTOSAR server example, “Configure AUTOSAR Server” on page 4-171. Here is the `readData` function from the server example.



The Function Caller parameters include function prototype and argument specification fields. The function name in the prototype must match the **Operation Name** specified for the corresponding server operation. See the operation creation step in “Configure AUTOSAR Server” on page 4-171. The argument types and dimensions also must match the server function arguments.




Note If you want to simulate the function invocation at this point, you must place the Function Caller block in a common model or test harness with the corresponding Simulink Function block. Simulation is not required for this example.

- 4 When the function invocation is completely formed in Simulink, set up the Function Caller block in a model configured for AUTOSAR. For example, configure the current model for AUTOSAR or copy the block into an AUTOSAR model.

Tip If you create (or copy) a Function Caller block in a model before you map and configure the AUTOSAR component, you have the option of having the software populate the AUTOSAR operation arguments for you, rather than creating the arguments manually. To have the arguments created for you, along with a fully-configured AUTOSAR client port and a fully mapped Simulink function caller, use the AUTOSAR Component Quick Start to create a default component. For more information, see “Create AUTOSAR Software Component in Simulink” on page 3-2.

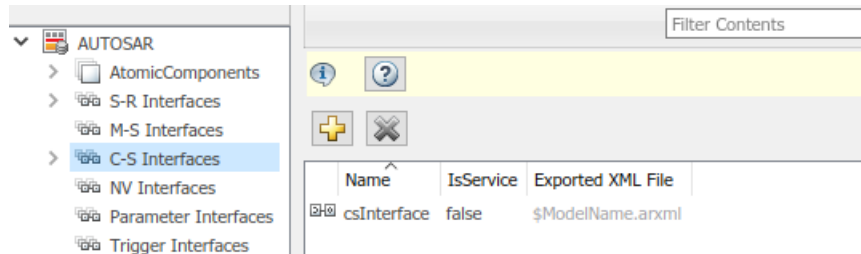
The example model is an AUTOSAR model, into which the Function Caller block `readData` has been copied. The block is connected to inports, outputs, and signal lines matching the function argument data types and dimensions.




Note Whenever you add or change a Function Caller block in an AUTOSAR model, update function callers in the AUTOSAR configuration. Open the Code Mappings editor. In the dialog box, click the **Update** button . This action loads or updates Simulink data transfers, function callers, and numeric types in your model. After updating, the function caller you added appears in the **Function Callers** tab of the Code Mappings editor.

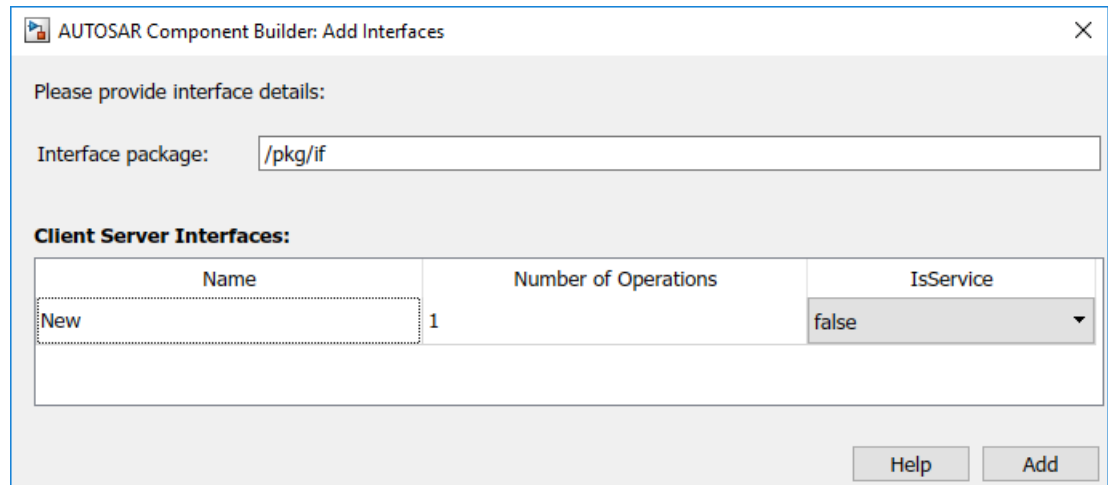
- 5 The required elements to configure an AUTOSAR client, in the general order they should be created, are:
- AUTOSAR client-server (C-S) interface
 - One or more AUTOSAR operations matching the Simulink server functions that you defined in the AUTOSAR server model
 - AUTOSAR client port to receive client requests for a server operation offered by the C-S interface

Open the AUTOSAR Dictionary. To view AUTOSAR C-S interfaces in the model, go to the **C-S Interfaces** view. The example model already contains a client-server interface named `csInterface`.



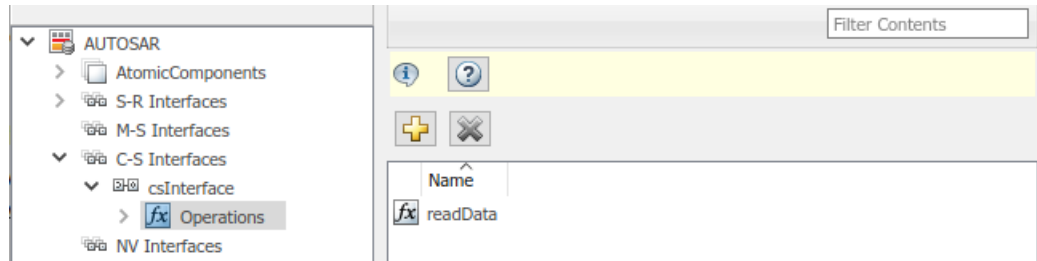
If a C-S interface does not yet exist in the AUTOSAR configuration, create one.

- a In the C-S interfaces view, click the **Add** button . This action opens the Add Interfaces dialog box.
- b In the dialog box, name the new C-S Interface, and specify the number of operations you intend to associate with the interface. Leave other parameters at their defaults. Click **Add**. The new interface appears in the C-S interfaces view.




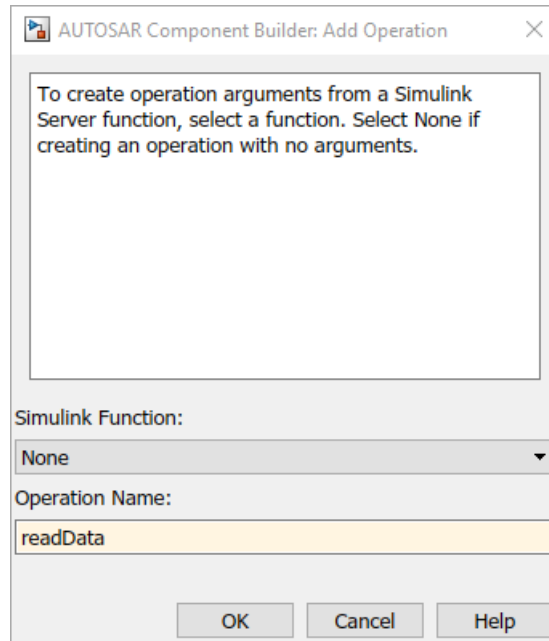
- 6 Under **C-S Interfaces**, create one or more AUTOSAR operations matching the Simulink server functions that you defined in the AUTOSAR server model.


Expand **C-S Interfaces** and expand the individual C-S interface to which you want to add an AUTOSAR operation. (In the example model, expand CsInterface.) To view operations for the interface, select **Operations**. The example model already contains an AUTOSAR operation named readData.

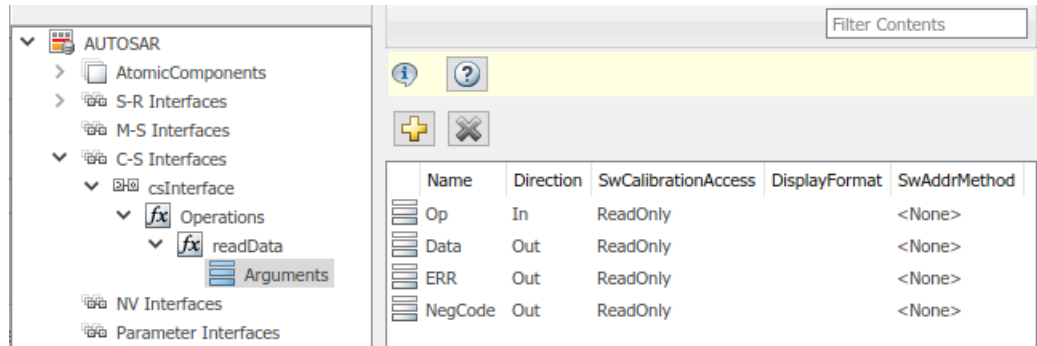


If an AUTOSAR operation does not yet exist in your model, create one. (If your C-S interface contains a placeholder operation named `Operation1`, you can safely delete it.)

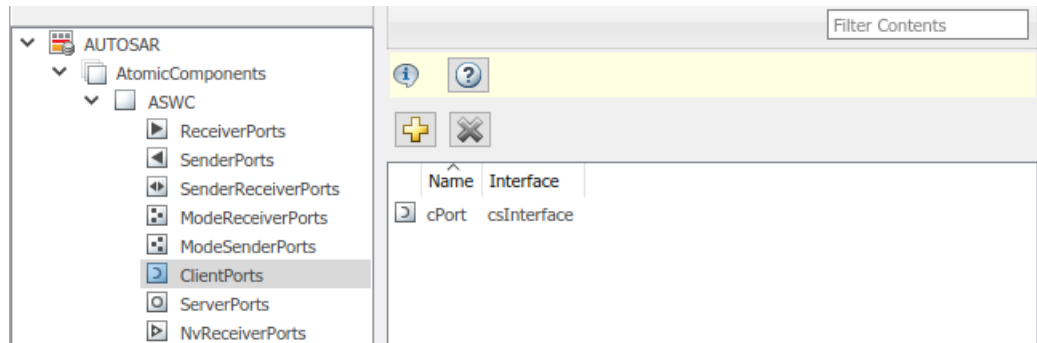
- a** In the operations view, click the **Add** button . This action opens the Add Operation dialog box.
- b** In the dialog box, enter the **Operation Name**. Specify the name of the corresponding Simulink server function. Leave **Simulink Function** set to None, because the client model does not contain the Simulink server function block. Click **OK**. The new operation appears in the operations view.




- 7 Add the AUTOSAR operation arguments.
 - a Expand **Operations**, expand the individual operation (for example, readData), and select **Arguments**.
 - b In the arguments view, click the **Add** button  one time for each function argument. For example, for readData, click the **Add** button four times, for arguments Op, Data, ERR, and NegCode. Each click creates one new argument entry.
 - c Select each argument entry and set the argument **Name** and **Direction** to match the function prototype.

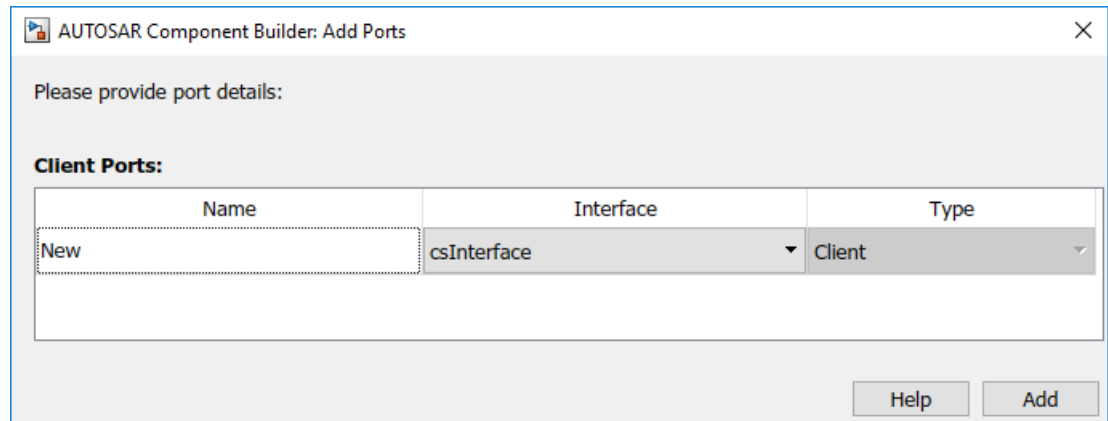


- 8 To view AUTOSAR client ports in the model, go to the client ports view. Expand **AtomicComponents**, expand the individual component that you are configuring, and select **ClientPorts**. The example model already contains an AUTOSAR client port named cPort.



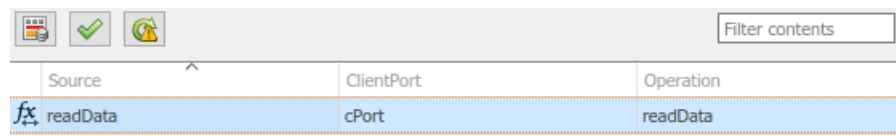
If a client port does not yet exist in your model, create one.


- a In the client ports view, click the **Add** button . This action opens the Add Ports dialog box.
- b In the dialog box, name the new client port, and select a C-S interface. Click **Add**. The new port appears in the client ports view.



This step completes the configuration of an AUTOSAR client in the AUTOSAR Dictionary view of the configuration.

- 9 Switch to the Code Mappings editor view of the configuration and map the Simulink function caller to an AUTOSAR client port and C-S operation.
 - a Open the Code Mappings editor. Select the **Function Callers** tab.
 - b Select the Simulink function caller. Click on the **ClientPort** field and select a port from the list of available AUTOSAR client ports. Click on the **Operation** field and select an operation from the list of available AUTOSAR C-S operations. In the example model, the Simulink function caller `readData` is mapped to AUTOSAR client port `cPort` and C-S operation `readData`.



- 10 To validate the AUTOSAR component configuration, click the **Validate** button . If errors are reported, fix the errors, and retry validation. Repeat until validation succeeds.
- 11 Generate C and arxml code for the model.

Configure AUTOSAR Client-Server Error Handling

AUTOSAR defines an application error status mechanism for client-server error handling. An AUTOSAR server returns error status, with a value matching a predefined possible error. An AUTOSAR client receives and responds to the error status. An AUTOSAR software component that follows client-server error handling guidelines potentially provides error status to AUTOSAR Basic Software, such as a Diagnostic Event Manager (DEM).

In Simulink, you can:

- Import a rxml code that implements client-server error handling.
- Configure error handling for a client-server interface.
- Generate C and a rxml code for client-server error handling.

If you import a rxml code that implements client-server error handling, the importer creates error status ports at the corresponding server call-point (Function-Caller block) locations.

To implement AUTOSAR client-server error handling in Simulink:

- 1 Define the possible error status values that the AUTOSAR server returns in a Simulink data type. Define one or more error codes in the range 0-63, inclusive. The underlying storage of the data type must be an unsigned 8-bit integer. The data scope must be Exported. For example, define an enumeration type appErrType:

```
classdef(Enumeration) appErrType < uint8

    enumeration
        SUCCESS(0)
        ERROR(1)
        COMM_MODE_LIMITATION(2)
        OVERFLOW(3)
        UNDERFLOW(4)
        VALUE_MOD3(5)
    end

    methods (Static = true)
        function descr = getDescription()
            descr = 'Definition of application error type.';
        end

        function hdrFile = getHeaderFile()
            hdrFile = '';
        end

        function retVal = addClassNameToEnumNames()
```

```

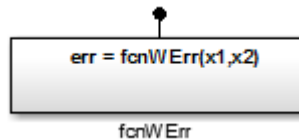
        retVal = false;
    end

    function dataScope = getDataScope()
        dataScope = 'Exported';
    end
end
end
end

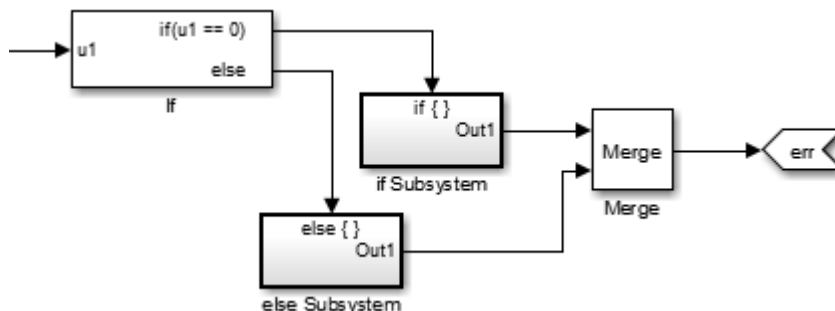
```

Note The Simulink data type that you define to represent possible errors in the model does not directly impact the AUTOSAR possible errors that are imported and exported in a `rxml` code. To modify the exported possible errors for a C-S interface or C-S operation, use AUTOSAR properties functions. This topic provides examples.

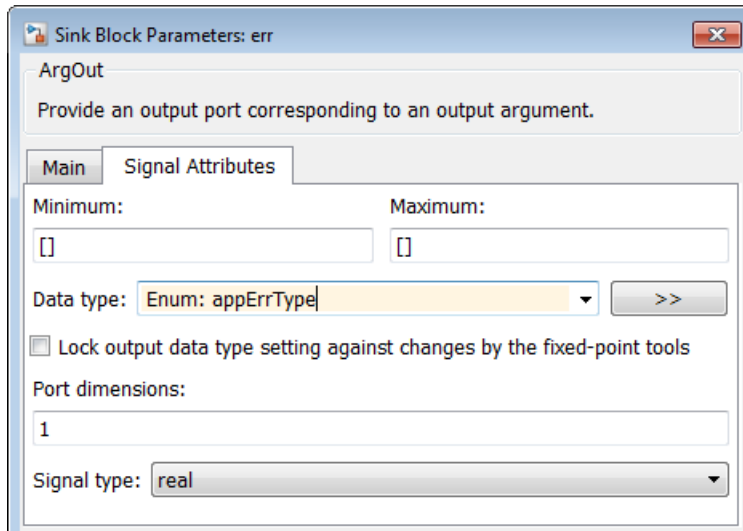
- 2 Define an error status output argument for the Simulink Function block that models the AUTOSAR server. Configure the error status argument as the only function output or add it to other outputs. For example, here is a Simulink Function block that returns an error status value in output `err`.




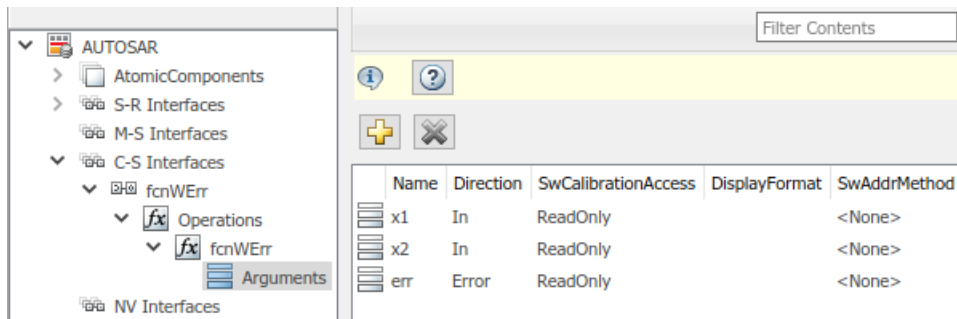
The Simulink Function block implements an algorithm to return error status.



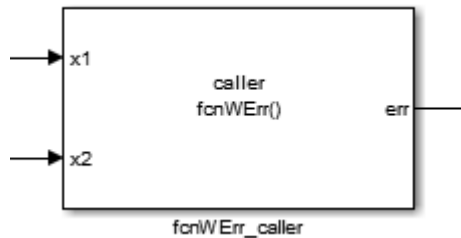
- 3 Reference the possible error values type in the model. In the Argument Outport block parameters for the error output, specify the error status data type, in this case, `appErrType`. Set **Port dimensions** to 1 and **Signal type** to `real`.



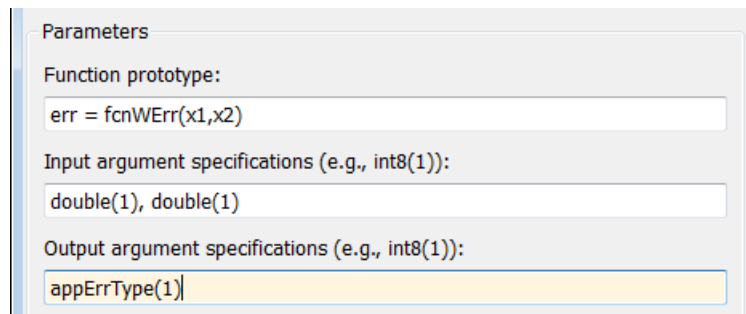
- Configure the AUTOSAR properties of the error argument in the client-server interface. Open the AUTOSAR Dictionary, expand **C-S Interfaces**, and navigate to the **Arguments** view of the AUTOSAR operation. To add an argument, click the **Add** button . Configure the argument name and set **Direction** to Error.



- Create an error port in each Function-Caller block that models an AUTOSAR client invocation. For example, here is a Function-Caller block that models an invocation of fcnWErr.



In the Function-Caller block parameters, specify the same error status data type.



Configure the AUTOSAR properties of the error argument to match the information in the AUTOSAR Dictionary, **Arguments** view, shown in Step 4.

The generated C code for the function reflects the configured function signature and the logic defined in the model for handling the possible errors.

```
appErrType fcnWErr(real_T x1, real_T x2)
{
    appErrType rty_err_0;
    if (...) == 0.0) {
        rty_err_0 = ...;
    } else {
        rty_err_0 = ...;
    }

    return rty_err_0;
}
```

Additionally, for the enumeration type class definition used in this example, the build generates header file `appErrType.h`, containing the possible error type definitions.

The exported `arxml` code contains the possible error definitions, and references to them.

```

<POSSIBLE-ERRORS>
  <APPLICATION-ERROR ...>
    <SHORT-NAME>SUCCESS</SHORT-NAME>
    <ERROR-CODE>0</ERROR-CODE>
  </APPLICATION-ERROR>
  <APPLICATION-ERROR ...>
    <SHORT-NAME>ERROR</SHORT-NAME>
    <ERROR-CODE>1</ERROR-CODE>
  </APPLICATION-ERROR>
  ...
  <APPLICATION-ERROR ...>
    <SHORT-NAME>UNDERFLOW</SHORT-NAME>
    <ERROR-CODE>4</ERROR-CODE>
  </APPLICATION-ERROR>
  <APPLICATION-ERROR ...>
    <SHORT-NAME>VALUE_MOD3</SHORT-NAME>
    <ERROR-CODE>5</ERROR-CODE>
  </APPLICATION-ERROR>
</POSSIBLE-ERRORS>

```

You can use AUTOSAR property functions to programmatically modify the possible errors that are exported in arxml code, and to set the **Direction** property of a C-S operation argument to Error.

The following example adds UNDERFLOW and VALUE_MOD3 to the possible errors for a C-S interface named fcnWErr.

```

>> arProps = autosar.api.getAUTOSARProperties(bdroot)
>> get(arProps, 'fcnWErr', 'PossibleError')
ans =
    'fcnWErr/SUCCESS'    'fcnWErr/ERROR'    'fcnWErr/COMM_MODE...'
    'fcnWErr/OVERFLOW'
>> get(arProps, 'fcnWErr/OVERFLOW', 'errorCode')
ans =
    3
>> add(arProps, 'fcnWErr', 'PossibleError', 'UNDERFLOW')
>> set(arProps, 'fcnWErr/UNDERFLOW', 'errorCode', 4)
>> add(arProps, 'fcnWErr', 'PossibleError', 'VALUE_MOD3')
>> set(arProps, 'fcnWErr/VALUE_MOD3', 'errorCode', 5)
>> get(arProps, 'fcnWErr', 'PossibleError')
ans =
    'fcnWErr/SUCCESS'    'fcnWErr/ERROR'    'fcnWErr/COMM_MODE...'
    'fcnWErr/OVERFLOW'    'fcnWErr/UNDERFLOW'    'fcnWErr/VALUE_MOD3'

```

You can also access possible errors on a C-S operation. The following example lists possible errors for operation fcnWErr on C-S interface fcnWErr.

```

>> arProps = autosar.api.getAUTOSARProperties(bdroot)
>> get(arProps, 'fcnWErr/fcnWErr', 'PossibleError')
ans =
    'fcnWErr/SUCCESS'    'fcnWErr/ERROR'    'fcnWErr/COMM_MODE...'
    'fcnWErr/OVERFLOW'

```


The following example sets the direction of C-S operation argument `err` to `Error`.

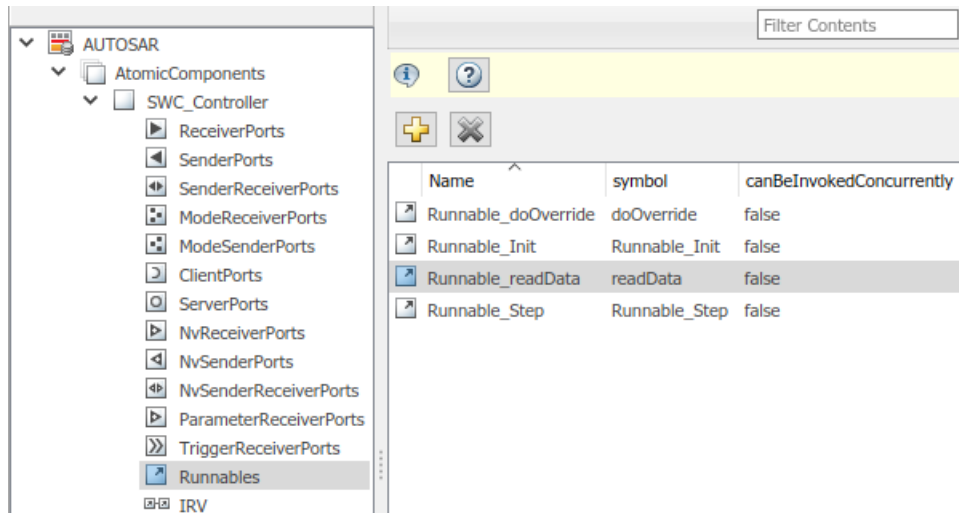
```
>> arProps = autosar.api.getAUTOSARProperties(bdroot)
>> set(arProps, 'fcnWErr/fcnWErr/err', 'Direction', 'Error')
>> get(arProps, 'fcnWErr/fcnWErr/err', 'Direction')
ans =
    Error
```

Concurrency Constraints for AUTOSAR Server Runnables

The following blocks and modeling patterns are incompatible with concurrent execution of an AUTOSAR server runnable.

- Blocks inside a Simulink function:
 - Blocks with state, such as Unit Delay.
 - Blocks with zero-crossing logic, such as Triggered Subsystem and Enabled Subsystem.
 - Stateflow charts.
 - Other Simulink Function blocks.
 - Noninlined subsystems.
 - Legacy C function calls with side effects.
- Modeling patterns inside a Simulink function:
 - Writing to a data store memory (for example, per-instance-memory).
 - Writing to a global block signal (for example, static memory).

To enforce concurrency constraints for AUTOSAR server runnables, use the runnable property `canBeInvokedConcurrently`. The property is located in the **Runnables** view in the AUTOSAR Dictionary.



When `canBeInvokedConcurrently` is set to `true` for a server runnable, AUTOSAR validation checks for blocks and modeling patterns that are incompatible with concurrent execution of a server runnable. If a Simulink function contains an incompatible block or modeling pattern, validation reports errors. If `canBeInvokedConcurrently` is set to `false`, validation does not check for blocks and modeling patterns that are incompatible with concurrent execution of a server runnable.

You can set the property `canBeInvokedConcurrently` to `true` only for an AUTOSAR server runnable — that is, a runnable with an `OperationInvokedEvent`. Runnables with other event triggers, such as timing events, cannot be concurrently invoked. If `canBeInvokedConcurrently` is set to `true` for a nonserver runnable, AUTOSAR validation fails.

To programmatically set the runnable property `canBeInvokedConcurrently`, use the AUTOSAR property function set. The following example sets the runnable property `canBeInvokedConcurrently` to `true` for an AUTOSAR server runnable named `Runnable_readData`.

```
open_system('mControllerWithInterface_server')
arProps = autosar.api.getAUTOSARProperties('mControllerWithInterface_server');
SRPath = find(arProps,[],'Runnable','Name','Runnable_readData')

SRPath =
    'SWC_Controller/ControllerWithInterface_ar/Runnable_readData'

invConc = get(arProps,'SWC_Controller/ControllerWithInterface_ar/Runnable_readData',...
    'canBeInvokedConcurrently')
```

```
invConc =  
    0  
  
set(arProps, 'SWC_Controller/ControllerWithInterface_ar/Runnable_readData', ...  
    'canBeInvokedConcurrently', true)  
invConc = get(arProps, 'SWC_Controller/ControllerWithInterface_ar/Runnable_readData', ...  
    'canBeInvokedConcurrently')  
  
invConc =  
    1'
```

Configure and Map AUTOSAR Server and Client Programmatically

To programmatically configure AUTOSAR properties of AUTOSAR client-server interfaces, use AUTOSAR property functions such as `set` and `get`.

To programmatically configure Simulink to AUTOSAR mapping information for AUTOSAR clients and servers, use these functions:

- `getFunction`
- `getFunctionCaller`
- `mapFunction`
- `mapFunctionCaller`

For example scripts that use AUTOSAR property and map functions, see “Configure AUTOSAR Client-Server Interfaces” on page 4-356.

See Also

[Argument Inport](#) | [Argument Outport](#) | [Function Caller](#) | [Simulink Function](#) | [Trigger](#)

Related Examples

- “Client-Server Interface” on page 2-30
- “Configure AUTOSAR Client-Server Interfaces” on page 4-356
- “Import AUTOSAR Software Component” on page 3-19
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “Model AUTOSAR Communication” on page 2-28
- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Mode-Switch Communication

AUTOSAR mode-switch (M-S) communication relies on a mode manager and connected mode users. The mode manager is an authoritative source for software components to query the current mode and to receive notification when the mode changes (switches). A mode manager can be provided by AUTOSAR Basic Software (BSW) or implemented as an AUTOSAR software component. A mode manager implemented as a software component is called an application mode manager. A software component that queries the mode manager and receives notifications of mode switches is a mode user.

In this section...

“Configure Mode Receiver Port and Mode-Switch Event for Mode User” on page 4-199

“Configure Mode Sender Port and Mode Switch Point for Application Mode Manager” on page 4-204

Configure Mode Receiver Port and Mode-Switch Event for Mode User

To model a mode user software component, use an AUTOSAR mode receiver port and a mode-switch event. The mode receiver port uses a mode-switch (M-S) interface to connect and communicate with a mode manager, which provides notifications of mode changes. You configure a mode-switch event to respond to a specified mode change by activating an associated runnable. This example shows how to configure an AUTOSAR mode-receiver port, mode-switch event, and related elements for a mode user.

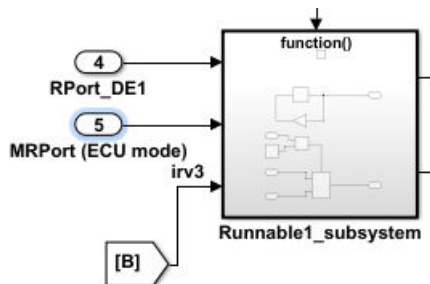
Note This example does not implement a meaningful algorithm for controlling component execution based on the current ECU mode.

- 1 Open the example model `autosar_swc_expfncs`. Save a copy to a writable work folder.
- 2 Declare a mode declaration group — a group of mode values — using Simulink enumeration. Specify the storage type as an unsigned integer. Enter the following command in the MATLAB Command Window:

```
Simulink.defineIntEnumType('mdgEcuModes', ...
    {'Run', 'Sleep'}, [0;1], ...
    'Description', 'Mode declaration group for ECU modes', ...
    'DefaultValue', 'Run', ...
```

```
'HeaderFile', 'Rte_Type.h', ...
'AddClassNameToEnumNames', false, ...
'StorageType', 'uint16');
```

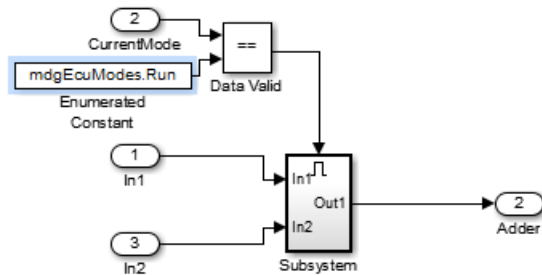
- 3 Rename the Simulink inport RPort_DE1 (ErrorStatus) to MRPort (ECU mode). For example, open the Model Data Editor (on the **AUTOSAR** tab, select **Settings** > **Model Data Editor**). Use the **Source** column to rename the inport. In a later step, you will map this inport to an AUTOSAR mode-receiver port.




- 4 Next, apply the mode declaration group mdgEcuModes to the inport. In the Model Data Editor, for the inport, set **Data Type** to Enum: mdgEcuModes. Additionally, set **Complexity** to auto.

Model Data										
Inports/Outports		Signals	Data Stores	States	Parameters					
Design Filter contents										
Source	#	Signal Name	Data Type	Min	Max	Dimensions	Complexity	Sample Time	Unit	
Runnable2	2		Inherit: auto			1	real	1	inherit	
Runnable3	3		Inherit: auto			1	real	10	inherit	
RPort_DE1	4		double			1	real	-1	inherit	
MRPort (ECU m...	5		Enum: mdgEcu...			1	auto	-1	inherit	

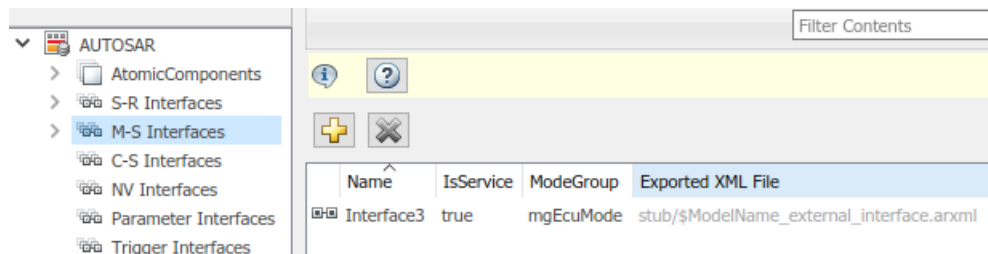
- 5 In the model window, open the function-call subsystem named Runnable1_subsystem and make the following changes:
 - a Rename inport ErrorStatus to CurrentMode.
 - b Replace Constant block RTE_E_OK with an Enumerated Constant block. (The Enumerated Constant block can be found in the Sources block group.) Double-click the block to open its block parameters dialog box. Set **Output data type** to Enum: mdgEcuModes and set **Value** to mdgEcuModes.Run. Click **OK**.




- 6 Add an AUTOSAR mode-switch interface to the model. Open the AUTOSAR Dictionary. Select **M-S Interfaces**. Click the **Add** button . In the Add Interfaces dialog box, specify **Name** as Interface3 and specify **ModeGroup** as mgEcuMode.

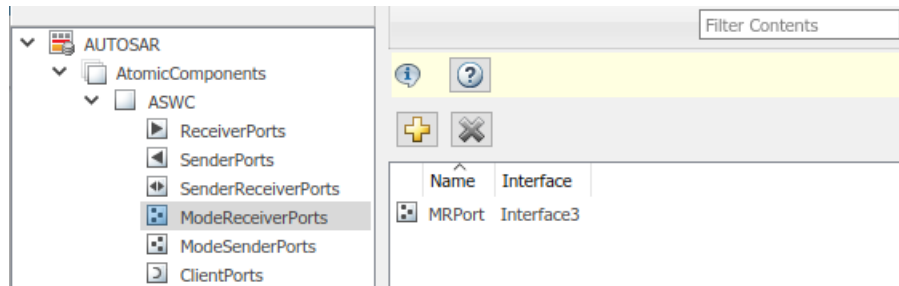
The **IsService** property of an M-S interface defaults to `true`. For the purposes of this example, you can leave **IsService** at its default setting, unless you have a reason to change it.

Click **Add**.




The value you specify for the AUTOSAR mode group is used in a later step, when you map a Simulink inport to an AUTOSAR mode-receiver port and element.

- 7 Add an AUTOSAR mode-receiver port to the model. Expand **AtomicComponents**, expand component ASWC, and select **ModeReceiverPorts**. To open the Add Ports dialog box, click the **Add** button . In the Add Ports dialog box, specify **Name** as MRPort. **Interface** is already set to Interface3 (the only available value in this configuration), and **Type** is already set to ModeReceiver. Click **Add**.



- 8 In the Code Mappings editor, map the Simulink inport MRPort (ECU mode) to the AUTOSAR mode-receiver port and element. Open the Code Mappings editor and select the **Inports** tab. In the row for inport MRPort (ECU mode), set **DataAccessMode** to ModeReceive, set **Port** to MRPort, and set **Element** to mgEcuMode. (The AUTOSAR element value matches the **ModeGroup** value you specified when you added AUTOSAR mode-switch interface Interface3.)

Source	DataAccessMode	Port	Element
RPort_DE1	ImplicitReceive	RPort	DE1
MRPort (ECU mode)	ModeReceive	MRPort	mgEcuMode
RPort_DE2	ImplicitReceive	RPort	DE2

This step completes the AUTOSAR mode-receiver port configuration. Click the **Validate** button  to validate the AUTOSAR component configuration. If errors are reported, address them and then retry validation. When the model passes validation, save the model.

Note The remaining steps create an AUTOSAR mode-switch event and set it up to trigger activation of an AUTOSAR runnable. If you intend to use ECU modes to control program execution, without using an event to activate a runnable, you can skip the remaining steps and implement the required flow-control logic in your design.

- 9 To add an AUTOSAR mode-switch event for a runnable:
 - a Open the AUTOSAR Dictionary. Expand **AtomicComponents**, expand the ASWC component, and select **Runnables**. In the list of runnables, select Runnable1. This selection activates an **Events** configuration pane for the runnable.

- b To add an event to the list of events for Runnable1, click **Add Event**. For the new event, set **Event Type** to ModeSwitchEvent. (This activates an **Event Properties** subpane.) Specify **Event Name** as Event_Run.
- c In the **Event Properties** subpane, set **Mode Activation** to OnEntry, set **Mode Receiver Port** to MRPort, and set **Mode Declaration** to Run. Click **Apply**.





The screenshot displays the AUTOSAR configuration tool interface. On the left, a tree view shows the project structure under 'AUTOSAR', with 'Runnables' selected. The right pane is divided into several sections:


- Filter Contents**: A search bar at the top right.
- Info and Help**: Information and help icons.
- Buttons**: Add (+) and Delete (X) buttons.
- Table**: A table listing runnables with columns for Name, symbol, and canBeInvokedConcurrently.

Name	symbol	canBeInvokedConcurrently
Runnable_Init	Runnable_Init	false
Runnable1	Runnable1	false
Runnable2	Runnable2	false
Runnable3	Runnable3	false
- Events**: A section with 'Add Event' and 'Delete Event' buttons. Below them is a table for event configuration:

Event Type	Event Name
TimingEvent	Event_t_1tic_A
ModeSwitchEvent	Event_Run
- Event Properties**: A section for configuring the selected event.
 - Mode Activation: OnEntry
 - Mode Receiver Port: MRPort
 - On Entry:
 - Mode Declaration: Run

- 10 Open the Code Mappings editor and select the **Functions** tab. In this example model, Simulink entry-point functions have already been mapped to AUTOSAR runnables, including the runnable Runnable1, to which you just added a mode-switch event.

Source	Runnable
 Exported Function:Runnable1	Runnable1
 Exported Function:Runnable2	Runnable2
 Exported Function:Runnable3	Runnable3
 Initialize Function	Runnable_Init

- This completes the AUTOSAR mode-switch event configuration. Click the **Validate** button  to validate the AUTOSAR component configuration. If errors are reported, address them and then retry validation. When the model passes validation, save the model. Optionally, you can generate XML and C code from the model and inspect the results.

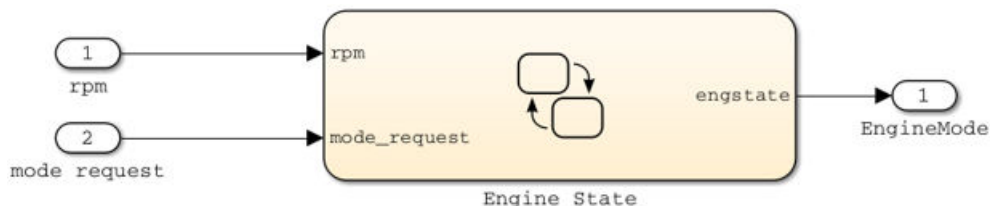
Configure Mode Sender Port and Mode Switch Point for Application Mode Manager

To model an application mode manager software component, use an AUTOSAR mode sender port (as defined in AUTOSAR Release 4). Mode sender ports use a mode-switch (M-S) interface to output a mode switch to connected mode user components.

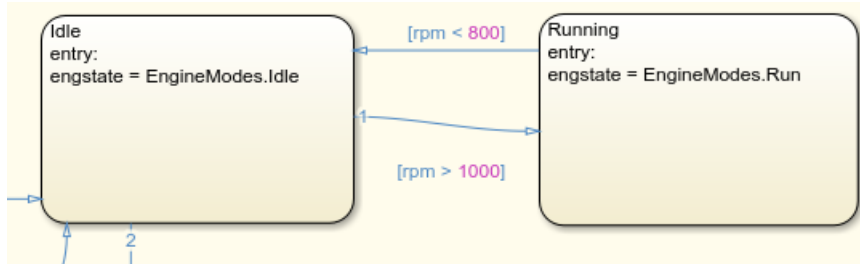
You model the mode sender port as a model root outport, which is mapped to an AUTOSAR mode sender port and a mode-switch (M-S) interface. The outport data type is an enumeration class with an unsigned integer storage type, representing an AUTOSAR mode declaration group.


This example shows how to configure a mode sender port and related elements for an application mode manager.

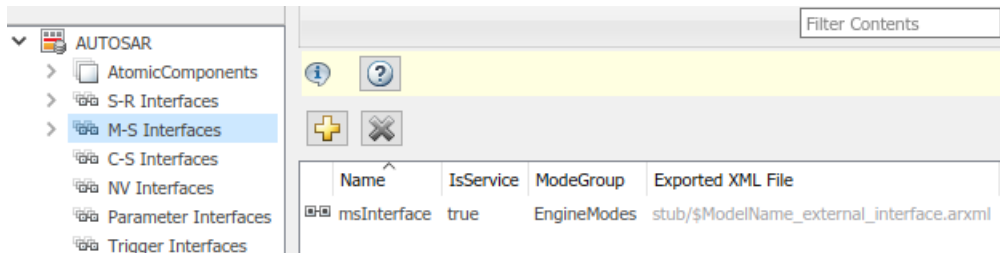
- Open a model configured for AUTOSAR code generation. This example uses a model that contains Stateflow logic for maintaining engine state. The model outputs the current engine mode value.




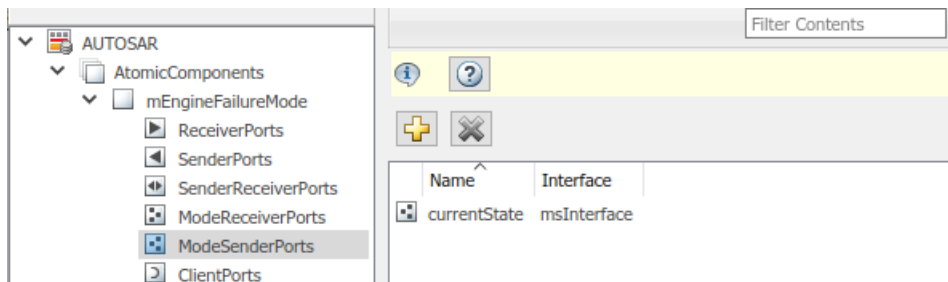
- 2 Declare a mode declaration group — a group of mode values. You can declare mode values with Simulink enumeration. In this example, the Stateflow logic defines EngineModes values Off, Crank, Stall, Idle, and Run. For example:



- 3 Add an AUTOSAR M-S interface to the model. Open the AUTOSAR Dictionary and select **M-S Interfaces**. Click the **Add** button . In the Add Interfaces dialog box, set **isService** to true and enter a **ModeGroup** name. In this example, the mode declaration group is EngineModes.



- 4 Add an AUTOSAR mode sender port to the model. Expand **AtomicComponents**, expand the component, and select **ModeSenderPorts**. Click the **Add** button . In the Add Ports dialog box, set **Interface** to the name of the M-S interface you created.



- Map the Simulink outputport that outputs the mode value to the AUTOSAR mode sender port you created. Open the Code Mappings editor and select the **Outputports** tab. To map the outputport to the AUTOSAR mode sender port, set **DataAccessMode** to **ModeSend**, select the **Port** name, and for **Element**, select the mode declaration group name that you specified for the M-S interface.

The screenshot shows the Code Mappings editor with the 'Outputports' tab selected. A table displays the mapping configuration:

Source	DataAccessMode	Port	Element
EngineMode	ModeSend	currentState	EngineModes

- Generate code for the model.

The arxml code includes referenced ModeSwitchPoints, ModeSwitchInterfaces, and ModeDeclarationGroups. For example, the following arxml code describes the ModeSwitchPoint for the AUTOSAR mode sender port.

```
<RUNNABLE-ENTITY>
...
<MODE-SWITCH-POINTS>
  <MODE-SWITCH-POINT UUID="...">
    <SHORT-NAME>OUT_currentState_EngineModes</SHORT-NAME>
    <MODE-GROUP-IREF>
      <CONTEXT-P-PORT-REF DEST="P-PORT-PROTOTYPE"/>/pkg/swc/mEngineFailureMode/currentState
    </CONTEXT-P-PORT-REF>
    <TARGET-MODE-GROUP-REF DEST="MODE-DECLARATION-GROUP-PROTOTYPE"/>
      /pkg/if/msInterface/EngineModes</TARGET-MODE-GROUP-REF>
    </MODE-GROUP-IREF>
  </MODE-SWITCH-POINT>
</MODE-SWITCH-POINTS>
...
</RUNNABLE-ENTITY>
```

The C code includes Rte_Switch API calls to communicate mode switches to other software components. For example, the following code communicates an EngineModes mode switch.

```
/* Outport: '<Root>/EngineMode' */
Rte_Switch_currentState_EngineModes(mEngineFailureMode_B.engstate);
```

See Also

Related Examples

- “Mode-Switch Interface” on page 2-32

- “Configure AUTOSAR Mode-Switch Interfaces” on page 4-359
- “Import AUTOSAR Software Component” on page 3-19
- “Configure AUTOSAR Code Generation” on page 5-8

More About


- “Model AUTOSAR Communication” on page 2-28
- “AUTOSAR Component Configuration” on page 4-3

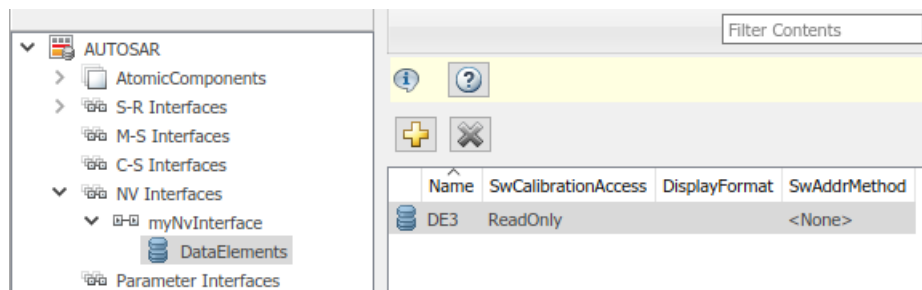
Configure AUTOSAR Nonvolatile Data Communication

AUTOSAR Release 4.0 introduced port-based nonvolatile (NV) data communication, in which an AUTOSAR software component reads and writes data to AUTOSAR nonvolatile components. To implement NV data communication, AUTOSAR software components define provide and require ports that send and receive NV data.

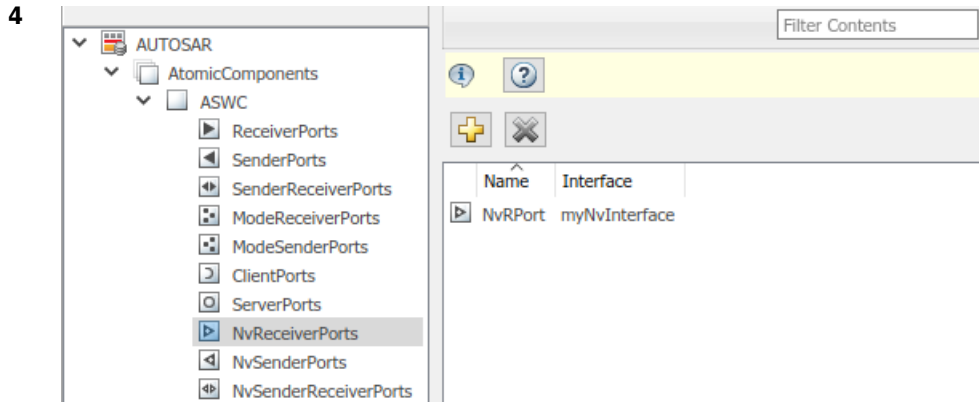
In Simulink, you can create AUTOSAR NV interfaces and ports, and map Simulink inports and outports to AUTOSAR NV ports. You model AUTOSAR NV ports with Simulink inports and outports, in the same manner described in “Sender-Receiver Interface” on page 2-29.

To create an NV data interface and ports in Simulink:

- 1 Add an AUTOSAR NV interface to the model. Open the AUTOSAR Dictionary and select **NV Interfaces**. Click the **Add** button . In the Add Interfaces dialog box, specify the interface name and the number of associated NV data elements.
- 2 Select and expand the new NV interface. Select **DataElements** and modify the data element attributes.



- 3 Add AUTOSAR NV ports to the model. Expand **AtomicComponents** and expand the component. Select and use the **NvReceiverPorts**, **NvSenderPorts**, and **NvSenderReceiverPorts** views to add the NV ports you require. For each NV port, select the NV interface you created.



- 5 Map Simulink inports and outports to the AUTOSAR NV ports you created. Open the Code Mappings editor. Select and use the **Inports** and **Outports** tabs to map the ports. For each inport or outport, select an AUTOSAR port, data element, and data access mode.

The screenshot shows the Code Mappings editor interface. It features a table with columns: Source, DataAccessMode, Port, and Element. Two mappings are listed:

Source	DataAccessMode	Port	Element
NVRPort_DE3	ImplicitReceive	NvRPort	DE3
RPort_DE2	ImplicitReceive	RPort	DE2

At the top of the editor are icons for a model, a checkmark, and a refresh symbol, along with a 'Filter contents' search box.

To programmatically configure AUTOSAR NV data communication elements, use the AUTOSAR property and mapping functions. For example, the following MATLAB code adds an AUTOSAR NV data interface and an NV receiver port to an open model. It then maps a Simulink inport to the AUTOSAR NV receiver port.

```
% Add AUTOSAR NV data interface myNvInterface with NV data element DE3
arProps = autosar.api.getAUTOSARProperties(hModel);
addPackageableElement(arProps, 'NvDataInterface', '/pkg/if', 'myNvInterface');
add(arProps, 'myNvInterface', 'DataElements', 'DE3');

% Add AUTOSAR NV receiver port NvRPort, associated with myNvInterface
add(arProps, 'ASWC', 'NvReceiverPorts', 'NvRPort', 'Interface', 'myNvInterface');

% Map Simulink inport NvRPort_DE3 to AUTOSAR port/element pair NvRPort and DE3
slMap = autosar.api.getSimulinkMapping(hModel);
mapInport(slMap, 'NvRPort_DE3', 'NvRPort', 'DE3', 'ImplicitReceive');
```

See Also

Related Examples

- “Nonvolatile Data Interface” on page 2-37
- “Configure AUTOSAR Sender-Receiver Interfaces” on page 4-354
- “Import AUTOSAR Software Component” on page 3-19
- “Configure AUTOSAR Code Generation” on page 5-8

More About


- “Model AUTOSAR Communication” on page 2-28
- “AUTOSAR Component Configuration” on page 4-3

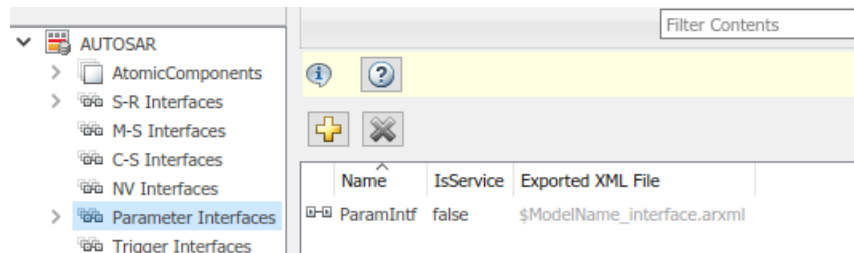
Configure Receiver for AUTOSAR Parameter Communication

AUTOSAR parameter communication relies on a parameter software component (ParameterSwComponent) and one or more atomic software components that require port-based access to parameter data. The parameter software component represents memory containing AUTOSAR parameters and provides parameter data to connected atomic software components.

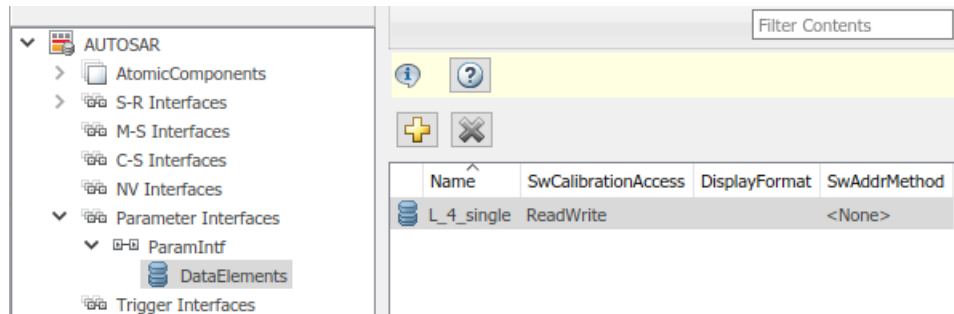
In Simulink, you can model the receiver portion of AUTOSAR port-based parameter communication. In an AUTOSAR atomic software component, you create a parameter interface with data elements and a parameter receiver port.


This example shows how to configure an AUTOSAR software component as a receiver for parameter communication.

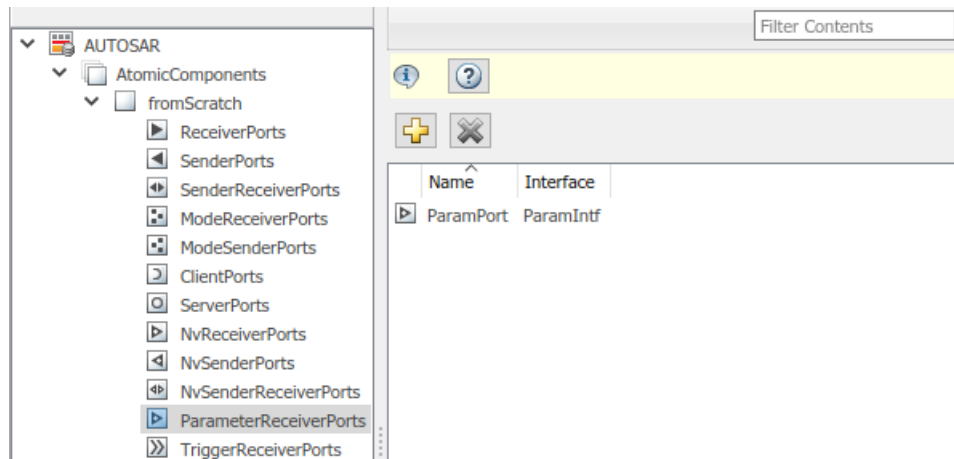
- 1 Open a model configured for AUTOSAR code generation in which the software component requires port-based access to parameter data.
- 2 Open the AUTOSAR Dictionary. Select the **Parameter Interfaces** view and use the **Add** button  to add a parameter interface to the model. In the Add Interfaces dialog box, specify the name of the new interface and set **Number of Data Elements** to 1.



- 3 Expand **Parameter Interfaces** and select the **DataElements** view. Examine and modify the properties of the associated data element that you created.



- Expand **AtomicComponents** and expand the component. Go to the **ParameterReceiverPorts** view and use the **Add** button  to add a parameter receiver port to the model. In the Add Ports dialog box, specify the name of the new port and set **Interface** to the name of the parameter interface you created.



- The AUTOSAR parameter interface data elements that you create then are available for lookup table mapping, using AUTOSAR function `mapLookupTable`. This code maps Simulink lookup table `L_4_single` to an AUTOSAR parameter receiver port and a parameter interface data element, which is accessed as a port-based parameter.

```
hModel = 'mySWC';
open_system(hModel)
slMap=autosar.api.getSimulinkMapping(hModel);
mapLookupTable(slMap,'L_4_single','PortParameter',...
    'ParamPort','L_4_single');
```

```
[arParameterAccessMode,arPortName,arParameterData] = ...
  getLookupTable(sMap,'L_4_single')

arParameterAccessmode =
  PortParameter

arPortName =
  ParamPort

arParameterData =
  L_4_single
```

See Also

[getLookupTable](#) | [mapLookupTable](#)

Related Examples

- “Create AUTOSAR Calibration Parameters By Using AUTOSAR Dictionary”

More About

- “Model AUTOSAR Communication” on page 2-28

Configure Receiver for AUTOSAR External Trigger Event Communication

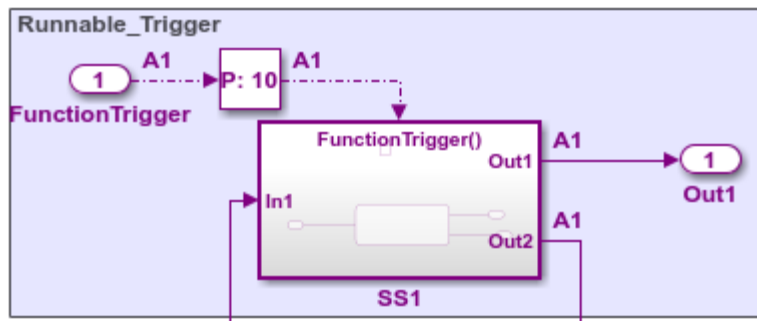
AUTOSAR Release 4.0 introduced external trigger event communication, in which an AUTOSAR software component or service signals an external trigger occurred event (`ExternalTriggerOccurredEvent`) to another component. The receiving component activates a runnable in response to the event.


In Simulink, you can model the receiver portion of AUTOSAR external trigger event communication. Select a component that you want to react to an external trigger. In the component, you create a trigger interface, a trigger receiver port to receive an `ExternalTriggerOccurredEvent`, and a runnable that the event activates.

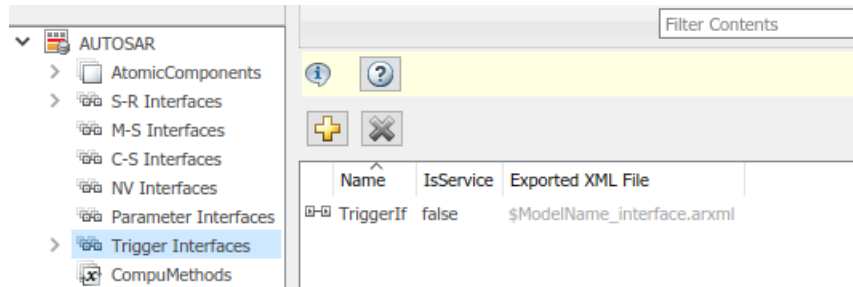
This example shows how to configure an AUTOSAR software component as a receiver for external trigger event communication.

- 1 Open a model configured for AUTOSAR code generation, in which you want to activate a runnable based on receiving an AUTOSAR `ExternalTriggerOccurredEvent`.

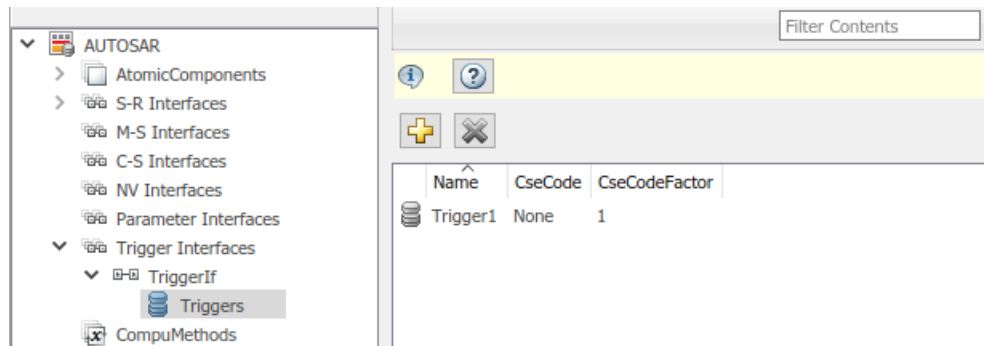
For a sample model that uses external trigger event communication, see `autosar_swc_fcncalls`. In `autosar_swc_fcncalls`, asynchronous function-call subsystem `SS1` models an AUTOSAR runnable. An `ExternalTriggerOccurredEvent` activates the runnable.




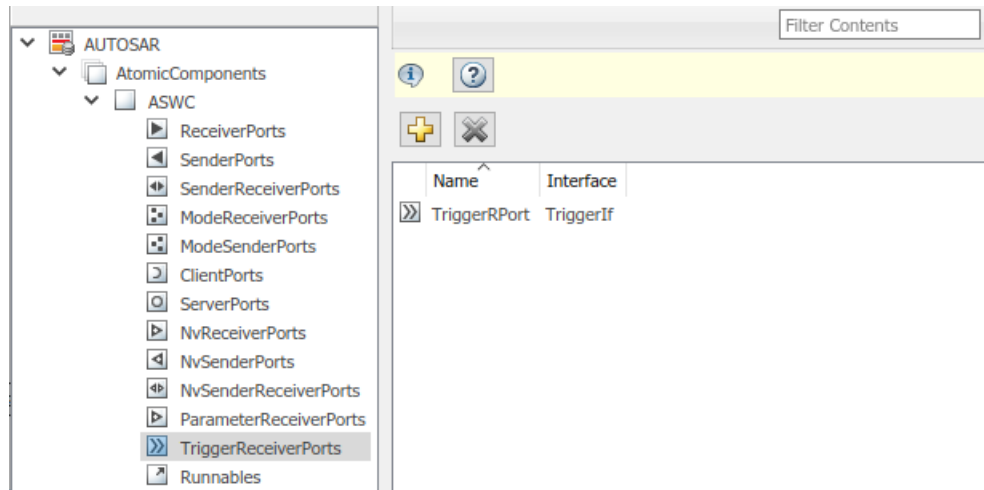
- 2 Open the AUTOSAR Dictionary. Select the **Trigger Interfaces** view and use the **Add** button  to add a trigger interface to the model. In the Add Interfaces dialog box, specify the name of the new interface and set **Number of Triggers** to 1.



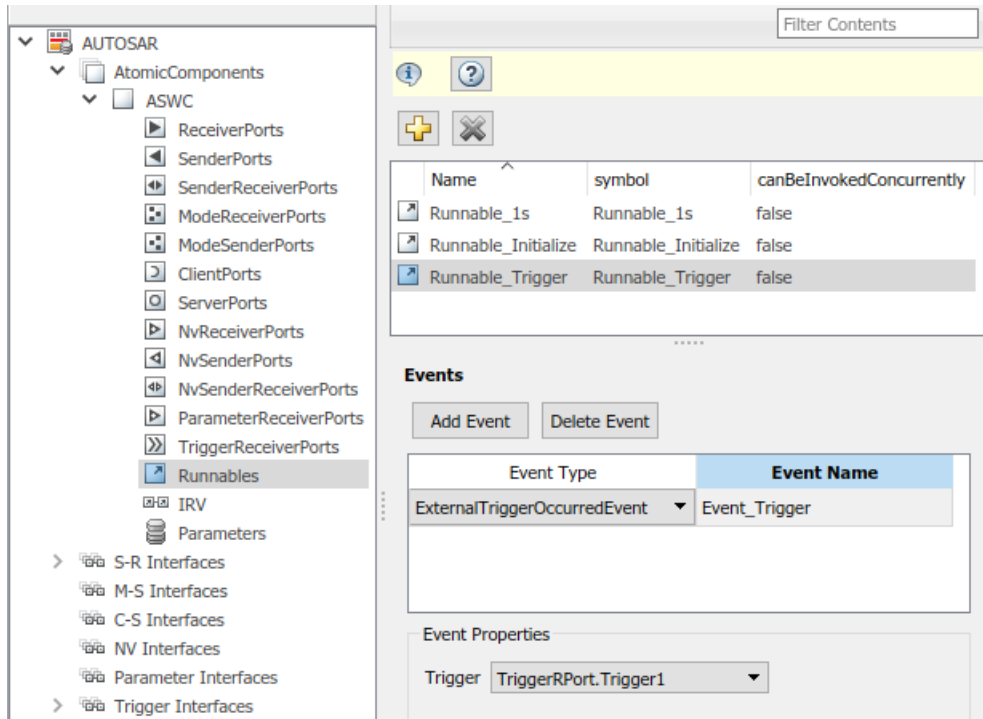
- Expand **Trigger Interfaces** and select the **Triggers** view. Examine the properties of the associated trigger. For an asynchronous (nonperiodic) trigger, set **CseCode** to **None**, indicating an unspecified trigger period. For more information about specifying trigger periods, click the help button in the triggers view.



- Expand **AtomicComponents** and expand the component. Select the **TriggerReceiverPorts** view and use the **Add** button  to add a trigger receiver port to the model. In the Add Ports dialog box, specify the name of the new port and set **Interface** to the name of the trigger interface you created.



- 5 Select the **Runnables** view and select the runnable that you want to activate based on receiving an AUTOSAR ExternalTriggerOccurredEvent. In the **Events** subpane, set **Event Type** to ExternalTriggerOccurredEvent. To display event properties, select the event name. For **Trigger**, select the value corresponding to the trigger receiver port and trigger you created.



- To complete the trigger receiver configuration, open the Code Mappings editor and select the **Functions** tab. Select the Simulink entry-point function for the subsystem that models the AUTOSAR ExternalTriggerOccurredEvent runnable. In the **Runnable** field, select the runnable name.



See Also

Related Examples

- “Add Top-Level Asynchronous Trigger to Periodic Rate-Based System” on page 4-239
- “Import AUTOSAR Software Component” on page 3-19
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “Model AUTOSAR Communication” on page 2-28
- “AUTOSAR Component Configuration” on page 4-3

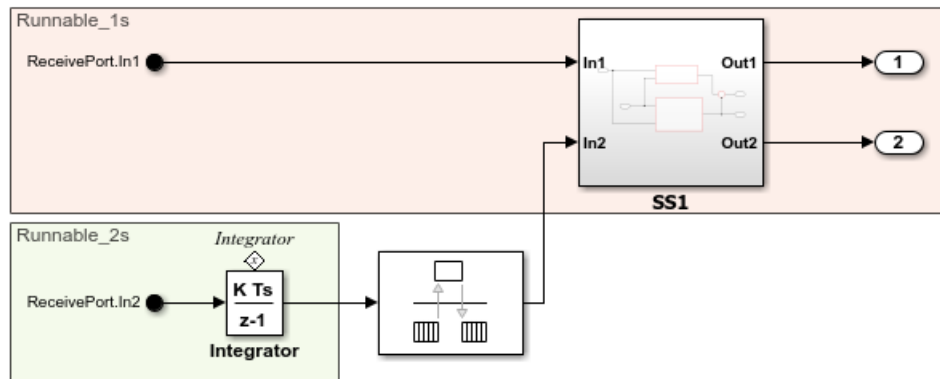
Configure AUTOSAR Ports By Using Simulink Bus Ports

You can model AUTOSAR ports by using Simulink bus ports instead of Simulink signal ports. Bus port blocks In Bus Element and Out Bus Element can simplify model interfaces. For more information, see “Simplify Bus Interfaces” (Simulink).

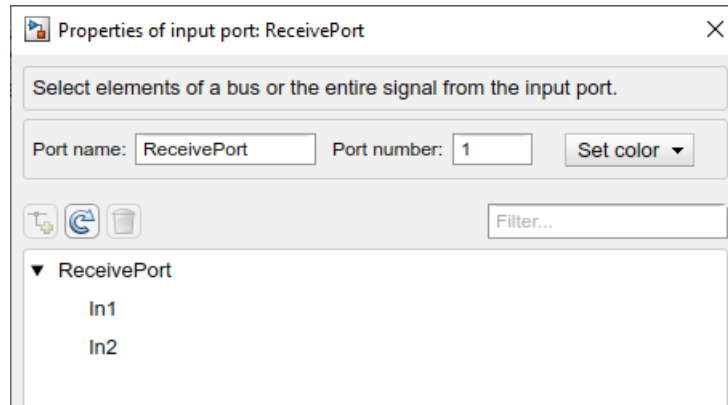
Bus port blocks provide a more intuitive way to model AUTOSAR communication ports, interfaces, and groups of data elements. If you model AUTOSAR ports with In Bus Element and Out Bus Element blocks, and type the bus ports with bus objects, basic properties of AUTOSAR ports, interfaces, and data elements are configured without using the AUTOSAR Dictionary.

To configure Simulink bus ports in an AUTOSAR model:

- 1 Create or open an AUTOSAR software component model. This example uses model `autosar_sw_c`.
- 2 Add two In Bus Element blocks to the model and connect them as root input ports. Configure the bus ports to share the same AUTOSAR port but have different elements. The bus port blocks are automatically mapped to AUTOSAR ports and elements.
 - a Delete the existing Inport blocks in the model.
 - b Create an In Bus Element block. Open the block parameters dialog box. Set **Port name** to `ReceivePort` and the signal name to `In1`.
 - c Connect the block to the first input signal. Make a copy of the block and connect it to the second input signal. In the model canvas (not the block parameters dialog box), click the name of the second block and change `In1` to `In2`.

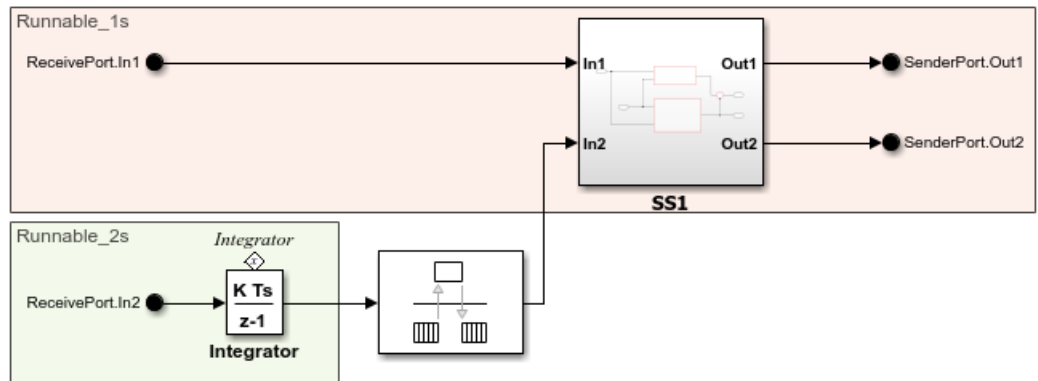


- d The In Bus Element block parameters dialog box now lists both signals.



Edit each signal and set the **Sample time** to 1 and 2, respectively.

- 3 Add two Out Bus Element blocks to the model and connect them as root output ports. Configure the bus ports to share the same AUTOSAR port but have different elements. The bus port blocks are automatically mapped to AUTOSAR ports and elements.
- a Delete the existing Output blocks in the model.
 - b Create an Out Bus Element block. Open the block parameters dialog box. Set **Port name** to SenderPort and the signal name to Out1.
 - c Connect the block to the first output signal. Make a copy of the block and connect it to the second input signal. In this case, the signal name is automatically set to Out2.

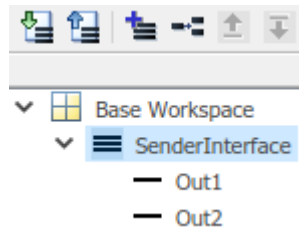


The Out Bus Element block parameters dialog box now lists both signals.

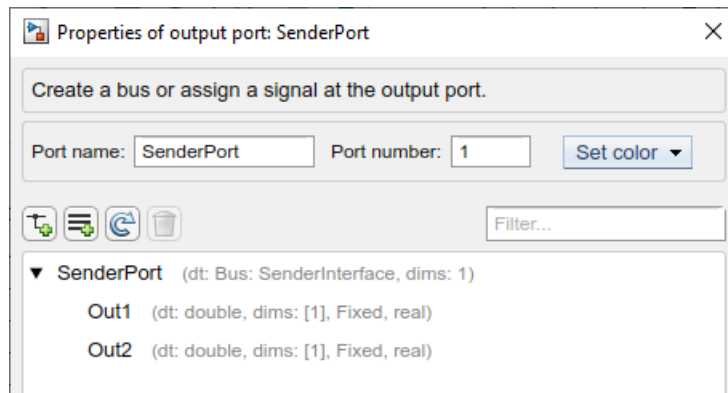
- 4 From the **Apps** tab, open the AUTOSAR Component Designer app. Use the Code Mappings editor to confirm that the rate-based functions and bus ports have been mapped to AUTOSAR runnables and ports. You can also open the AUTOSAR Dictionary and view the AUTOSAR component ports, runnables, S-R interfaces, and data elements.
- 5 If you generate code for the model:
 - The generated arxml file `autosar_swc_component.arxml` describes periodic runnables for each sample rate, named `Runnable_1s` and `Runnable_2s`.
 - The generated code file `autosar_swc.c` defines the rate-based functions `Runnable_1s` and `Runnable_2s`.

To define an AUTOSAR interface, type a bus port with a bus object. This example replaces the sender interface `Output_If` in `autosar_swc` with a new interface named `SenderInterface`.

- 1 With the modified `autosar_swc` open, open the Bus Editor. On the **Modeling** tab, select **Design > Bus Editor**.
- 2 In the Bus Editor dialog box, add a bus and name it `SenderInterface`. Add two bus elements and name them `Out1` and `Out2`. (You do not need to save the bus objects when exiting the dialog.)

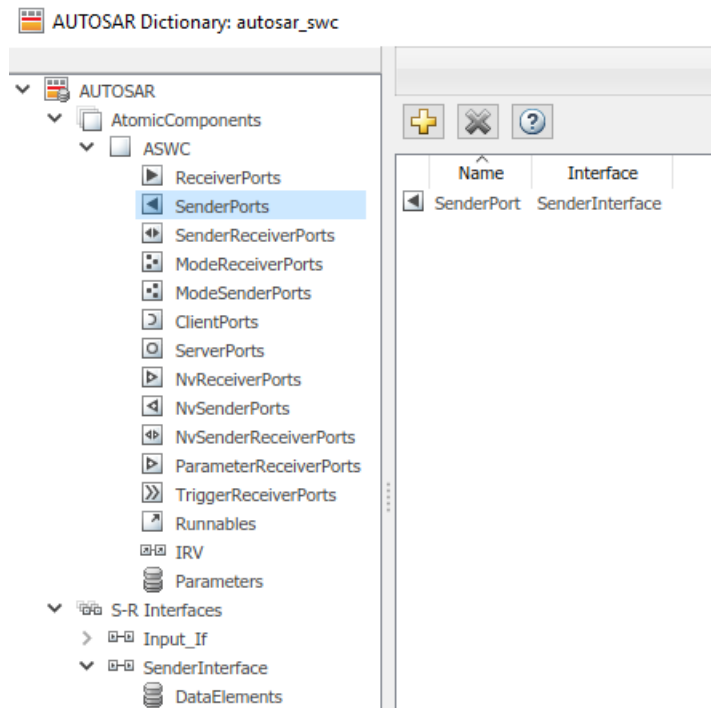


- 3 Open the SenderPort block dialog box. Edit the port SenderPort (not the signals) and set the **Data type** to Bus:SenderInterface.



- 4 Because the new interface is replacing an existing mapped interface, you must explicitly delete the existing sender port and sender interface. Open the AUTOSAR Component Designer app and open AUTOSAR Dictionary. Select and delete sender port SenderPort and S-R interface Output_If.
- 5 To generate and map the new sender interface, either call function `autosar.api.create` to update the model mapping or press **Ctrl+B** to generate model code (requires Embedded Coder). Here is the `autosar.api.create` function call.

```
autosar.api.create('autosar_sw');
```
- 6 Optionally, open the AUTOSAR Dictionary and view the new sender port and S-R interface definitions.



See Also

In Bus Element | Out Bus Element | `autosar.api.create`

Related Examples

- “Model AUTOSAR Communication” on page 2-28
- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14

More About

- “Simplify Bus Interfaces” (Simulink)

Configure AUTOSAR Runnables and Events

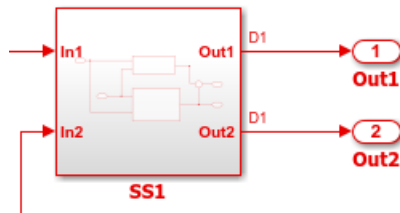
The internal behavior of an AUTOSAR software component is implemented by a set of runnable entities (runnables). A runnable is a sequence of operations provided by the component that can be started by the run-time environment (RTE). The component configures an event to activate each runnable - for example, a timing event, data received, a client request, a mode change, component startup or shutdown, or a trigger.

In Simulink, you can configure these types of AUTOSAR events.

Event Type	Workflow	Example
DataReceivedEvent	Sender-receiver (S-R) communication	“Configure Events for Runnable Activation” on page 4-349
DataReceiveErrorEvent	Sender-receiver (S-R) communication	“Configure AUTOSAR Receiver Port for DataReceiveErrorEvent” on page 4-138
ExternalTrigger-OccurredEvent	External trigger event communication	“Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214
InitEvent	R4.1 activation of initialization runnable	“Configure AUTOSAR Initialization Runnable (R4.1)” on page 4-242
ModeSwitchEvent	Mode-switch (M-S) communication	“Configure AUTOSAR Mode-Switch Communication” on page 4-199
OperationInvokedEvent	Client-server (C-S) communication	“Configure AUTOSAR Client-Server Communication” on page 4-171
TimingEvent	Periodic activation of runnable	“Configure AUTOSAR TimingEvent for Periodic Runnable” on page 4-346

To configure an AUTOSAR runnable in Simulink:

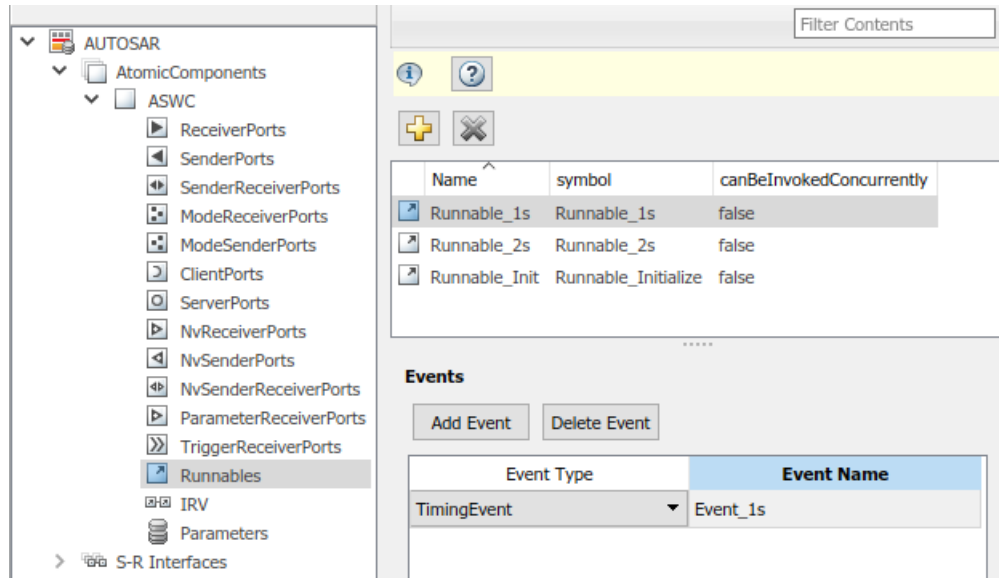
- 1 Open a model that is configured for AUTOSAR code generation. This example uses a writable copy of the example model `autosar_sw_c`.
- 2 In the model, create or identify a root-level Simulink subsystem or function that implements a sequence of operations. The subsystem or function must generate an entry-point function in C code. In `autosar_sw_c`, the subsystem SS1 generates rate-based model step function `Runnable_1s`.



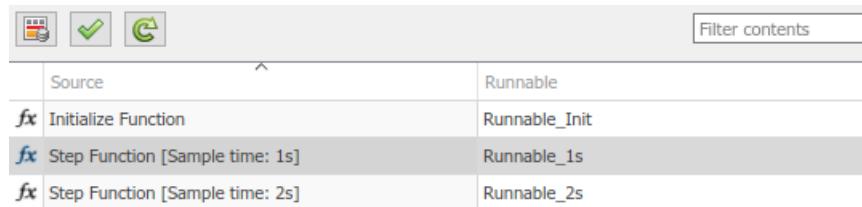
- 3 Create or identify an AUTOSAR runnable to which to map the Simulink entry point function. Open the AUTOSAR Dictionary. Expand **AtomicComponents**, expand the component, and select the **Runnables** view. If you need to create a new AUTOSAR runnable, click the plus sign. The model `autosar_sw` contains the periodic runnable `Runnable_1s`.
- 4 Select the row containing the runnable and configure its properties, including name and symbol. The AUTOSAR runnable symbol-name that you specify is exported in `arxml` descriptions and C code. For an AUTOSAR server runnable, set the runnable property `canBeInvokedConcurrently` to designate whether to enforce concurrency constraints. For nonserver runnables, leave `canBeInvokedConcurrently` set to `false`. For more information, see “Concurrency Constraints for AUTOSAR Server Runnables” on page 4-195.
- 5 Configure an event to activate the runnable. Go to the **Events** pane for the selected runnable. If you need to create an event, click **Add Event**. Enter an event name and set the event type.

The steps to configure an event depend on the type of event. If the event relies on a communication interface, such as data received (sender-receiver) or client request (client-server), you must first configure the communication interface before configuring the event.

In the model `autosar_sw`, the periodic runnable `Runnable_1s` is activated by a `TimingEvent` named `Event_1s`.



- Map the Simulink entry-point function to the AUTOSAR runnable. Open the Code Mappings editor and select the **Functions** tab. For model `autosar_swc`, select the model step function with a 1s sample time and map it to AUTOSAR runnable `Runnable_1s`.



To see the results of AUTOSAR runnable and event configuration in `arxml` descriptions and C code, build the model.

See Also

Related Examples

- “Import AUTOSAR Software Component” on page 3-19
- “Modeling Patterns for AUTOSAR Runnables” on page 2-13
- “Model AUTOSAR Software Components” on page 2-3
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Runnable Execution Order By Using Schedule Editor

In an AUTOSAR software component model, you can use the Schedule Editor to schedule and specify the execution order of runnables for simulation. In the Schedule Editor, you can:

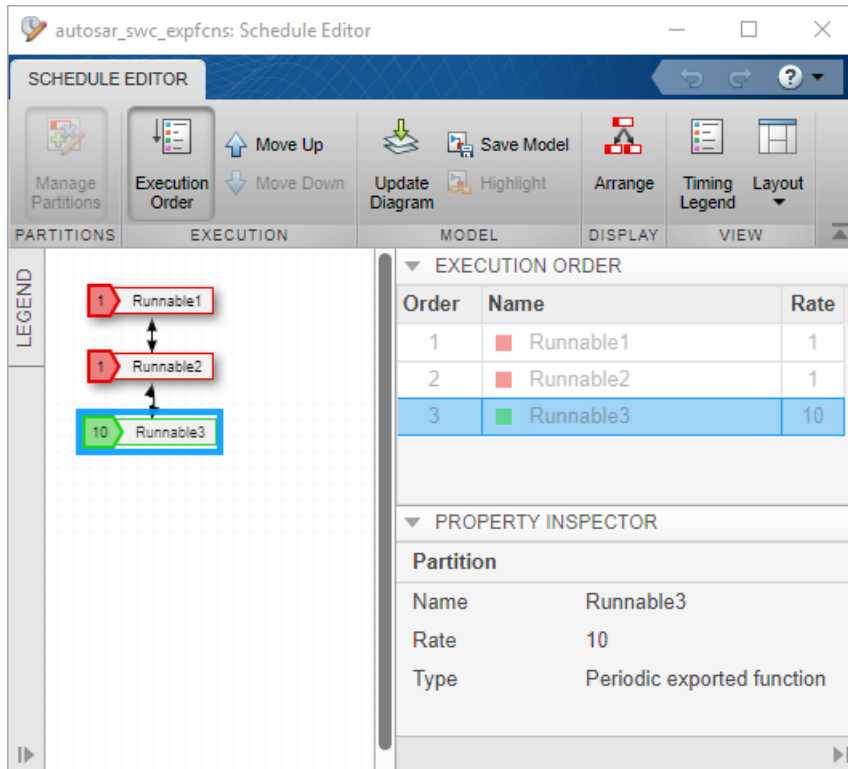
- View a graphical representation of runnables as partitions in an AUTOSAR component.
- Directly specify the execution order of runnables.

For more information, see “Using the Schedule Editor” (Simulink).

You can also use the Schedule Editor in AUTOSAR architecture modeling. See “Configure AUTOSAR Scheduling and Simulation” on page 8-25.

In an AUTOSAR component model, you can configure implicit or explicit partitions. To view and configure implicit partitions:

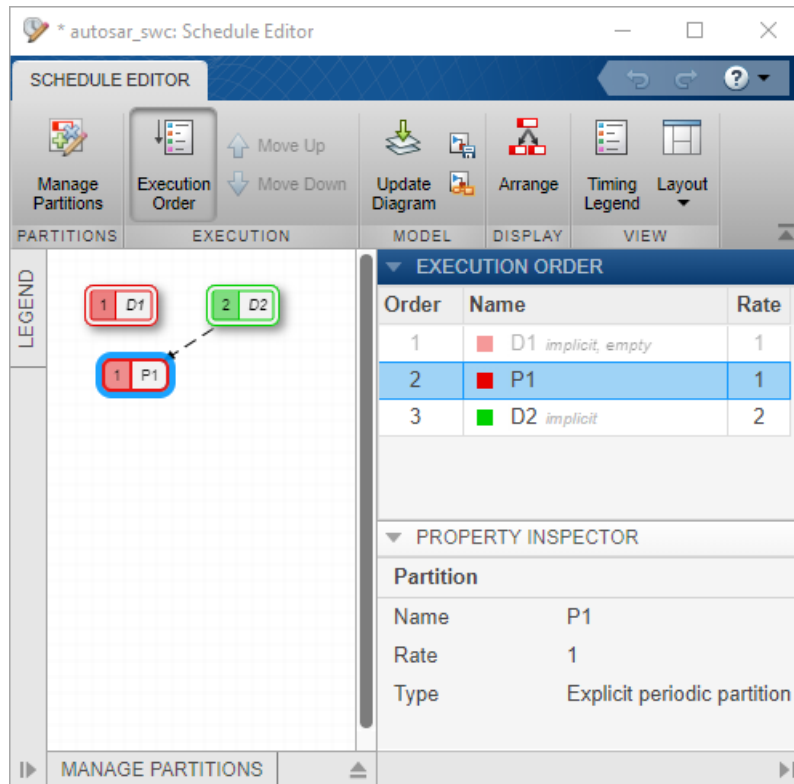
- 1 Open AUTOSAR example model `autosar_sw_c_expfcns`, which uses Simulink exported functions to model AUTOSAR runnables.
- 2 Open the **Modeling** tab and select **Design > Schedule Editor**. The Schedule Editor opens. The editor displays the implicit partitions (tasks) in the model.



- 3 You can use the editor controls to reorder the partitions.
- 4 Simulate the component model.

To create explicit partitions in an AUTOSAR software component:

- 1 Open AUTOSAR example model `autosar_sw_c`, which models periodic runnables with multiple sample rates.
- 2 To create a partition, open the block parameters dialog box for the SS1 subsystem and select **Treat as atomic unit**. Set parameter **Schedule as** to **Periodic partition**. Specify a partition name and sample time. Click **Apply**.
- 3 Open the **Modeling** tab and select **Design > Schedule Editor**. The Schedule Editor opens. The editor displays the explicit periodic partition in the model.



- 4 In the model window, open the **Functions** tab in the Code Mappings editor. Map the partition function to an AUTOSAR runnable. If necessary, use the AUTOSAR Dictionary to add a new runnable.
- 5 Simulate the component model.

See Also

Schedule Editor

Related Examples

- “Configure AUTOSAR Runnables and Events” on page 4-224
- “Using the Schedule Editor” (Simulink)

- “Configure AUTOSAR Scheduling and Simulation” on page 8-25

More About

- “Modeling Patterns for AUTOSAR Runnables” on page 2-13
- “Model AUTOSAR Runnables Using Exported Functions” on page 2-23

Configure AUTOSAR Initialize, Reset, or Terminate Runnables

AUTOSAR applications sometimes require complex logic to execute during system initialization, reset, and termination sequences. To model startup, reset, and shutdown processing in an AUTOSAR software component, use the Simulink blocks Initialize Function and Terminate Function.

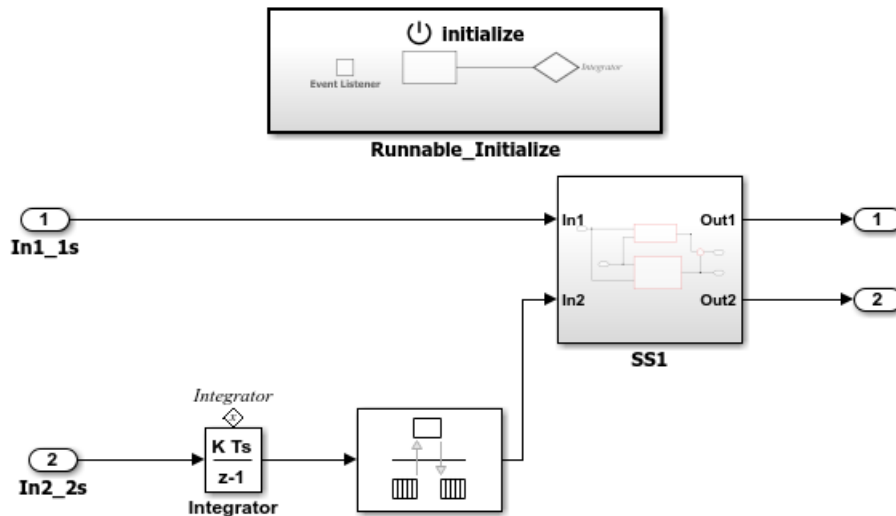
The Initialize Function and Terminate Function blocks can control execution of a component in response to initialize, reset, or terminate events. For more information, see “Using Initialize, Reset, and Terminate Functions” (Simulink), “Generate Code That Responds to Initialize, Reset, and Terminate Events” (Simulink Coder), and AUTOSAR topic “Startup, Reset, and Shutdown” on page 2-11.

In an AUTOSAR model, you map each Simulink initialize, reset, or terminate entry-point function to an AUTOSAR runnable. For each runnable, configure the AUTOSAR event that activates the runnable. In general, you can select any AUTOSAR event type except `TimingEvent`. The runnables work with any AUTOSAR component modeling style. (However, software-in-the-loop simulation of AUTOSAR initialize, reset, or terminate runnables works only with exported function modeling.)

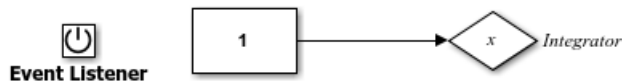
This example shows how to configure an AUTOSAR software component for simple startup and termination processing, using the Initialize Function and Terminate Function blocks.

- 1 Open a model that is configured for AUTOSAR code generation. This example uses a writable copy of the example model `autosar_sw_c`.

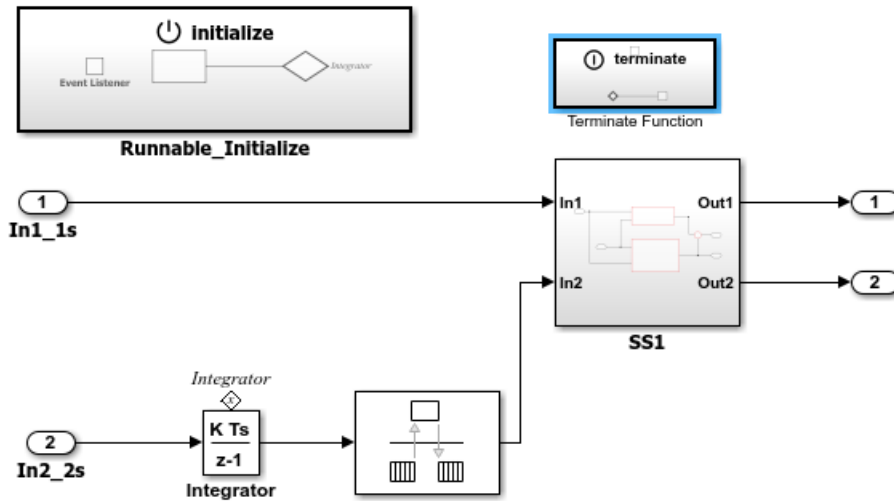
Add an Initialize Function block to the model.



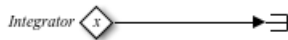
- 2 In the Initialize Function block, develop the logic that is required to execute during component initialization, using the techniques described in “Using Initialize, Reset, and Terminate Functions” (Simulink).




- 3 Add a Terminate Function block to the model.




- 4 In the Terminate Function block, develop the logic that is required to execute during component termination, using the techniques described in “Using Initialize, Reset, and Terminate Functions” (Simulink).

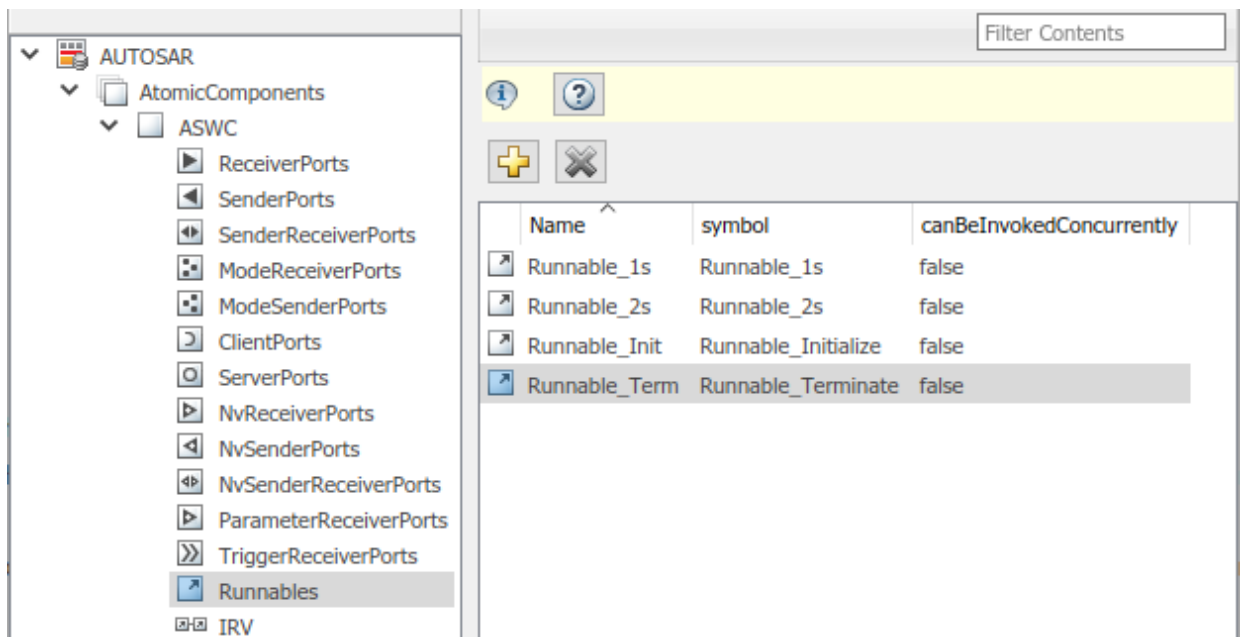


In this example, the Terminator block is a placeholder for saving the state value.

- 5 Add a terminate entry-point function to the model. In the Configuration Parameters dialog box, in the **Code Generation > Interface** pane, under **Advanced parameters**, select the option **Terminate function required**. Click **Apply**.
- 6 Open the Code Mappings editor. To update the Simulink to AUTOSAR mapping of the model, click the **Update** button . The mapping now reflects the addition of the Initialize Function and Terminate Function blocks and enabling of a terminate entry-point function.
- 7 Open the AUTOSAR Dictionary. Expand **AtomicComponents**, expand the component, and select the **Runnables** view.

The runnables list already contains an initialization runnable, created as part of the initial Simulink representation of the AUTOSAR software component. Use the **Add** button  to add a terminate runnable to the component. Select each runnable and configure its name and properties.

The runnable **symbol** value shown in the runnables view becomes the runnable function name. The runnable **Name** value is used in the names of RTE access methods generated for the runnable.

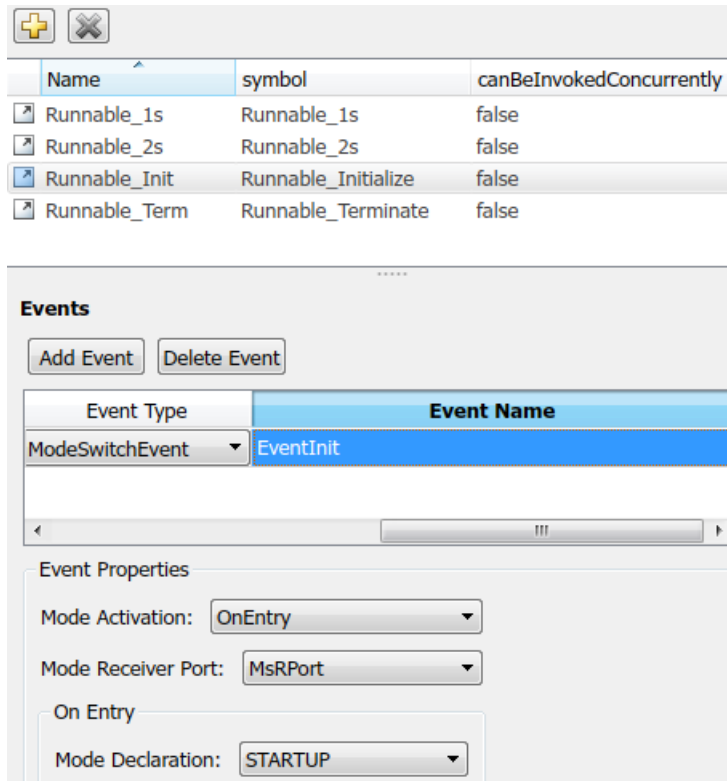


Name	symbol	canBeInvokedConcurrently
Runnable_1s	Runnable_1s	false
Runnable_2s	Runnable_2s	false
Runnable_Init	Runnable_Initialize	false
Runnable_Term	Runnable_Terminate	false

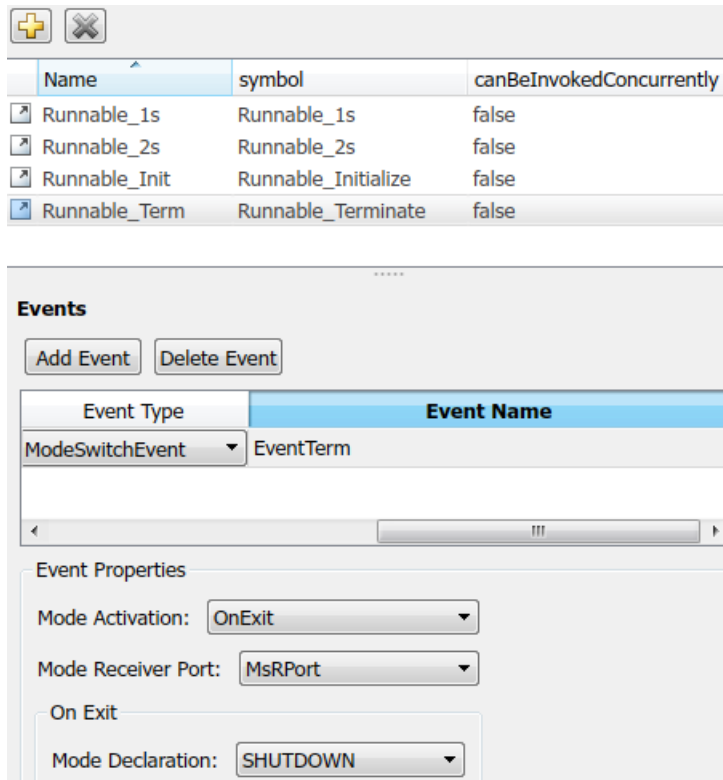
- For both the initialize and terminate runnables, configure an AUTOSAR event that activates the runnable.

This example defines a `ModeSwitchEvent` for each runnable. Using a `ModeSwitchEvent` requires creating a model declaration group, a mode-switch (M-S) interface, and a mode receiver port for the model. For more information, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.

In the runnables view, click the initialize runnable name to display and modify its associated event properties. Add and configure an event.



In the runnables view, click the terminate runnable name to display and modify its associated event properties. Add and configure an event.



- Open the Code Mappings editor and select the **Functions** tab. Select the Simulink initialize and terminate functions and map them to the AUTOSAR initialize and terminate runnables that you configured.



- Build the model and examine the generated code.

- The exported arxml code contains an AUTOSAR runnable for each initialize, reset, or terminate subsystem in the model, with the specified AUTOSAR runnable name and symbol. The runnable description includes each AUTOSAR data access point and server call point associated with the runnable.
- The generated C code contains RTE access methods for parameters, states, function callers, and external I/O associated with the runnable.

See Also

Event Listener | Initialize Function | State Reader | State Writer | Terminate Function

Related Examples

- “Using Initialize, Reset, and Terminate Functions” (Simulink)
- “Generate Code That Responds to Initialize, Reset, and Terminate Events” (Simulink Coder)
- “Create Test Harness to Generate Function Calls” (Simulink)
- “Configure AUTOSAR Mode-Switch Communication” on page 4-199

More About

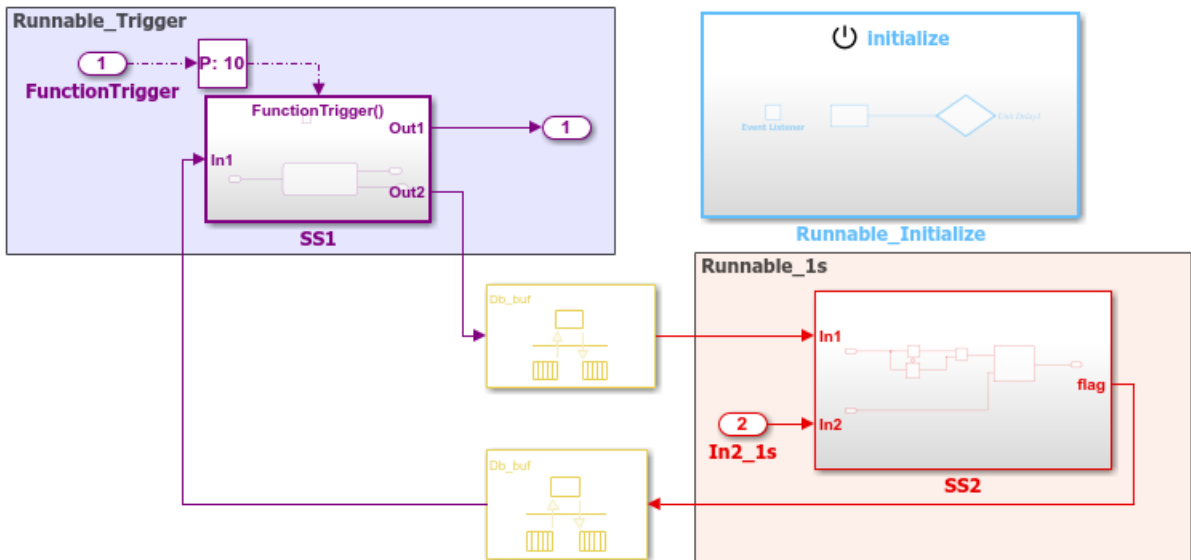
- “Startup, Reset, and Shutdown” on page 2-11
- “Configure Code Generation for Model Entry-Point Functions” (Simulink Coder)
- “AUTOSAR Component Configuration” on page 4-3

Add Top-Level Asynchronous Trigger to Periodic Rate-Based System

In Simulink, you can model an AUTOSAR software component in which an asynchronous function-call runnable interacts with periodic rate-based runnables. This type of component uses both periodic and asynchronous rates (sample times).

The approach can be used to model the JMAAB complex control model type beta (β) architecture. This architecture is described in the Japan MBD Automotive Advisory Board (JMAAB) document *Control Algorithm Modeling Guidelines Using MATLAB, Simulink, and Stateflow - Version 4.01*. The document is available from the MAAB web page at <https://www.mathworks.com/solutions/automotive/standards/maab.html>.

In JMAAB type beta modeling, at the top level of a control model, you place function layers above scheduling layers. For example, here is an AUTOSAR example model, `autosar_swc_fcncalls`. In this model, an asynchronous function-call runnable at the top level of the model interacts with a periodic rate-based runnable.



Some guidelines apply to AUTOSAR modeling of the JMAAB type beta controller layout:

- IRVs must be modeled with Rate Transition blocks.

- Function-call subsystems must have asynchronous rates. (In the function-call subsystem Trigger block, **Sample time type** must be triggered, not periodic.)
- For each asynchronous function-call subsystem, you must insert an Asynchronous Task Specification task block between the function-call root inport and the subsystem.

Here is the AUTOSAR Dictionary view of the runnables. An event triggers the asynchronous function-call runnable. The event must be of type `DataReceivedEvent`, `DataReceiveErrorEvent`, `ModeSwitchEvent`, `InitEvent`, or `ExternalTriggerOccurredEvent`.

The screenshot shows the AUTOSAR Dictionary view. On the left, the component tree is expanded to 'Runnables'. On the right, the 'Runnables' section is active, showing a table of runnables and an 'Events' section.

Name	symbol	canBeInvokedConcurrently
Runnable_1s	Runnable_1s	false
Runnable_Initialize	Runnable_Initialize	false
Runnable_Trigger	Runnable_Trigger	false

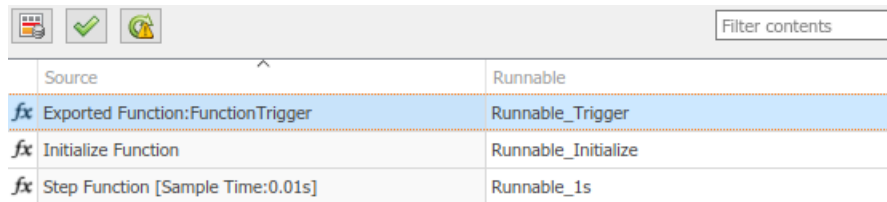
Below the table, the 'Events' section contains 'Add Event' and 'Delete Event' buttons. A table maps event types to event names:

Event Type	Event Name
ExternalTriggerOccurredEvent	Event_Trigger

The 'Event Properties' section shows the 'Trigger' property set to 'TriggerRPort.Trigger1'.

In this example, an `ExternalTriggerOccurredEvent` activates the AUTOSAR runnable. A trigger interface delivers the event to a trigger receiver port. For more information about `ExternalTriggerOccurredEvents`, see “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214.

Here is the Code Mappings editor view of the Simulink entry-point functions. The functions are mapped to AUTOSAR function-trigger, initialization, and periodic runnables, respectively.



Source	Runnable
fx Exported Function:FunctionTrigger	Runnable_Trigger
fx Initialize Function	Runnable_Initialize
fx Step Function [Sample Time:0.01s]	Runnable_1s

See Also

Asynchronous Task Specification | Rate Transition

Related Examples

- “Configure Receiver for AUTOSAR External Trigger Event Communication” on page 4-214
- “Modeling Patterns for AUTOSAR Runnables” on page 2-13
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “Model AUTOSAR Software Components” on page 2-3
- “AUTOSAR Component Configuration” on page 4-3

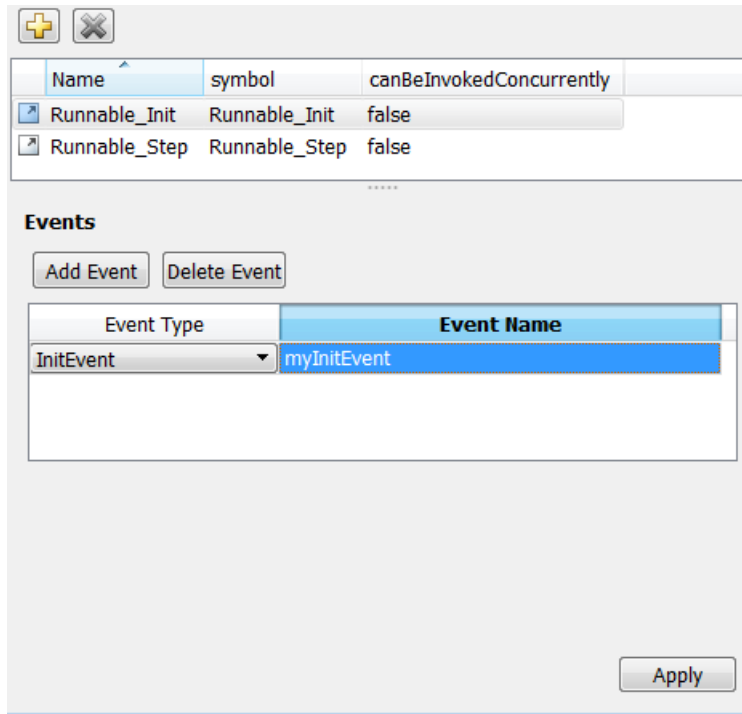
Configure AUTOSAR Initialization Runnable (R4.1)

AUTOSAR Release 4.1 introduced the AUTOSAR initialization event (`InitEvent`). You can use an `InitEvent` to designate an AUTOSAR runnable as an initialization runnable, and then map an initialization function to the runnable. Using an `InitEvent` to initialize a software component is a potentially simpler and more efficient than using AUTOSAR mode management, in which you define a `ModeDeclarationGroup` with a mode for setting up and initializing a software component. (For more information on the mode management approach, see “Configure AUTOSAR Mode-Switch Communication” on page 4-199.)

If you import a `arxml` code that describes a runnable with an `InitEvent`, the `arxml` importer configures the runnable in Simulink as an initialization runnable.

Alternatively, you can configure a runnable to be the initialization runnable in Simulink. For example,

- 1 Open a model configured for AUTOSAR.
- 2 Open the Configuration Parameters dialog box, go to **Code Generation > AUTOSAR Code Generation Options**, and verify that the selected AUTOSAR schema version is 4.1 or higher.
- 3 Open the AUTOSAR Dictionary. Navigate to a software component, and select the **Runnables** view.
- 4 Select a runnable to configure as an initialization runnable, and click **Add Event**. From the **Event Type** drop-down list, select `InitEvent`, and specify the **Event Name**. In this example, initialization event `myInitEvent` is configured for runnable `Runnable_Init`.



You can configure at most one `InitEvent` for a runnable.

- 5 Open the Code Mappings editor and select the **Functions** tab.
- 6 To map an initialization function to the initialization runnable, select the function. From the **Runnable** drop-down list, select the runnable for which you configured an `InitEvent`. In this example, Simulink entry-point function `Initialize Function` is mapped to AUTOSAR runnable `Runnable_Init`.

The screenshot shows a table in the Code Mappings editor. At the top left are three icons: a document with a red X, a green checkmark, and a circular refresh icon. At the top right is a 'Filter contents' search box. The table has two columns: 'Source' and 'Runnable'. The first row is highlighted in blue and shows 'fx Initialize Function' in the 'Source' column and 'Runnable_Init' in the 'Runnable' column. The second row shows 'fx Step Function [Sample Time:0.1s]' in the 'Source' column and 'Runnable_Step' in the 'Runnable' column.

Source	Runnable
fx Initialize Function	Runnable_Init
fx Step Function [Sample Time:0.1s]	Runnable_Step

When you export `arxml` code from a model containing an initialization runnable, the `arxml` exporter generates an `InitEvent` that is mapped to the initialization runnable and function. For example:

```
<EVENTS>
  <INIT-EVENT UUID="...">
    <SHORT-NAME>myInitEvent</SHORT-NAME>
    <START-ON-EVENT-REF DEST="RUNNABLE-ENTITY">/.../Runnable_Init</START-ON-EVENT-REF>
  </INIT-EVENT>
</EVENTS>
```

Configure Disabled Mode for AUTOSAR Runnable Event

AUTOSAR Release 4.0 introduced the ability to set the `DisabledMode` property of a runnable event to potentially prevent a runnable from running in certain modes.

Given a model containing a mode receiver port and defined mode values, you can programmatically get and set the `DisabledMode` property of a `TimingEvent`, `DataReceivedEvent`, `ModeSwitchEvent`, `OperationInvokedEvent`, `DataReceiveErrorEvent`, or `ExternalTriggerOccurredEvent`. The property is not supported for an `InitEvent`.

The value of the `DisabledMode` property is either `''` (no disabled modes) or one or more mode values of the form `'mrPortName.modeName'`. To set the `DisabledMode` property of a runnable event in your model, use the AUTOSAR property function `set`.

The following example sets the `DisabledMode` property for a timing event named `Event_t_ltic_B`. The `set` function call potentially disables the event for modes `STARTUP` and `SHUTDOWN`, which are defined on mode-receiver port `myMRPort`.

```
addpath (fullfile(matlabroot, '/help/toolbox/autosar/examples'));
hModel = 'mAutosarMsConfigAfter';
open_system(hModel)
arProps = autosar.api.getAUTOSARProperties(hModel);
eventPaths = find(arProps,[], 'TimingEvent')

eventPaths =
    {'ASWC/Behavior/Event_t_ltic_B'}    {'ASWC/Behavior/Event_t_10tic'}

dsblModes = get(arProps,eventPaths{1}, 'DisabledMode')

dsblModes =
    1x0 empty cell array

set(arProps,eventPaths{1}, 'DisabledMode', {'myMRPort.STARTUP', 'myMRPort.SHUTDOWN'});
dsblModes = get(arProps,eventPaths{1}, 'DisabledMode')

dsblModes =
    {'myMRPort.STARTUP'}    {'myMRPort.SHUTDOWN'}
```

When you export arxml files for the model, the timing event description for `Event_t_ltic_B` includes a `DISABLED-MODE-IREFS` section that references the mode-receiver port, the mode declaration group, and each disabled mode.

The software preserves the `DisabledMode` property of a runnable event across round trips between an AUTOSAR authoring tool (AAT) and Simulink.

Configure AUTOSAR Per-Instance Memory

To model AUTOSAR per-instance memory (PIM) for AUTOSAR applications, you import per-instance memory definitions from `arxml` files or create per-instance memory content in Simulink. For information about the high-level PIM workflow, see “Per-Instance Memory” on page 2-42.

AUTOSAR typed per-instance memory (`ArTypedPerInstanceMemory`), introduced in AUTOSAR schema version 4.0, defines an AUTOSAR typed memory block that is available for each instance of an AUTOSAR software component. In the AUTOSAR run-time environment, calibration tools can access `arTypedPerInstanceMemory` blocks for measurement and calibration.

To model AUTOSAR PIM, you can use Simulink block signals, discrete states, or data stores in your model.

In this section...
“Configure Block Signals and States as AUTOSAR Typed Per-Instance Memory” on page 4-246
“Configure Data Stores as AUTOSAR Typed Per-Instance Memory” on page 4-248

Configure Block Signals and States as AUTOSAR Typed Per-Instance Memory

To generate `arTypedPerInstanceMemory` blocks for Simulink block signal and discrete state data in your AUTOSAR model, open the Code Mappings editor and select the **Signals/States** tab. Select signals and states and map them to `arTypedPerInstanceMemory`. For example:

- 1 Open an AUTOSAR model that contains signals or states that you want to generate `arTypedPerInstanceMemory` blocks for. This example uses model `autosar_sw_c_counter`.
- 2 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Signals/States** tab. In the list of available signals, select `sum_out`. Selecting a signal highlights the signal in the model diagram and displays the signal attributes in the Property Inspector. Use the Property Inspector to modify the signal attributes. In the **Mapped To** drop-down list, select `ArTypedPerInstanceMemory`. For more information about signal code and calibration attributes, see “Map Block Signals and States to AUTOSAR Variables” on page 4-80.

The screenshot shows the Simulink environment for configuring an AUTOSAR component. The main workspace displays a block diagram for 'autosar_sw_counter'. The diagram includes an 'INC' block, a 'sum_out' signal, a 'LIMIT' block, an 'equal_to_count' block, a 'RESET' block, a 'switch_out' block, and an 'Amplifier' block. The 'Code Mappings - AUTOSAR SW Component' window is open, showing a table of signal mappings. The 'sum_out' signal is highlighted, and its 'Mapped To' property is set to 'ArTypedPerInstanceMemory'. The 'Property Inspector' window on the right shows the configuration for the 'sum_out' signal, with 'Mapped To' set to 'ArTypedPerInstanceMemory'.

Source	Mapped To	Path
equal_to_count	StaticMemory	autosar_sw_counter
sum_out	ArTypedPerInstanceMemory	autosar_sw_counter
switch_out	Auto	autosar_sw_counter

- 3 In the **Signals/States** tab, from the list of available states, select state X. Use the Property Inspector to modify the state attributes. In the **Mapped To** drop-down list, select **ArTypedPerInstanceMemory**.

When you generate code:

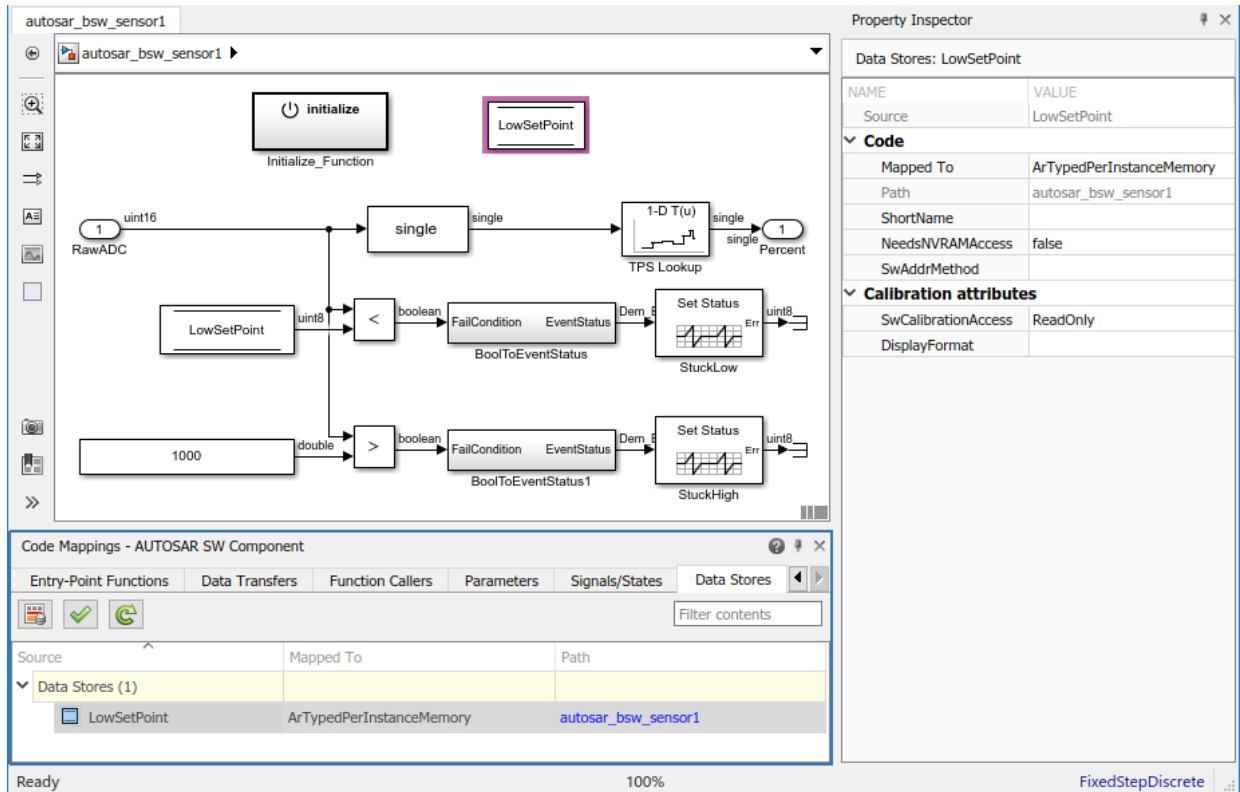
- Exported arxml files contain AR-TYPED-PER-INSTANCE-MEMORYS descriptions for signals and states that you configured as **ArTypedPerInstanceMemory**.
- Generated C code contains `Rte_Pim_*` API calls for signal and state variables.

For referenced models within an AUTOSAR component model, Embedded Coder maps internal signals and states for model reference code generation. Internal signals and states map to AUTOSAR **ArTypedPerInstanceMemory** for multi-instance model reference or to AUTOSAR **StaticMemory** for single-instance model reference.

Configure Data Stores as AUTOSAR Typed Per-Instance Memory

To generate `ArTypedPerInstanceMemory` blocks for Simulink data store memory blocks in your AUTOSAR model, open the Code Mappings editor and select the **Data Stores** tab. Select data stores and map them to `ArTypedPerInstanceMemory`. For example:

- 1 Open an AUTOSAR model that contains data stores that you want to generate `ArTypedPerInstanceMemory` blocks for. This example uses model `autosar_bsw_sensor1`.
- 2 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Data Stores** tab. In the list of available data stores, select data store `LowSetPoint`. Selecting a data store highlights the data store memory block in the model diagram and displays the data store attributes in the Property Inspector. Use the Property Inspector to modify the data store attributes. In the **Mapped To** drop-down list, select `ArTypedPerInstanceMemory`. For more information about data store code and calibration attributes, see “Map Data Stores to AUTOSAR Variables” on page 4-77.



When you generate code:

- Exported arxml files contain AR-TYPED-PER-INSTANCE-MEMORYS descriptions for data stores that you configured as ArTypedPerInstanceMemory.
- Generated C code contains Rte_Pim_* API calls for data store variables.

When you build your model, the XML files that are generated define an exclusive area for each Data Store Memory block that references per-instance memory. Every runnable that accesses per-instance memory runs inside the corresponding exclusive area. If multiple AUTOSAR runnables have access to the same Data Store Memory block, the exported AUTOSAR specification enforces data consistency by using an AUTOSAR exclusive area. With this specification, the runnables have mutually exclusive access to the per-instance memory global data, which prevents data corruption.

If you select **needsNVRAMAccess**, a SERVICE-NEEDS entry (schema version 3.0 or later) or NVRAM-MAPPINGS entry (schema version 2.1) is declared in XML files. The entry indicates that the per-instance memory is a RAM mirror block and requires service from the NvM manager module.

See Also

Data Store Memory | [getDataStore](#) | [getSignal](#) | [getState](#) | [mapDataStore](#) | [mapSignal](#) | [mapState](#)

Related Examples

- “Map Block Signals and States to AUTOSAR Variables” on page 4-80
- “Map Data Stores to AUTOSAR Variables” on page 4-77
- “Model AUTOSAR Component Behavior” on page 2-39

More About

- “Per-Instance Memory” on page 2-42

Configure AUTOSAR Static Memory

To model AUTOSAR static memory for AUTOSAR applications, you import static memory definitions from `arxml` files or create static memory content in Simulink. For information about the high-level static memory workflow, see “Static and Constant Memory” on page 2-43.

AUTOSAR static memory (`StaticMemory`), introduced in AUTOSAR schema version 4.0, corresponds to Simulink internal global signals. In the AUTOSAR run-time environment, calibration tools can access `StaticMemory` blocks for measurement and calibration.

To model AUTOSAR static memory, you can use Simulink block signals, discrete states, or data stores in your model.

In this section...

“Configure Block Signals and States as AUTOSAR Static Memory” on page 4-251

“Configure Data Stores as AUTOSAR Static Memory” on page 4-253

Configure Block Signals and States as AUTOSAR Static Memory

To generate `StaticMemory` blocks for Simulink block signal and discrete state data in your AUTOSAR model, open the Code Mappings editor and select the **Signals/States** tab. Select signals and states and map them to `StaticMemory`. For example:

- 1 Open an AUTOSAR model that contains signals or states that you want to generate `StaticMemory` blocks for. This example uses model `autosar_swc_counter`.
- 2 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Signals/States** tab. In the list of available signals, select `equal_to_count`. Selecting a signal highlights the signal in the model diagram and displays the signal attributes in the Property Inspector. Use the Property Inspector to modify the signal attributes. In the **Mapped To** drop-down list, select `StaticMemory`. For more information about signal code and calibration attributes, see “Map Block Signals and States to AUTOSAR Variables” on page 4-80.

The screenshot shows the Embedded Coder IDE interface for an AUTOSAR SW Component. The main workspace displays a block diagram for the component 'autosar_sw_counter'. The diagram includes several blocks: an 'INC' block (uint8) feeding into a 'sum_out' block (uint8); a 'LIMIT' block (uint8) feeding into an 'equal to count' block (boolean); a 'RESET' block (uint8) feeding into a 'switch_out' block (uint8); and an 'Amplifier' block (int32) with 'In' and 'Out' ports. The 'equal to count' block is highlighted with a pink border. The 'Property Inspector' on the right shows the configuration for the 'equal_to_count' signal/state, with 'Mapped To' set to 'StaticMemory'. The 'Code Mappings' window at the bottom shows a table mapping source signals and states to their target memory locations and paths.

Source	Mapped To	Path
equal_to_count	StaticMemory	autosar_sw_counter
sum_out	ArTypedPerInstanceMemory	autosar_sw_counter
switch_out	Auto	autosar_sw_counter
X	StaticMemory	autosar_sw_counter

- 3 Select the **Signals/States** tab, and then select state X. Use the Property Inspector to modify the state attributes. From the **Mapped To** drop-down list, select **StaticMemory**.

When you generate code:

- Exported arxml files contain `STATIC-MEMORYS` descriptions for signals and states that you configured as `StaticMemory`.
- Generated C code declares and references the static memory variables.

For referenced models within an AUTOSAR component model, Embedded Coder maps internal signals and states for model reference code generation. Internal signals and states map to AUTOSAR `ArTypedPerInstanceMemory` for multi-instance model reference or to AUTOSAR `StaticMemory` for single-instance model reference.

Configure Data Stores as AUTOSAR Static Memory

To generate `StaticMemory` blocks for Simulink data store memory blocks in your AUTOSAR model, open the Code Mappings editor and select the **Data Stores** tab. Select data stores and map them to `StaticMemory`. For example:

- 1 Open an AUTOSAR model that contains data stores that you want to generate `StaticMemory` blocks for. This example uses model `autosar_bsw_sensor1`.
- 2 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Data Stores** tab. From the list of available data stores, select data store `LowSetPoint`. Selecting a data store highlights the data store memory block in the model diagram and displays the data store attributes in the Property Inspector. Use the Property Inspector to modify the data store attributes. From the **Mapped To** drop-down list, select `StaticMemory`. For more information about data store code and calibration attributes, see “Map Data Stores to AUTOSAR Variables” on page 4-77.

The screenshot displays the AUTOSAR development environment for a component named 'autosar_bsw_sensor1'. The main workspace shows a block diagram with the following elements:

- initialize** block (Initialize_Function)
- RawADC** input (uint16)
- LowSetPoint** data store (uint8)
- Two comparison blocks: **<** (boolean) and **>** (boolean)
- Two **FailCondition** blocks: 'FailCondition' and 'FailCondition1'
- Two **EventStatus** blocks: 'EventStatus' and 'EventStatus1'
- Two **Set Status** blocks: 'Set Status' (StuckLow) and 'Set Status' (StuckHigh)
- Other blocks include 'single', '1-D T(u)', and 'TPS Lookup'.

The **Property Inspector** on the right shows the configuration for the 'LowSetPoint' data store:

Data Stores: LowSetPoint	
NAME	VALUE
Source	LowSetPoint
Code	
Mapped To	StaticMemory
Path	autosar_bsw_sensor1
ShortName	
Volatile	false
AdditionalNativeTypeQualifier	
SwAddrMethod	
Calibration attributes	
SwCalibrationAccess	ReadOnly
DisplayFormat	

The **Code Mappings - AUTOSAR SW Component** window at the bottom shows the mapping for 'Data Stores (1)':

Source	Mapped To	Path
LowSetPoint	StaticMemory	autosar_bsw_sensor1

When you generate code:

- Exported arxml files contain `STATIC-MEMORYS` descriptions for data stores that you configured as `StaticMemory`.
- Generated C code declares and references the static memory variables.

Note AUTOSAR Blockset does not support static memory code generation for data stores in referenced models.

See Also

Data Store Memory | `getDataStore` | `getSignal` | `getState` | `mapDataStore` | `mapSignal` | `mapState`

Related Examples

- “Map Block Signals and States to AUTOSAR Variables” on page 4-80
- “Map Data Stores to AUTOSAR Variables” on page 4-77
- “Model AUTOSAR Component Behavior” on page 2-39

More About

- “Static and Constant Memory” on page 2-43

Configure AUTOSAR Constant Memory

You can model AUTOSAR constant memory for AUTOSAR applications. To model AUTOSAR constant memory, import constant memory definitions from `arxml` files or create constant memory content in Simulink. For information about the high-level constant memory workflow, see “Static and Constant Memory” on page 2-43.

AUTOSAR constant memory (`ConstantMemory`), introduced in AUTOSAR schema version 4.0, corresponds to Simulink internal global parameters. In the AUTOSAR run-time environment, calibration tools can access `ConstantMemory` blocks for measurement and calibration.

To model AUTOSAR constant memory, you can use Simulink model workspace parameters in your model. To generate `ConstantMemory` blocks for model workspace parameter data in your AUTOSAR model, open the Code Mappings editor. Use the **Parameters** tab to map parameters to `ConstantMemory`. For example:

- 1 Open an AUTOSAR model that contains model workspace parameters for which you want to generate `ConstantMemory` blocks. This example uses model `autosar_swc_counter`.
- 2 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Parameters** tab. In the list of available parameters, select `INC`. Selecting a parameter displays the parameter attributes in the Property Inspector. Use the Property Inspector to modify the parameter attributes. In the **Mapped To** drop-down list, select `ConstantMemory`. For more information about parameter code and calibration attributes, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.

The screenshot displays the AUTOSAR SW Component development environment. The main window shows a block diagram for the 'autosar_sw_counter' component. The diagram includes an 'INC' block (uint8) connected to a summing junction (+) labeled 'sum_out' (uint8). The output of the summing junction is compared against a 'LIMIT' block (uint8) using an inequality block (≠). The result is a 'boolean' signal 'equal_to_count'. This signal is connected to a 'switch_out' block (uint8) and an 'Amplifier' block. The 'Amplifier' block has an input of 'int32' (value 1) and an output of 'int32' (value 1). The 'switch_out' block is also connected to a 'RESET' block (uint8) and a gain block (1/z) labeled 'X' (uint8). The 'Code Mappings - AUTOSAR SW Component' window shows the following table:

Source	Mapped To
INC	ConstantMemory
K	SharedParameter
LIMIT	Auto
RESET	Auto

The 'Property Inspector' window shows the parameters for the 'INC' block:

NAME	VALUE
Source	INC

Additional properties for 'INC' include:

- Code: Mapped To: ConstantMemory, Const: true, Volatile: false, AdditionalNativeTypeQualifier: my_qualifier, SwAddrMethod: VAR
- Calibration attributes: SwCalibrationAccess: ReadWrite, DisplayFormat: (empty)

When you generate code:

- Exported arxml files contain CONSTANT-MEMORYS descriptions for parameters that you configured as ConstantMemory.
- Generated C code declares and references the constant memory parameters.

See Also

[getParameter](#) | [mapParameter](#)

Related Examples

- “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74
- “Model AUTOSAR Component Behavior” on page 2-39

More About

- “Static and Constant Memory” on page 2-43

Configure AUTOSAR Shared or Per-Instance Parameters

In this section...

“Configure Model Workspace Parameters as AUTOSAR Shared Parameters” on page 4-259

“Configure Model Workspace Parameters as AUTOSAR Per-Instance Parameters” on page 4-261

You can model AUTOSAR shared parameters (`SharedParameters`) and per-instance parameters (`PerInstanceParameters`) for use in AUTOSAR software components that potentially are instantiated multiple times. Shared parameter values are shared among all instances of a component. Per-instance parameter values are unique and private to each component instance. In the AUTOSAR run-time environment, calibration tools can access `SharedParameters` and `PerInstanceParameters` for measurement and calibration.

To model AUTOSAR shared or per-instance parameters, import parameter definitions from `arxml` files or create parameter content in Simulink. For information about the high-level shared and per-instance parameters workflow, see “Shared and Per-Instance Parameters” on page 2-43 .

To model AUTOSAR parameters in Simulink, you use model workspace parameters.

In this section...

“Configure Model Workspace Parameters as AUTOSAR Shared Parameters” on page 4-259

“Configure Model Workspace Parameters as AUTOSAR Per-Instance Parameters” on page 4-261

Configure Model Workspace Parameters as AUTOSAR Shared Parameters

To model AUTOSAR shared parameters in Simulink:

- 1 Open an AUTOSAR model that contains a model workspace parameter for which you want to generate an AUTOSAR `SharedParameter`. This example uses model `autosar_sw_counter`.
- 2 To model an AUTOSAR shared parameter in Simulink, configure a model workspace parameter that is not a model argument (that is, not unique to each instance of a

multi-instance model). For example, in the Model Explorer view of the parameter, clear the **Argument** property. In example model `autosar_sw_counter`, clear the **Argument** property for parameter K. Leave the parameter **StorageClass** set to **Auto**.

The screenshot shows the Model Explorer interface. On the left, the Model Hierarchy tree is expanded to show the `autosar_sw_counter` workspace. The main pane displays the 'Contents of: Model Workspace (only)' view, showing a table of data objects. The table has columns for Name, Value, DataType, Dimensions, Complexity, Min, Max, Unit, Argument, and StorageClass. The parameter 'K' is selected and highlighted in blue.

Name	Value	DataType	Dimensions	Complexity	Min	Max	Unit	Argument	StorageClass
INC	1	uint8	[1 1]	real	[]	[]		<input type="checkbox"/>	Auto
K	2	uint8	[1 1]	real	[]	[]		<input type="checkbox"/>	Auto
LIMIT	16	uint8	[1 1]	real	[]	[]		<input type="checkbox"/>	Auto
RESET	0	uint8	[1 1]	real	[]	[]		<input type="checkbox"/>	Auto

- 3 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Parameters** tab. In the list of available parameters, select K. Selecting a parameter displays the parameter attributes in the Property Inspector. Use the Property Inspector to modify the parameter attributes. In the **Mapped To** drop-down list, select parameter type **SharedParameter**. For more information about parameter code and calibration attributes, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.

The screenshot displays a Simulink workspace for a component named 'autosar_swc_counter'. The main workspace shows a control loop diagram with blocks for 'INC', 'sum_out', 'LIMIT', 'RESET', 'switch_out', and 'Amplifier'. A 'Property Inspector' window on the right shows the configuration for parameter 'K', with 'Mapped To' set to 'SharedParameter'. Below the workspace, the 'Code Mappings - AUTOSAR SW Component' window shows a table of parameter mappings.

Source	Mapped To
INC	ConstantMemory
K	SharedParameter
LIMIT	Auto
RESET	Auto

When you generate code:

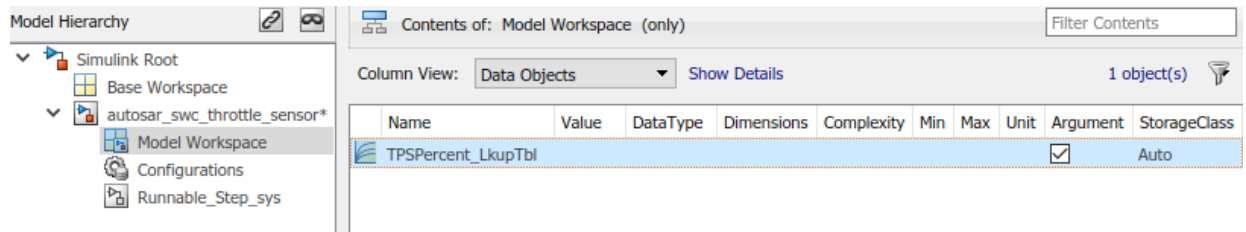
- Exported arxml files contain SHARED-PARAMETERS descriptions for parameters that you configured as SharedParameter.
- Generated C code contains Rte_CData calls where shared parameters are used.

```
autosar_swc_counter_B.Gain = Rte_CData_K() *
    Rte_IRead_Runnable_Step_RPort_InData();
```

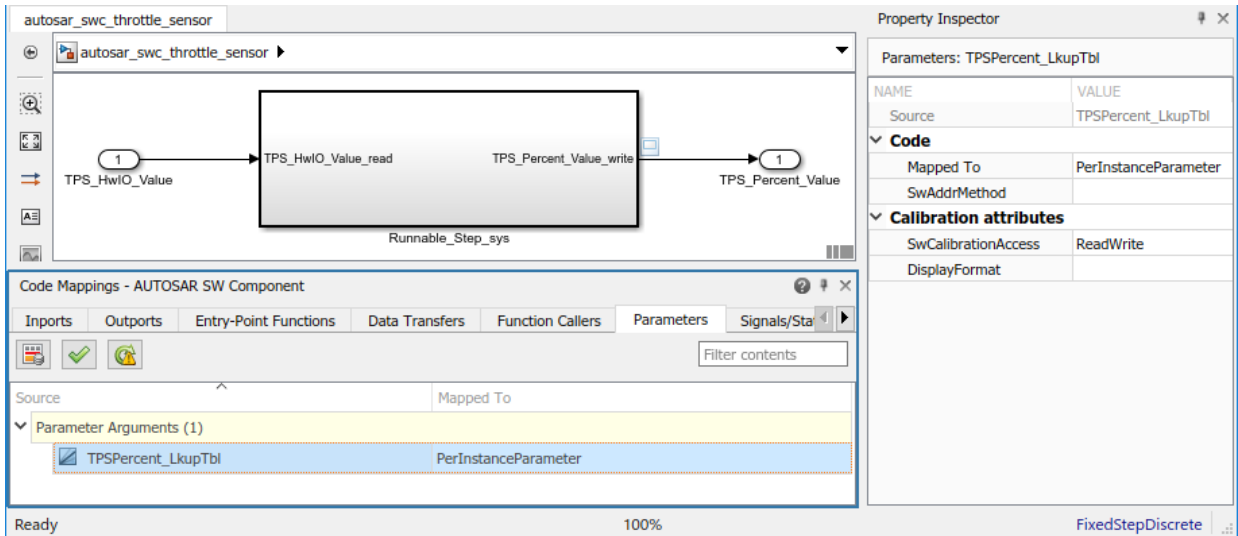
Configure Model Workspace Parameters as AUTOSAR Per-Instance Parameters

To model AUTOSAR per-instance parameters in Simulink:

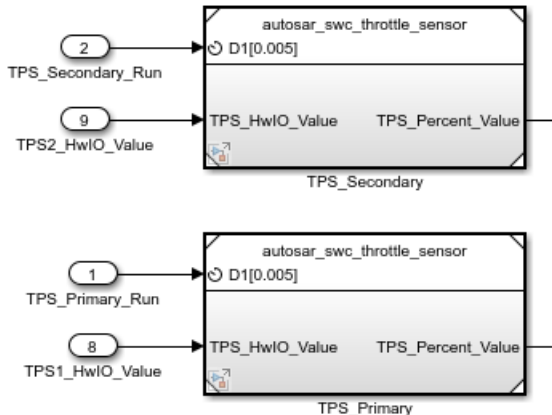
- 1 Open an AUTOSAR model that contains a model workspace parameter for which you want to generate an AUTOSAR PerInstanceParameter. This example uses model `autosar_swc_throttle_sensor`. This model is part of AUTOSAR composition model `autosar_composition`, which contains two instances of `autosar_swc_throttle_sensor`.
- 2 To model an AUTOSAR per-instance parameter in Simulink, configure a model workspace parameter that is a model argument (that is, unique to each instance of a multi-instance model). For example, in the Model Explorer view of the parameter, select the **Argument** property. In example model `autosar_swc_throttle_sensor`, select the **Argument** property for parameter `TPSPercent_LkupTbl`. Leave the parameter **StorageClass** set to Auto.



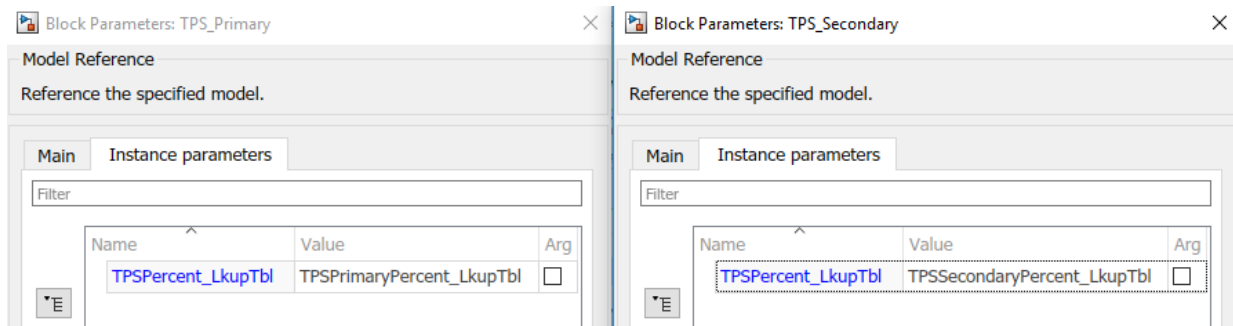
- 3 In the AUTOSAR code perspective, open the Code Mappings editor and select the **Parameters** tab. Select parameter `TPSPercent_LkupTbl`. Selecting a parameter displays the parameter attributes in the Property Inspector. Use the Property Inspector to modify the parameter attributes. In the **Mapped To** drop-down list, select parameter type `PerInstanceParameter`. For more information about parameter code and calibration attributes, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.



AUTOSAR example model `autosar_composition` is a composition model that contains several components, including two instances of component model `autosar_swc_throttle_sensor`.



If you open `autosar_composition`, you can right-click the Model blocks that represent instances of `autosar_swc_throttle_sensor`. If you open up each Model block dialog box, **Instance Parameters** tab, and view them together, notice that each Model block uses a different value for the per-instance parameter.



When you generate code:

- Exported arxml files contain PER-INSTANCE-PARAMETERS descriptions for parameters that you configured as PerInstanceParameter.
- Generated C code contains Rte_CData calls where per-instance parameters are used.

```
Rte_IWrite_Runnable_Step_TPS_Percent_Value(self, look1_iflf_linlcpw((float32)
rtb_DataTypeConversion, (Rte_CData_TPSPercent_LkupTbl(self))->BP1,
(Rte_CData_TPSPercent_LkupTbl(self))->Table, 10U));
```

See Also

[getParameter](#) | [mapParameter](#)

Related Examples

- “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74
- “Model AUTOSAR Component Behavior” on page 2-39

More About

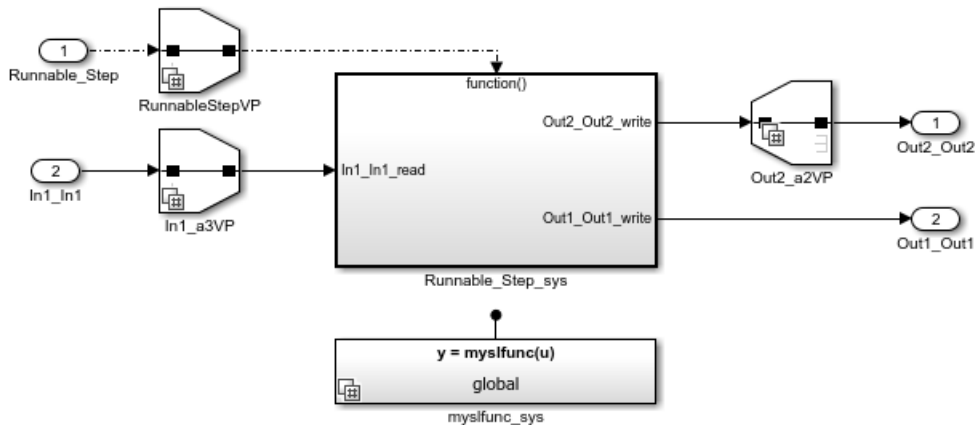
- “Shared and Per-Instance Parameters” on page 2-43

Configure Variants for AUTOSAR Ports and Runnables

AUTOSAR software components can use `VariationPoint` elements to enable or disable AUTOSAR elements, such as ports and runnables, based on defined conditions. In Simulink, to configure variants that enable or disable AUTOSAR ports and runnables:

- Use Variant Sink and Variant Source blocks to define variant condition logic and propagate variant conditions.
- Use `AUTOSAR.Parameter` data objects with storage class `SystemConstant` to model AUTOSAR system constants. The system constants represent the condition values that enable or disable ports and runnables.

For example, here is an AUTOSAR component model that contains two Variant Source blocks and a Variant Sink block. You can open the model from `matlabroot/help/toolbox/autosar/examples/mAutosarInlineVariant.slx`.

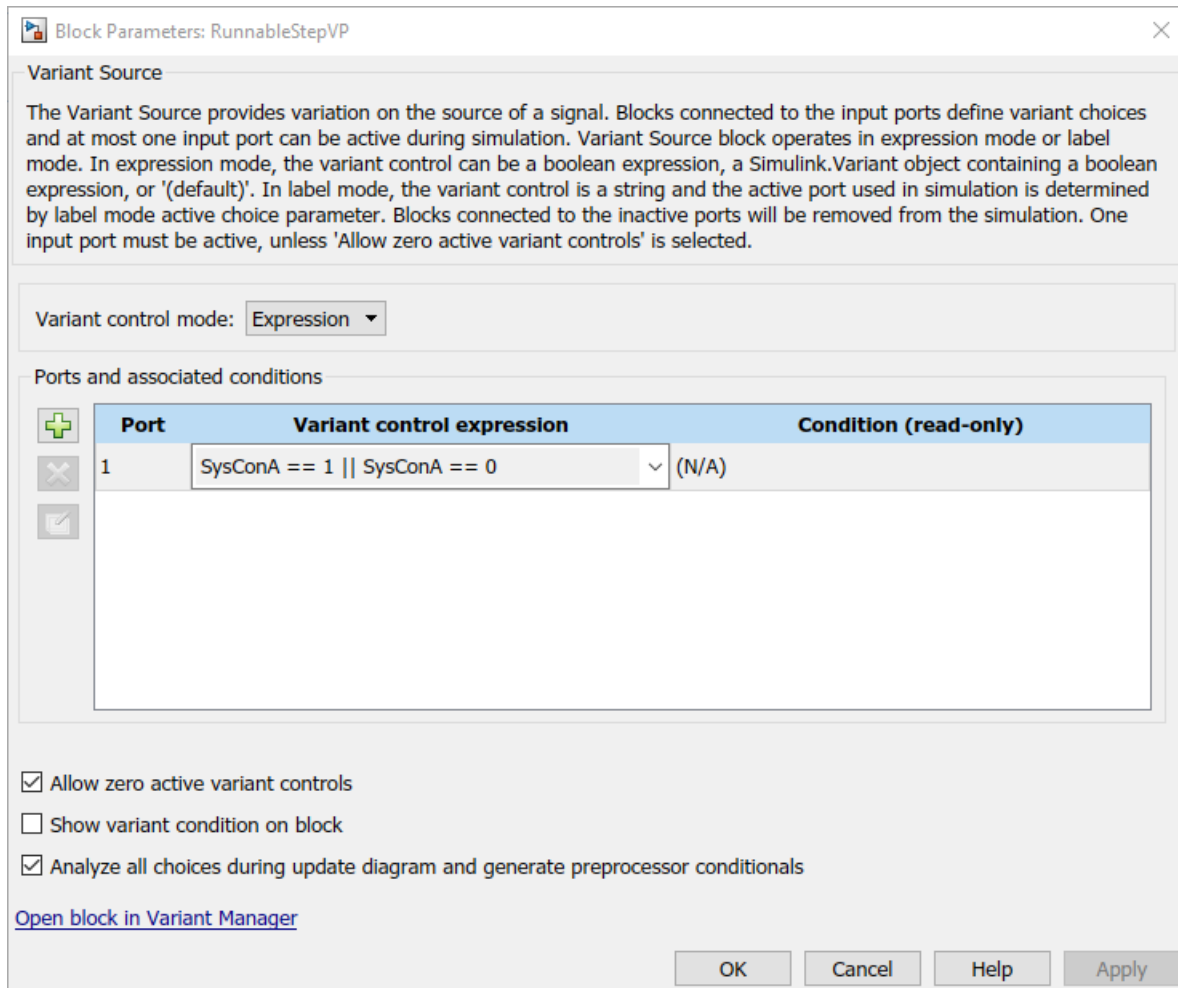


To model an AUTOSAR system constant, the model defines `AUTOSAR.Parameter` data object `SysConA`:

```
SysConA = AUTOSAR.Parameter;
SysConA.CoderInfo.StorageClass = 'Custom';
SysConA.CoderInfo.CustomStorageClass = 'SystemConstant';
SysConA.DataType = 'int32';
SysConA.Value = 1;
```

Each Variant Source or Variant Sink block defines variant condition logic, which is based on the system constant value. You can specify an expression or a `Simulink.Variant`

object containing an expression. Here is the variant condition logic for Variant Source block RunnableStepVP.



When you generate code for the model:

- The exported arxml code contains definitions for variation point proxies and variation points. In this example, the VARIATION-POINT-PROXY entry has short-name c0,

which is referenced in the generated C code. SysConA appears as a system constant representing the associated condition value.

```
<VARIATION-POINT-PROXYS>
  <VARIATION-POINT-PROXY UUID="...">
    <SHORT-NAME>c0</SHORT-NAME>
    <CATEGORY>CONDITION</CATEGORY>
    <CONDITION-ACCESS BINDING-TIME="PRE-COMPILE-TIME">
      <SYSC-REF DEST="SW-SYSTEMCONST">/mInlineVariant_pkg/mInlineVariant_dt/SystemConstants/SysConA</SYSC-REF DEST="SW-SYSTEMCONST">
      == 0 ||
      <SYSC-REF DEST="SW-SYSTEMCONST">/mInlineVariant_pkg/mInlineVariant_dt/SystemConstants/SysConA</SYSC-REF DEST="SW-SYSTEMCONST">
      == 1</CONDITION-ACCESS>
    </VARIATION-POINT-PROXY>
  </VARIATION-POINT-PROXYS>
```

VARIATION-POINT entries appear for AUTOSAR ports, runnables, and runnable accesses to external data.

```
<R-PORT-PROTOTYPE UUID="...">
  <SHORT-NAME>In1</SHORT-NAME>
  <VARIATION-POINT>
    <SHORT-LABEL>In1_a3VP</SHORT-LABEL>
    <SW-SYSCOND BINDING-TIME="PRE-COMPILE-TIME">
      <SYSC-REF DEST="SW-SYSTEMCONST">/mInlineVariant_pkg/mInlineVariant_dt/SystemConstants/SysConA</SYSC-REF DEST="SW-SYSTEMCONST">
      == 0 ||
      <SYSC-REF DEST="SW-SYSTEMCONST">/mInlineVariant_pkg/mInlineVariant_dt/SystemConstants/SysConA</SYSC-REF DEST="SW-SYSTEMCONST">
      == 1</SW-SYSCOND>
    </VARIATION-POINT>
    ...
  </R-PORT-PROTOTYPE>
```

- In the RTE compatible C code, short-name c0 is encoded in the names of preprocessor symbols used in the variant condition logic. For example:

```
#if Rte_SysCon_c0
...
#endif
```

For more information, see “Variant Systems” (Embedded Coder) and “Variant Systems” (Simulink).

See Also

AUTOSAR.Parameter | Variant Sink | Variant Source

Related Examples

- “Model AUTOSAR Variants” on page 2-45

More About

- “Variant Systems” (Embedded Coder)
- “System Constants” on page 2-41

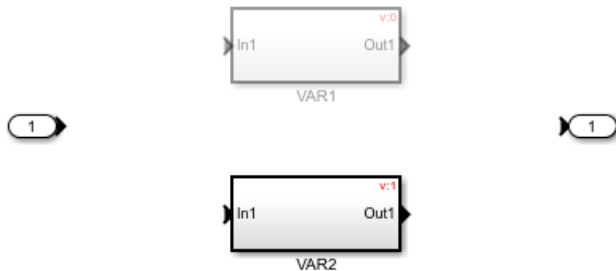
Configure Variants for AUTOSAR Runnable Implementations

To vary the implementation of an AUTOSAR runnable, AUTOSAR software components can specify variant condition logic inside a runnable. In Simulink, to model variant condition logic inside a runnable:

- To represent variant implementations of a subsystem or model and define variant condition logic, use a Variant Subsystem block.
- To model AUTOSAR system constants, use `AUTOSAR.Parameter` data objects with storage class `SystemConstant`. The system constants represent the condition values that determine the active subsystem or model implementation.

For example, here is an AUTOSAR component model that contains a Variant Subsystem block, which models two variant implementations of a subsystem. You can open the model from `matlabroot/help/toolbox/autosar/examples/mAutosarVariantSubsystem.slx`.

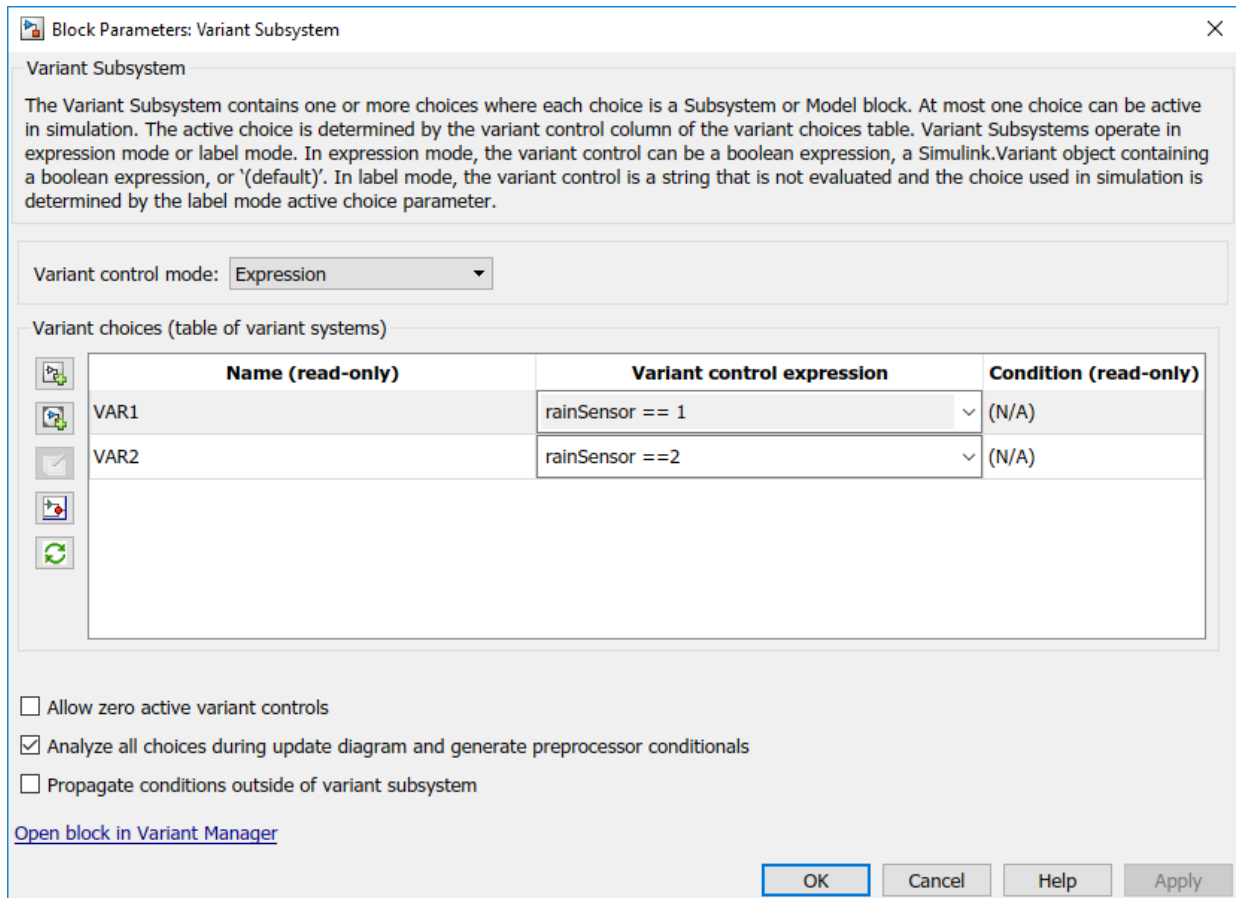
The variant choices are subsystems VAR1 and VAR2. The blocks are not connected because connectivity is determined during simulation, based on the active variant.



To model an AUTOSAR system constant, the model defines `AUTOSAR.Parameter` data object `rainSensor`:

```
rainSensor = AUTOSAR.Parameter;
rainSensor.CoderInfo.StorageClass = 'Custom';
rainSensor.CoderInfo.CustomStorageClass = 'SystemConstant';
rainSensor.DataType = 'uint8';
rainSensor.Value = 2;
```

The Variant Subsystem block dialog box defines the variant condition logic, which is based on the system constant value. You can specify an expression or a Simulink.Variant object containing an expression.



When you generate code for the model:

- In the arxml code, the variant choices appear as VARIATION-POINT-PROXY entries with short-names c0 and c1. rainSensor appears as a system constant representing the associated condition value. For example:

```
<VARIATION-POINT-PROXYS>
  <VARIATION-POINT-PROXY UUID="...">
    <SHORT-NAME>c0</SHORT-NAME>
```

```

<CATEGORY>CONDITION</CATEGORY>
<CONDITION-ACCESS BINDING-TIME="PRE-COMPILE-TIME">
  <SYSC-REF DEST="SW-SYSTEMCONST">/vss_pkg/vss_dt/SystemConstants/rainSensor</SYSC-REF>
  == 1</CONDITION-ACCESS>
</VARIATION-POINT-PROXY>
<VARIATION-POINT-PROXY UUID="...">
  <SHORT-NAME>c1</SHORT-NAME>
  <CATEGORY>CONDITION</CATEGORY>
  <CONDITION-ACCESS BINDING-TIME="PRE-COMPILE-TIME">
    <SYSC-REF DEST="SW-SYSTEMCONST">/vss_pkg/vss_dt/SystemConstants/rainSensor</SYSC-REF>
    == 2</CONDITION-ACCESS>
  </VARIATION-POINT-PROXY>
</VARIATION-POINT-PROXYS>

```

- In the RTE compatible C code, short-names c0 and c1 are encoded in the names of preprocessor symbols used in the variant condition logic. For example:

```

#if Rte_SysCon_c0
...
#elif Rte_SysCon_c1
...
#endif

```

See Also

AUTOSAR.Parameter | Variant Subsystem

Related Examples

- “Model AUTOSAR Variants” on page 2-45

More About

- “System Constants” on page 2-41

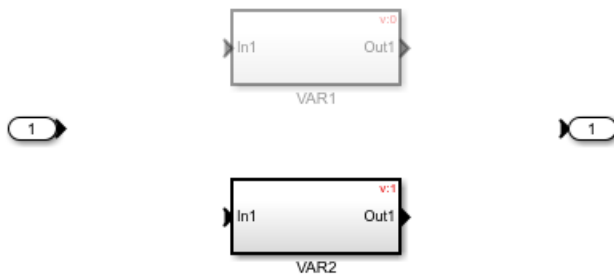
Export Variation Points for AUTOSAR Calibration Data

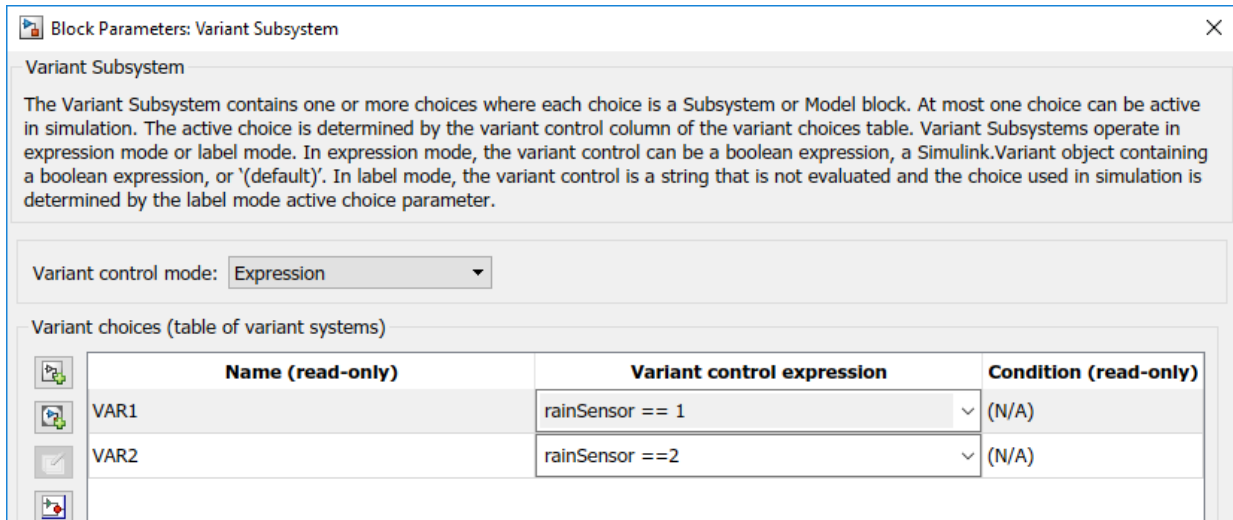
You can export variation points for AUTOSAR calibration data, including:

- Parameters — Calibration, shared internal, instance-specific, or constant memory
- Per-instance memory — C- typed or AR-typed
- Inter-runnable variables (IRVs) — Implicit or explicit

You can model calibration data in combination with different types of variant conditions. Model the variant conditions by using Variant Source and Variant Sink blocks, Variant Subsystem blocks, or model reference variants. When you build your model, the exported AUTOSAR XML (`arxml`) files contain the conditionally used data elements and their variation points.

For example, suppose that you open an AUTOSAR component model containing a Variant Subsystem block, which models two variant implementations of a subsystem, VAR1 and VAR2.





In VAR1, which is enabled when `rainSensor == 1`, you define a parameter named `scale` and reference it in a block. When you build the model, the exported `arxml` contains a variation point description for the parameter. In the variation point `SHORT-LABEL`, the parameter name is prefixed with `vp`. In this example, the description indicates that the `scale` parameter is used when variant condition `rainSensor == 1` is true.

```
<VARIATION-POINT>
  <SHORT-LABEL>vpscale</SHORT-LABEL>
  <SW-SYSCOND BINDING-TIME="PRE-COMPILE-TIME"><SYSC-REF DEST="SW-SYSTEMCONST">
    /vss_pkg/vss_dt/SystemConstants/rainSensor</SYSC-REF> == 1</SW-SYSCOND>
</VARIATION-POINT>
```

See Also

Variant Sink | Variant Source | Variant Subsystem

Related Examples

- “Configure Variants for AUTOSAR Ports and Runnables” on page 4-265
- “Configure Variants for AUTOSAR Runnable Implementations” on page 4-269

More About

- “Model AUTOSAR Variants” on page 2-45

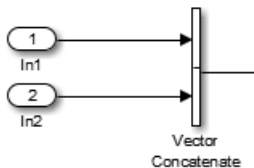
Configure Variants for AUTOSAR Array Sizes

AUTOSAR software components can flexibly specify the dimensions of an AUTOSAR element, such as a port, by using a symbolic reference to a system constant. The system constant defines the array size of the port data type. To model AUTOSAR elements with variant array sizes in Simulink:

- Create blocks that represent AUTOSAR elements.
- To represent array size values, add `AUTOSAR.Parameter` data objects with storage class `SystemConstant`.
- To specify array size for an AUTOSAR element, reference an `AUTOSAR.Parameter` data object.

With variant array sizes, you can modify array size values in system constants between model simulations, without regenerating code for simulation. When you build the model, the generated C and arxml code contains symbols corresponding to variant array sizes.

Suppose that you create a Simulink inport `In1` to represent an AUTOSAR receiver port with a variant array size.



To model the AUTOSAR system constant that specifies the dimensions of `In1`, create an `AUTOSAR.Parameter` data object, `SymDimA`, with storage class `SystemConstant`.

```
SymDimA = AUTOSAR.Parameter;
SymDimA.CoderInfo.StorageClass = 'custom';
SymDimA.CoderInfo.CustomStorageClass = 'SystemConstant';
SymDimA.DataType = 'uint8';
SymDimA.Value = 5;
```

In the dialog box for inport block `In1`, enter the parameter name, `SymDimA`, in the **Port dimensions** field.

Port dimensions (-1 for inherited):

When you generate code for the model, the name of the system constant, `SymDimA`, appears in C and arxml code to represent the variant array size.

Example 4.3. Generated C Code

```
/* SignalConversion: '<Root>/ConcatBufferAtVector ConcatenateIn1' */  
for (i = 0; i < Rte_SysCon_SymDimA; i++) {  
    rtb_VectorConcatenate[i] = tmp[i];  
}
```

Example 4.4. Exported arxml Code

```
<MAX-NUMBER-OF-ELEMENTS BINDING-TIME="PRE-COMPILE-TIME">  
    <SYSC-REF DEST="SW-SYSTEMCONST"/>pkg/dt/SC/SymDimA</SYSC-REF>  
</MAX-NUMBER-OF-ELEMENTS>
```

See Also

AUTOSAR.Parameter

Related Examples

- “Implement Dimension Variants for Array Sizes in Generated Code” (Embedded Coder)
- “Model AUTOSAR Variants” on page 2-45

More About

- “System Constants” on page 2-41

Control AUTOSAR Variants with Predefined Value Combinations

To define the values that control variation points in an AUTOSAR software component, components use the following AUTOSAR elements:

- `SwSystemconst` — Defines a system constant that serves as an input to control a variation point.
- `SwSystemconstantValueSet` — Specifies a set of system constant values to apply to an AUTOSAR software component.
- `PredefinedVariant` — Describes a combination of system constant values, among potentially multiple valid combinations, to apply to an AUTOSAR software component.

For example, in arxml code, you can define `SwSystemconsts` for automobile features, such as `Transmission`, `Headlight`, `Sunroof`, and `Turbocharge`. Then a `PredefinedVariant` can map feature combinations to automobile model variants, such as `Basic`, `Economy`, `Senior`, `Sportive`, and `Junior`.

Suppose that you have an arxml specification of an AUTOSAR software component. If the arxml files also define a `PredefinedVariant` or `SwSystemconstantValueSets` for controlling variation points in the component, you can resolve the variation points at model creation time. Specify a `PredefinedVariant` or `SwSystemconstantValueSets` with which the importer can initialize `SwSystemconst` data.

Typical steps include:

- 1 Get a list of the `PredefinedVariants` or `SwSystemconstantValueSets` defined in the arxml file.

```
>> obj = arxml.importer('mySWC.arxml');
>> find(obj, '/', 'PredefinedVariant', 'PathType', 'FullyQualified');
ans =
    '/pkg/body/Variants/Basic'
    '/pkg/body/Variants/Economy'
    '/pkg/body/Variants/Senior'
    '/pkg/body/Variants/Sportive'
    '/pkg/body/Variants/Junior'

>> obj = arxml.importer('mySWC.arxml');
>> find(obj, '/', 'SystemConstValueSet', 'PathType', 'FullyQualified')
ans =
    '/pkg/body/SystemConstantValues/A'
    '/pkg/body/SystemConstantValues/B'
    '/pkg/body/SystemConstantValues/C'
    '/pkg/body/SystemConstantValues/D'
```

- 2 Create a model from the arxml file, and specify a `PredefinedVariant` or one or more `SwSystemconstantValueSets`.

This example specifies `PredefinedVariant Senior`, which describes a combination of values for `Transmission`, `Headlight`, `Sunroof`, and `Turbocharge`.

```
>> createComponentAsModel(obj,compNames{1},'ModelPeriodicRunnablesAs','AtomicSubsystem',...  
    'PredefinedVariant','/pkg/body/Variants/Senior');
```

This example specifies `SwSystemconstantValueSets A` and `B`, which together provide values for `SwSystemconst`s in the AUTOSAR software component.

```
>> createComponentAsModel(obj,compNames{1},'ModelPeriodicRunnablesAs','AtomicSubsystem',...  
    'SystemConstValueSets',{'/pkg/body/SystemConstantValues/A','/pkg/body/SystemConstantValues/B'});
```

- 3 During model creation, the arxml importer creates `AUTOSAR.Parameter` data objects, with **Storage class** set to `SystemConstant`. The importer initializes the system constant data with values based on the specified `PredefinedVariant` or `SwSystemconstantValueSets`.

After model creation, you can run simulations and generate code based on the combination of variation point input values that you specified.

In Simulink, you can redefine the `SwSystemconst` data that controls variation points without recreating the model. Call the AUTOSAR property function `createSystemConstants`, and specify a different imported `PredefinedVariant` or a different cell array of `SwSystemconstantValueSets`. The function creates a set of system constant data objects with the same names as the original objects. You can run simulations and generate code based on the revised combination of variation point input values.

This example creates a set of system constant data objects with names and values based on imported `PredefinedVariant '/pkg/body/Variants/Economy'`.

```
arProps = autosar.api.getAUTOSARProperties(hModel);  
createSystemConstants(arProps,'/pkg/body/Variants/Economy');
```

Building the model exports previously imported `PredefinedVariants` and `SwSystemconstantValueSets` to arxml code.

See Also

Related Examples

- “Model AUTOSAR Variants” on page 2-45
- “Configure Variants for AUTOSAR Ports and Runnables” on page 4-265

More About

- “System Constants” on page 2-41

Configure Parameters and Signals for AUTOSAR Calibration and Measurement

Configure Simulink® model workspace parameters and signals for AUTOSAR run-time calibration and measurement.

Map Model Workspace Parameters to AUTOSAR Parameters

Open the example model `autosar_sw_counter.slx`.

```
open_system('autosar_sw_counter')
```

From the **Apps** tab, open the AUTOSAR Component Designer app. Open the Code Mappings editor and the Property Inspector. In the Code Mappings editor, select the **Parameters** tab. Expand the list of available model parameters and select **INC**. In the **Mapped To** drop-down list, select **ConstantMemory**.

Selecting a parameter displays the parameter attributes in the Property Inspector. Use the Property Inspector to modify the parameter attributes. For more information about parameter code and calibration attributes, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.

This model maps Simulink model workspace parameters and signals to AUTOSAR parameters and variables for AUTOSAR run-time calibration and measurement.

Property Inspector: Parameters: INC

NAME	VALUE
Source	INC
Description	
<input type="checkbox"/> Argument	
> Design	
Code	
Mapped To	ConstantMemory
Const	true
Volatile	false
AdditionalNativeTypeQualifier	my_qualifier
SwAddrMethod	VAR
Calibration attributes	
SwCalibrationAccess	ReadWrite
DisplayFormat	

Code Mappings - AUTOSAR SW Component

Source	Mapped To
Model Parameter Arguments (0)	
Model Parameters (4)	
INC	ConstantMemory
K	SharedParameter
LIMIT	Auto
RESET	Auto

If you have Simulink Coder and Embedded Coder software, you can generate algorithmic C code and AUTOSAR XML (arxml) component descriptions. You can test the generated code in Simulink or integrate the code and descriptions into an AUTOSAR run-time environment.

When you generate code:

- Exported arxml files contain CONSTANT-MEMORYS descriptions for parameters that you configured as ConstantMemory. In the AUTOSAR run-time environment, calibration tools can access AUTOSAR ConstantMemory blocks for measurement and calibration.
- Generated C code declares and references the constant memory parameters.

Map Simulink Signals and States to AUTOSAR Variables

Open the example model `autosar_sw_counter.slx`, if it is not already open.

From the **Apps** tab, open the AUTOSAR Component Designer app. Open the Code Mappings editor and the Property Inspector. In the Code Mappings editor, select the **Signals** tab. Expand the list of available signals and select `equal_to_count`. In the **Mapped To** drop-down list, select `StaticMemory`.

Selecting a signal highlights the signal in the model diagram and displays the signal attributes in the Property Inspector. Use the Property Inspector to modify the signal attributes. For more information about signal code and calibration attributes, see “Map Block Signals and States to AUTOSAR Variables” on page 4-80.

The screenshot displays the Simulink model workspace for 'autosar_sw_counter'. The model includes blocks for 'INC', a summing junction, 'LIMIT', 'RESET', 'switch_out', and 'Amplifier'. A signal named 'equal_to_count' is highlighted in pink, connecting the summing junction to the 'RESET' block. A text box at the bottom of the model workspace states: "This model maps Simulink model workspace parameters and signals to AUTOSAR parameters and variables for AUTOSAR run-time calibration and measurement."

The Property Inspector on the right shows the configuration for the 'equal_to_count' signal. The 'Design' tab is active, and the 'Code' section is expanded, showing the 'Mapped To' field set to 'StaticMemory'. The 'Calibration attributes' section is also visible.

The Code Mappings - AUTOSAR SW Component window at the bottom shows the 'Signals/States' tab. It lists three signals: 'equal_to_count' (mapped to 'StaticMemory'), 'sum_out' (mapped to 'ArTypedPerInstanceMemory'), and 'switch_out' (mapped to 'Auto').

NAME	VALUE
Source	equal_to_count

Design	
Code	
Mapped To	StaticMemory
Path	autosar_sw_cou...
ShortName	SM_equal_to_count
Volatile	true
AdditionalNativeTypeQualifier	my_qualifier
SwAddrMethod	VAR
Calibration attributes	
SwCalibrationAccess	ReadOnly
DisplayFormat	

Source	Mapped To	Path
equal_to_count	StaticMemory	autosar_sw_counter
sum_out	ArTypedPerInstanceMemory	autosar_sw_counter
switch_out	Auto	autosar_sw_counter

If you have Simulink Coder and Embedded Coder software, you can generate algorithmic C code and AUTOSAR XML (a.xml) component descriptions. You can test the generated code in Simulink or integrate the code and descriptions into an AUTOSAR run-time environment.

When you generate code:

- Exported a.xml files contain `STATIC-MEMORYS` descriptions for signals and states that you configured as `StaticMemory`. In the AUTOSAR run-time environment, calibration tools can access AUTOSAR `StaticMemory` blocks for measurement and calibration.
- Generated C code declares and references the static memory variables.

Related Links

- “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74
- “Configure AUTOSAR Constant Memory” on page 4-256
- “Map Block Signals and States to AUTOSAR Variables” on page 4-80
- “Configure AUTOSAR Static Memory” on page 4-251
- “Configure AUTOSAR Per-Instance Memory” on page 4-246

Configure AUTOSAR Data for Measurement and Calibration

In Simulink, you can import and export AUTOSAR software data definition properties and modify the properties for some forms of AUTOSAR data.

In this section...
“About Software Data Definition Properties (SwDataDefProps)” on page 4-284
“Configure SwCalibrationAccess” on page 4-285
“Configure DisplayFormat” on page 4-287
“Configure SwAddrMethod” on page 4-291
“Configure SwAlignment” on page 4-295
“Export SwImplPolicy” on page 4-295
“Export SwRecordLayout for Lookup Table Data” on page 4-296

About Software Data Definition Properties (SwDataDefProps)

Embedded Coder supports arxml import and export of the following AUTOSAR software data definition properties (SwDataDefProps):

- Software calibration access (SwCalibrationAccess) — Specifies measurement and calibration tool access to a data object.
- Display format (DisplayFormat) — Specifies measurement and calibration display format for a data object.
- Software address method (SwAddrMethod) — Specifies a method to access a data object (for example, a measurement or calibration parameter) according to a given address. Used to group data in memory for access by run-time measurement and calibration tools.
- Software alignment (SwAlignment) — Specifies the intended alignment of a data object within a memory section.
- Software implementation policy (SwImplPolicy) — Specifies the implementation policy for a data object, regarding consistency mechanisms of variables.
- Software record layout (SwRecordLayout) — Specifies how to serialize data in the memory of an AUTOSAR ECU.

In the Simulink environment, you can directly modify software data definition properties for some forms of AUTOSAR data. You cannot modify the `SwImplPolicy` or `SwRecordLayout` properties, but the properties are exported in `arxml` code.

For more information, see “Configure `SwCalibrationAccess`” on page 4-285, “Configure `DisplayFormat`” on page 4-287, “Configure `SwAddrMethod`” on page 4-291, “Configure `SwAlignment`” on page 4-295, “Export `SwImplPolicy`” on page 4-295, and “Export `SwRecordLayout` for Lookup Table Data” on page 4-296.

Configure `SwCalibrationAccess`

You can specify the `SwCalibrationAccess` property for measurement variables, calibration parameters, and signal and parameter data objects. The valid values are:

- `ReadOnly` — Data element appears in the generated description file with read access only.
- `ReadWrite` — Data element appears in the generated description file with both read and write access.
- `NotAccessible` — Data element does not appear in the generated description file and is not accessible with measurement and calibration tools.

If you open a model with signals and parameters, you can specify the `SwCalibrationAccess` property in the following ways:

- “Specify `SwCalibrationAccess` for AUTOSAR Data Elements” on page 4-285
- “Specify Default `SwCalibrationAccess` for Application Data Types” on page 4-287

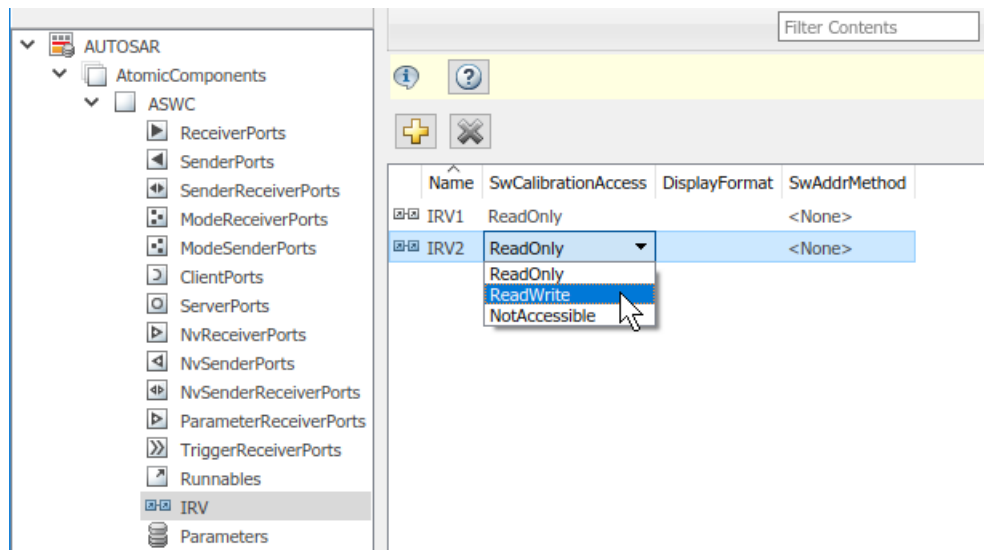
Specify `SwCalibrationAccess` for AUTOSAR Data Elements

You can use either the AUTOSAR Dictionary or MATLAB function calls to specify the `SwCalibrationAccess` property for the following AUTOSAR data elements:

- Sender-receiver interface data elements
- Nonvolatile interface data elements
- Client-server arguments
- Inter-runnable variables

For example:

- 1 Open a model that is configured for AUTOSAR.
- 2 Open the AUTOSAR Dictionary. Navigate to one of the following views:
 - S-R or NV interface, **DataElements** view
 - C-S interface, **Arguments** view
 - Atomic component, **IRV** view
- 3 Use the **SwCalibrationAccess** drop-down list to select the level of measurement and calibration tool access to allow for the data element.



Alternatively, you can use the AUTOSAR property functions to specify the `SwCalibrationAccess` property for AUTOSAR data elements. For example, the following code opens the `autosar_swc_fcncalls` example model and sets measurement and calibration access to inter-runnable variable IRV2 to `ReadWrite`.

```
hModel = 'autosar_swc_fcncalls';
open_system(hModel)
arProps = autosar.api.getAUTOSARProperties(hModel);
get(arProps, '/Company/Powertrain/Components/ASWC/ASWC_IB/IRV2', 'SwCalibrationAccess')

set(arProps, '/Company/Powertrain/Components/ASWC/ASWC_IB/IRV2', 'SwCalibrationAccess', 'ReadWrite');
get(arProps, '/Company/Powertrain/Components/ASWC/ASWC_IB/IRV2', 'SwCalibrationAccess')

ans =
    'ReadOnly'
```

```
ans =
    'ReadWrite'
```

Here is a sample call to the AUTOSAR properties `set` function to set `SwCalibrationAccess` for an S-R interface data element in the same model.

```
set(arProps, '/Company/Powertrain/Interfaces/InIf/In1', 'SwCalibrationAccess', 'ReadWrite');
get(arProps, '/Company/Powertrain/Interfaces/InIf/In1', 'SwCalibrationAccess')
```

```
ans =
    'ReadWrite'
```

Specify Default `SwCalibrationAccess` for Application Data Types

The AUTOSAR XML options include **`SwCalibrationAccess DefaultValue`** (property `SwCalibrationAccessDefault`), which defines the default `SwCalibrationAccess` value for AUTOSAR application data types in your model. You can use the AUTOSAR property functions to modify the default. For example, the following code opens the `autosar_swc_fcncalls` example model and changes the default measurement and calibration access for AUTOSAR application data types from `ReadOnly` to `ReadWrite`.

```
hModel = 'autosar_swc_fcncalls';
open_system(hModel)
arProps = autosar.api.getAUTOSARProperties(hModel);
get(arProps, 'XmlOptions', 'SwCalibrationAccessDefault')

set(arProps, 'XmlOptions', 'SwCalibrationAccessDefault', 'ReadWrite');
get(arProps, 'XmlOptions', 'SwCalibrationAccessDefault')

ans =
    'ReadOnly'

ans =
    'ReadWrite'
```

Configure DisplayFormat

AUTOSAR display format specifications control the width and precision display for measurement and calibration data. You can import and export AUTOSAR display format specifications, and edit the specifications in Simulink. You can specify display format for the following AUTOSAR elements:

- Inter-runnable variables
- Sender-receiver interface data elements
- Client-server interface operation arguments
- `CompuMethods`

The display format specification is a subset of ANSI C printf specifiers, with the following form:

`%[flags][width][.precision]type`

Field	Description
flags (optional)	Characters specifying flags supported by AUTOSAR schemas: <ul style="list-style-type: none"> • (' '): Insert a space before the value. • -: Left-justify. • +: Display plus or minus sign, even for positive numbers. • #: <ul style="list-style-type: none"> • For types o, x, and X, display 0, 0x, or 0X prefix. • For types e, E, and f, display decimal point even if the precision is 0. • For types g and G, do not remove trailing zeros or decimal point.
width (optional)	Positive integer specifying the minimum number of characters to display.
precision (optional)	Positive integer specifying the precision to display: <ul style="list-style-type: none"> • For integer type values (d, i, o, u, x, and X), specifies the minimum number of digits. • For types e, E, and f, specifies the number of digits to the right of the decimal point. • For types g and G, specifies the number of significant digits.

Field	Description
type	<p>Characters specifying a numeric conversion type supported by AUTOSAR schemas:</p> <ul style="list-style-type: none"> • d: Signed decimal integer. • i: Signed decimal integer. • o: Unsigned octal integer. • u: Unsigned decimal integer. • x: Unsigned hexadecimal integer, using characters "abcdef". • X: Unsigned hexadecimal integer, using characters "ABCDEF". • e: Signed floating-point value in exponential notation. The value has the form [-]d.dddd e [sign]ddd. <ul style="list-style-type: none"> • d is a single decimal digit. • dddd is one or more decimal digits. • ddd is exactly three decimal digits. • sign is + or -. • E: Identical to the e format except that E, rather than e, introduces the exponent. • f: Signed floating-point value in fixed-point notation. The value has the form [-]dddd.dddd. <ul style="list-style-type: none"> • dddd is one or more decimal digits. • The number of digits before the decimal point depends on the magnitude of the number. • The number of digits after the decimal point depends on the requested precision. • g: Signed value printed in f or e format, whichever is more compact for the given value and precision. Trailing zeros are truncated, and the decimal point appears only if one or more digits follow it. • G: Identical to the g format, except that E, rather than e, introduces the exponent (where required).

For example, the format specifier `%2.1d` specifies width 2, precision 1, and type signed decimal, producing a displayed value such as 12.2.

The **DisplayFormat** attribute appears in dialog boxes for AUTOSAR elements to which it applies. You can specify display format in a dialog box or with an element API that can modify attributes.

```
hModel = 'autosar_sw_counter';
open_system(hModel);
slMap = autosar.api.getSimulinkMapping(hModel);
mapParameter(slMap, 'INC', 'ConstantMemory', 'DisplayFormat', '%2.6f')
```

The screenshot displays the Simulink environment for the 'autosar_sw_counter' component. The main workspace shows a block diagram with an 'INC' block, a summing junction, a 'LIMIT' block, an 'equal_to_count' block, a 'RESET' block, a switch, and an 'Amplifier' block. The 'Property Inspector' on the right shows the configuration for the 'INC' parameter, including its source, code attributes, and calibration attributes.

Parameters: INC	
NAME	VALUE
Source	INC
Code	
Mapped To	ConstantMemory
Const	false
Volatile	false
AdditionalNativeTypeQualifier	
SwAddrMethod	
Calibration attributes	
SwCalibrationAccess	ReadWrite
DisplayFormat	%2.6f

Below the diagram, the 'Code Mappings - AUTOSAR SW Component' window shows the 'Parameters' tab with the following table:

Source	Mapped To
INC	ConstantMemory
K	SharedParameter
LIMIT	Auto
RESET	Auto

If you specify a display format, exporting a rxml code generates a corresponding DISPLAY-FORMAT specification.

```
<PARAMETER-DATA-PROTOTYPE UUID="...">
  <SHORT-NAME>INC</SHORT-NAME>
  <CATEGORY>VALUE</CATEGORY>
  <SW-DATA-DEF-PROPS>
    <SW-DATA-DEF-PROPS-VARIANTS>
      <SW-DATA-DEF-PROPS-CONDITIONAL>
        <SW-CALIBRATION-ACCESS>READ-WRITE</SW-CALIBRATION-ACCESS>
        <DISPLAY-FORMAT>%2.6f</DISPLAY-FORMAT>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
</PARAMETER-DATA-PROTOTYPE>
```



```

        <SW-IMPL-POLICY>STANDARD</SW-IMPL-POLICY>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
  ...
</PARAMETER-DATA-PROTOTYPE>


```

Configure SwAddrMethod

AUTOSAR software components use software address methods (`SwAddrMethods`) to group data and functions into memory sections for access by run-time measurement and calibration tools. For a Simulink model mapped to an AUTOSAR software component, you can associate `SwAddrMethods` with these elements:

- Model parameter mapped to AUTOSAR constant memory
- Model parameter mapped to AUTOSAR internal calibration parameter
- Signal, state, or data store mapped to AUTOSAR static memory
- Signal, state, or data store mapped to AUTOSAR per-instance memory
- Model entry-point function mapped to AUTOSAR runnable
- Internal data inside a model entry-point function

To create and use `SwAddrMethods` in an AUTOSAR model:

- 1 Import `SwAddrMethods` from `arxml` files or create `SwAddrMethods` in Simulink.
 - To import `SwAddrMethods` from `arxml` files, use an `arxml.importer` function – `createComponentAsModel` or `createCompositionAsModel` for a new model, or `updateModel` or `updateAUTOSARProperties` for an existing model.
 - To create `SwAddrMethods` in an existing model, open the AUTOSAR Dictionary, `SwAddrMethods` view, and click the **Add** button . Alternatively, use equivalent AUTOSAR property functions. For more information, see “Create `SwAddrMethods` in Simulink” on page 4-292.
- 2 Associate `SwAddrMethods` with model data and functions. Open the Code Mappings editor and select the **Parameters**, **Data Stores**, **Signals/States**, or **Functions** tab. Select an element within that tab and use the Property Inspector to set the **SwAddrMethod** attribute. Alternatively, use the equivalent AUTOSAR map function. For more information, see “Associate `SwAddrMethod` with Model Data or Function” on page 4-294.

- 3 Generate code for your AUTOSAR model. (This example uses a signal mapped to AUTOSAR static memory in the model `autosar_swc_counter`.) In the generated files:

- Exported arxml files contain `SwAddrMethod` descriptions and references.

```
<VARIABLE-DATA-PROTOTYPE UUID="...">
  <SHORT-NAME>SM_equal_to_count</SHORT-NAME>
  <CATEGORY>VALUE</CATEGORY>
  <SW-DATA-DEF-PROPS>
    <SW-DATA-DEF-PROPS-VARIANTS>
      <SW-DATA-DEF-PROPS-CONDITIONAL>
        <SW-ADDR-METHOD-REF DEST="SW-ADDR-METHOD">
          /Company/Powertrain/DataTypes/SwAddrMethods/VAR
        </SW-ADDR-METHOD-REF>
        <SW-CALIBRATION-ACCESS>READ-ONLY</SW-CALIBRATION-ACCESS>
        <SW-IMPL-POLICY>STANDARD</SW-IMPL-POLICY>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
  <TYPE-TREF DEST="IMPLEMENTATION-DATA-TYPE">
    /Company/Powertrain/DataTypes/Boolean_volatile_my_qualifier</TYPE-TREF>
</VARIABLE-DATA-PROTOTYPE>
```

- AUTOSAR-compliant C code contains comments and `#define` and `#include` statements that provide a wrapper around data or function definitions belonging to each `SwAddrMethod` memory section.

```
/* Static Memory for Internal Data */


/* SwAddrMethod VAR for Internal Data */
#define autosar_swc_counter_START_SEC_VAR
#include "autosar_swc_counter_MemMap.h"

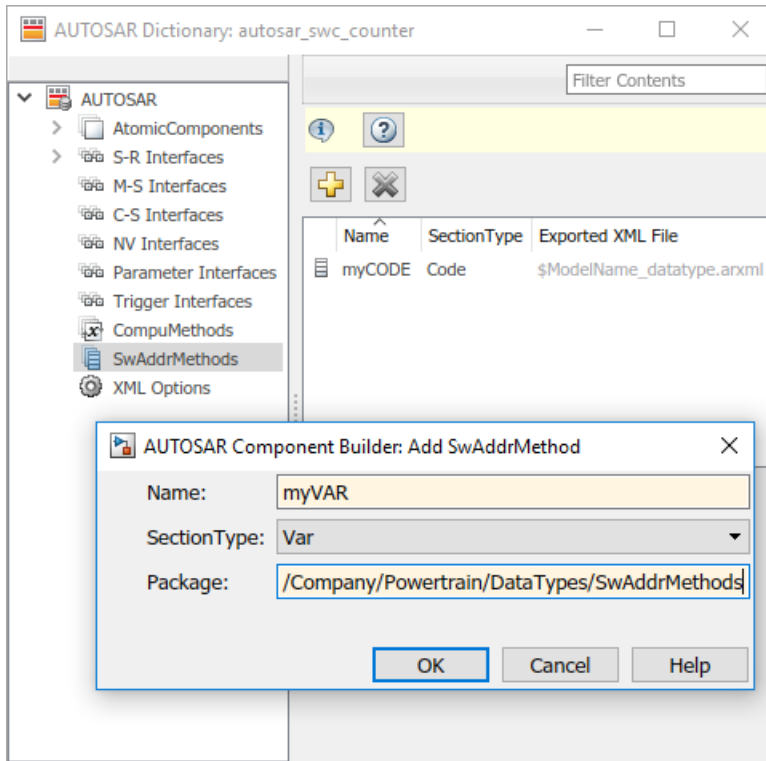
volatile my_qualifier boolean SM_equal_to_count;

#define autosar_swc_counter_STOP_SEC_VAR
#include "autosar_swc_counter_MemMap.h"
```

- “Create `SwAddrMethods` in Simulink” on page 4-292
- “Associate `SwAddrMethod` with Model Data or Function” on page 4-294

Create `SwAddrMethods` in Simulink

To create `SwAddrMethods` in an existing model, open the AUTOSAR Dictionary, `SwAddrMethods` view, and click the **Add** button .



Alternatively, use equivalent AUTOSAR property functions. This code adds SwAddrMethods myCODE and myVAR to an AUTOSAR component model.

```
hModel = 'autosar_sw_counter';
open_system(hModel)
arProps = autosar.api.getAUTOSARProperties(hModel);
addPackageableElement(arProps, 'SwAddrMethod', ...
    '/Company/Powertrain/DataTypes/SwAddrMethods', 'myCODE', ...
    'SectionType', 'Code')
swAddrPaths = find(arProps, [], 'SwAddrMethod', 'PathType', 'FullyQualified', ...
    'SectionType', 'Code')
addPackageableElement(arProps, 'SwAddrMethod', ...
    '/Company/Powertrain/DataTypes/SwAddrMethods', 'myVAR', ...
    'SectionType', 'Var')
swAddrPaths = find(arProps, [], 'SwAddrMethod', 'PathType', 'FullyQualified', ...
    'SectionType', 'Var')

swAddrPaths =
    {'/Company/Powertrain/DataTypes/SwAddrMethods/CODE'}
    {'/Company/Powertrain/DataTypes/SwAddrMethods/myCODE'}
```

```
swAddrPaths =
    {'/Company/Powertrain/DataTypes/SwAddrMethods/VAR'}
    {'/Company/Powertrain/DataTypes/SwAddrMethods/myVAR'}
```

Associate SwAddrMethod with Model Data or Function

To associate SwAddrMethods with model data and functions, open the Code Mappings editor and select the **Parameters, Data Stores, Signals/States, or Functions** tab. Select an element within that tab and use the Property Inspector to set the **SwAddrMethod** attribute. In this example, SwAddrMethod VAR is selected for signal `equal_to_count`, which is mapped to AUTOSAR static memory.

The screenshot displays the MATLAB/Simulink environment. The main window shows a Simulink model named 'mAutosarCounter'. The model contains several blocks: an 'INC' block, a summing junction labeled 'sum_out', a 'LIMIT' block, a 'RESET' block, a 'switch_out' block, and an 'Amplifier' block. A signal labeled 'equal_to_count' is shown connecting the 'LIMIT' block to the 'RESET' block. A text box at the bottom of the model area states: "This model generates AUTOSAR compliant code and software component XML files." Below the model is the 'Code Mappings - AUTOSAR' editor, which has tabs for Outports, Entry-Point Functions, Data Transfers, Function Callers, Lookup Tables, Parameters, and Signals. The 'Signals' tab is active, showing a table with the following data:

Source	Name	Mapped To	Path
RelOpt	equal_to_count	StaticMemory	mAutosarCounter
Sum	sum_out	ArTypedPerInstanceMemory	mAutosarCounter
Switch	switch_out	Auto	mAutosarCounter

The 'Property Inspector' on the right side of the window shows the properties for the selected signal 'equal_to_count'. The 'SwAddrMethod' attribute is set to 'VAR'. The 'Calibration attributes' section is expanded, showing 'VAR' selected in a dropdown menu.

Alternatively, use the equivalent AUTOSAR map function. For more information, see the reference page for `mapFunction`, `mapParameter`, `mapSignal`, `mapState`, or `mapDataStore`.

Configure SwAlignment

The `SwAlignment` property describes the intended alignment of AUTOSAR data within a memory section. `SwAlignment` defines a quantity of bits. Valid values include 8, 12, 32, UNKNOWN (deprecated), UNSPECIFIED, and BOOLEAN. For numeric data, typical `SwAlignment` values are 8, 16, and 32.

If you do not define the `SwAlignment` property, the `swBaseType` size and the `memoryAllocationKeywordPolicy` of the referenced `SwAlignment` determine the alignment.

You can use the AUTOSAR property function `set` to set `SwAlignment` for S-R interface data elements and inter-runnable variables. For example:

```
interfacePath = '/A/B/C/Interfaces/If1/';  
dataElementName = 'E11';  
swAlignmentValue = '32';  
set(dataObj,[interfacePath dataElementName],'SwAlignment',swAlignmentValue);
```

To support the round-trip workflow, the `arxml` importer imports and preserves the `SwAlignment` property for the following AUTOSAR data:

- Per-instance memory
- Software component parameters
- Parameter interface data elements
- Client-server interface operation arguments
- Static and constant memory

Export SwImplPolicy

The `SwImplPolicy` property specifies the implementation policy for a data element, regarding consistency mechanisms of variables. You cannot modify the `SwImplPolicy` property, but the property is set to `standard` or `queued` for AUTOSAR data in exported `arxml` code. The value is set to:

- `standard` for
 - Per-instance memory
 - Inter-runnable variables
 - Software component parameters

- Parameter interface data elements
- Client-server interface operation arguments
- Static and constant memory
- standard or queued for
Sender-receiver interface data elements

Export SwRecordLayout for Lookup Table Data

AUTOSAR software components use software record layouts (SwRecordLayouts) to specify how to serialize data in the memory of an AUTOSAR ECU. The arxml importer imports and preserves the SwRecordLayout property for AUTOSAR data.

You can import SwRecordLayouts from arxml files in either of two ways:

- If you create your AUTOSAR model from arxml files using importer function createComponentAsModel, include an arxml file that contains SwRecordLayout definitions in the import. The imported SwRecordLayouts are preserved and later exported in arxml code.
- If you create your AUTOSAR model in Simulink, you can import shared definitions of SwRecordLayouts from arxml files. Use importer function updateAUTOSARProperties. For example:

```
importerObj = arxml.importer(arxmlFileName);
updateAUTOSARProperties(importerObj,modelName);
```

When you generate model code, the exported arxml code contains references to the imported read-only SwRecordLayout elements, but not their definitions.

```
<APPLICATION-PRIMITIVE-DATA-TYPE>
  <SHORT-NAME>App1_L_6_s16En4</SHORT-NAME>
  <CATEGORY>CURVE</CATEGORY>
  <SW-DATA-DEF-PROPS>
    ...
    <SW-RECORD-LAYOUT-REF DEST="SW-RECORD-LAYOUT">
      /AUTOSAR/Ifx/SwRecordLayouts_Blueprint/IntCur_s16_s16
    </SW-RECORD-LAYOUT-REF>
  </SW-DATA-DEF-PROPS>
</APPLICATION-PRIMITIVE-DATA-TYPE>
```

For more information, see “Reuse AUTOSAR Element Descriptions” on page 3-41.

See Also

Related Examples

- “Import AUTOSAR Software Component” on page 3-19
- “Model AUTOSAR Calibration Parameters and Lookup Tables” on page 2-49
- “Configure AUTOSAR CompuMethods” on page 4-311
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “AUTOSAR Component Configuration” on page 4-3

Configure Lookup Tables for AUTOSAR Measurement and Calibration

In Simulink, you can implement standard axis (STD_AXIS) and common axis (COM_AXIS) lookup tables for AUTOSAR applications. AUTOSAR applications can use lookup tables in either or both of two ways:

- Implement fast search operations.
- Support tuning of the application with measurement and calibration tools.

To model lookup tables for automotive application tuning, use the classes `Simulink.LookupTable` and `Simulink.Breakpoint`. By creating `Simulink.LookupTable` and `Simulink.Breakpoint` objects in the model workspace, you can store and share lookup table and breakpoint data and configure the data for AUTOSAR code generation.

In this section...

“Configure STD_AXIS Lookup Tables by Using Lookup Table Objects” on page 4-298

“Configure COM_AXIS Lookup Tables by Using Lookup Table and Breakpoint Objects” on page 4-303

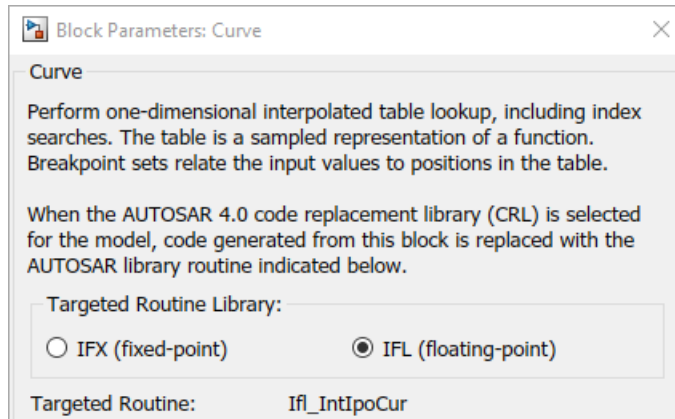
Configure STD_AXIS Lookup Tables by Using Lookup Table Objects

This example shows how to create STD_AXIS lookup tables in Simulink, using `Simulink.LookupTable` objects, and configure the lookup tables for AUTOSAR code generation. The example uses the model `matlabroot/help/toolbox/autosar/examples/mAutosarLutObjs.slx`.

- 1 Model an AUTOSAR lookup table in a STD_AXIS configuration.
 - a In a mapped AUTOSAR software component model, add an AUTOSAR Blockset Curve or Map block. This example adds a Curve block.



- b** Open the Curve block and configure it to generate a routine from the AUTOSAR 4.0 code replacement library (CRL). As you modify block settings, the block dialog box updates the name of the targeted AUTOSAR routine.



In the block dialog box, make these selections:

- To generate a floating-point routine, select **IFL (floating-point)**.
 - In the **Table Specification** tab, to specify table data using a lookup table object, set **Data Specification** to Lookup table object.
- c** In the model workspace, create a `Simulink.LookupTable` object and configure it to store the lookup table data.

Simulink.LookupTable: L_4_single

Number of table dimensions:

Table

Value	Data type	Dimensions	Min	Max	Unit	Field name	Description
[10 20 30 40]	single	[1 4]	[]	[]		Table	

Breakpoints

Specification: Support tunable size

	Value	Data type	Dimensions	Min	Max	Unit	Field name	Tunable size name	Description
1	[1 2 3 4]	single	[1 4]	[]	[]		Bp1	Nx	

Argument

Code generation options

Data definition

Storage class:

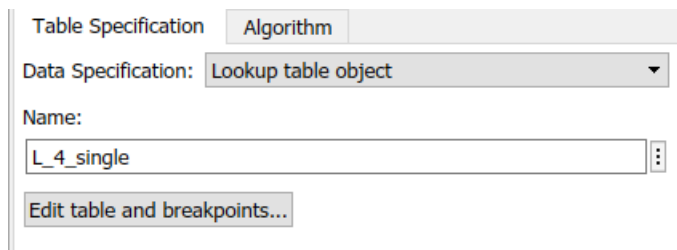
Struct type definition

Name:

Data scope:

Header file:

- d In the Curve block dialog box, **Table Specification** tab, enter the `Simulink.LookupTable` object name in the **Name** field.

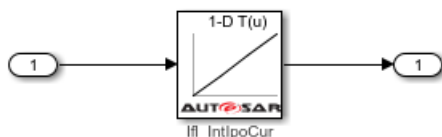


- e In the block dialog box, **Algorithm** tab, set **Integer Rounding Method** to Zero. Leave **Interpolation Method** set to Linear point-slope and **Index Search Method** set to Linear search.

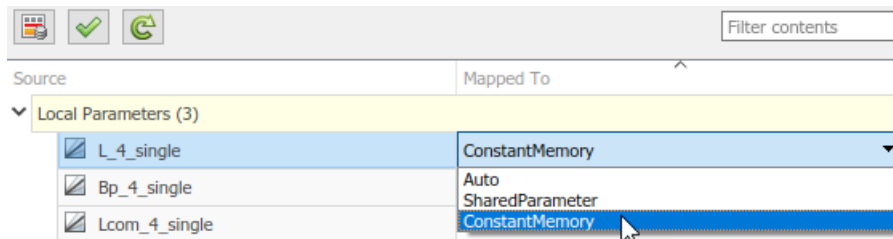
Table data appears in generated AUTOSAR C code as fields of a single structure. To control the characteristics of the structure type, such as its name, use the properties of the object.

- 2 Connect the Curve or Map block.

- Add AUTOSAR operating points to the lookup tables. Connect a root-level inport to the Curve or Map block. Alternatively, configure an input signal to the Curve or Map block with static global memory.
- Connect an output to the Curve or Map block.

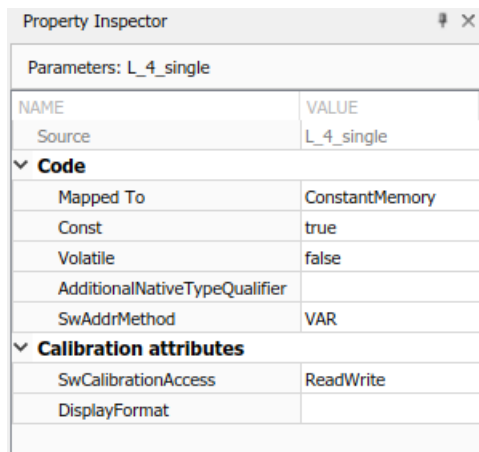


- 3 In the AUTOSAR code perspective, use the Code Mappings editor to map `Simulink.LookupTable` objects to AUTOSAR internal calibration parameters. In the **Parameters** tab, select each `Simulink.LookupTable` object that you created. Map each object to AUTOSAR parameter type `ConstantMemory`, `SharedParameter`, or `Auto`. To accept software mapping defaults, specify `Auto`.



In this example, STD_AXIS lookup table object `L_4_single` is mapped to AUTOSAR `ConstantMemory`.

- For each parameter, if you select a parameter type other than `Auto`, use the Property Inspector to view or modify other code and calibration attributes. For more information on parameter properties, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.



- Configure the model to generate C code based on the AUTOSAR 4.0 library. Open the Configuration Parameters dialog box and select **Code Generation > Interface**. Set the **Code replacement library** parameter to `AUTOSAR_4.0`. For more information, see “Code Generation with AUTOSAR Code Replacement Library” on page 5-15.
- Build the model. The generated C code contains the expected `Ifl` and `Ifx` lookup function calls and `Rte` data access function calls. For example, you can search the HTML code generation report for the `Ifl` or `Ifx` routine prefix.

```

/* Model step function */
void Runnable_Step(void)
{
  /* Outport: '<Root>/Out1' incorporates:
   * Inport: '<Root>/In1'
   * Lookup_n-D: '<Root>/Curve'
   */
  Rte_IWrite_Runnable_Step_Out1_Out1(Ifl_IntIpoCur_f32_f32
    (Rte_IRead_Runnable_Step_In1_In1(), L_4_single.Nx, L_4_single.Bp1,
    L_4_single.Table));
}

```

The generated arxml files contain data types of category CURVE (1-D table data) and MAP (2-D table data). The data types have the data calibration properties that you configured.

Configure COM_AXIS Lookup Tables by Using Lookup Table and Breakpoint Objects

This example shows how to create COM_AXIS lookup tables in Simulink, using Simulink.LookupTable and Simulink.Breakpoint objects, and configure the lookup tables for AUTOSAR code generation. The example uses the model *matlabroot/help/toolbox/autosar/examples/mAutosarLutObjs.slx*.

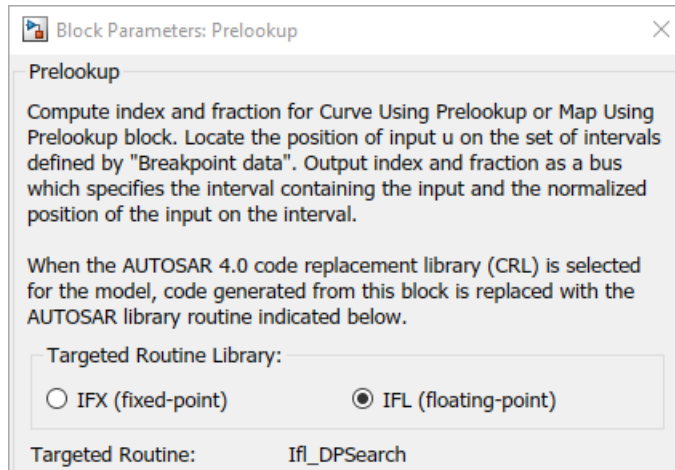
In this example, to model an AUTOSAR lookup table in a COM_AXIS configuration, you pair AUTOSAR Blockset Prelookup blocks with Curve Using Prelookup or Map Using Prelookup blocks.

1 Configure Prelookup blocks.

- a In a mapped AUTOSAR software component model, add one or more AUTOSAR Blockset Prelookup blocks. This example adds one Prelookup block.



- b Open each block and configure it to generate a routine from the AUTOSAR 4.0 code replacement library (CRL). As you modify block settings, the block updates the name of the targeted AUTOSAR routine.



In the block dialog box, make these selections:

- To generate a floating-point routine, select **IFL (floating-point)**.
 - In the **Table Specification** tab, to specify breakpoint data using a breakpoint object, set **Breakpoints specification** to Breakpoint object.
- c For each breakpoint vector, in the model workspace, create and configure a Simulink.Breakpoint object.

Simulink.Breakpoint: Bp_4_single

Breakpoints

Support tunable size

Value	Data type	Dimensions	Min	Max	Unit	Field name	Tunable size name	Description
[1 2 3 4]	single ▾	[1 4]	[]	[]		Bp1	Nx	

Argument

Code generation options

Data definition

Storage class: Auto ▾

Struct type definition

Name: BP_4_single_type

Data scope: Auto ▾

Header file:

- d In the Prelookup block dialog box, **Table Specification** tab, enter the Simulink.Breakpoint object name in the **Name** field. You can reduce memory consumption by sharing breakpoint data between lookup tables.

Table Specification Algorithm

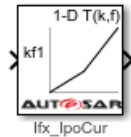
Breakpoints specification: Breakpoint object ▾

Name: Bp_4_single

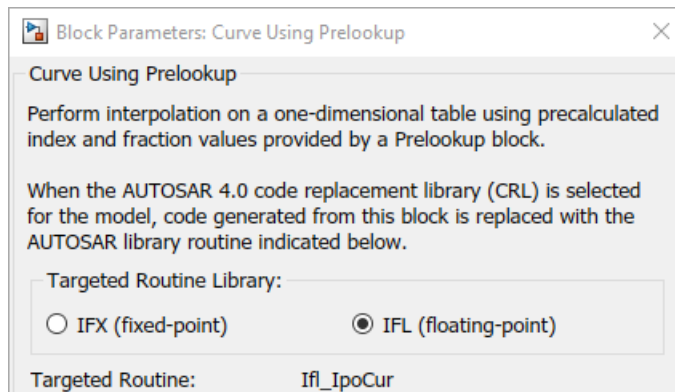
- e In the block dialog box, **Algorithm** tab, set **Integer Rounding Method** to Zero. Leave **Index Search Method** set to Linear search.

2 Configure Curve Using Prelookup and Map Using Prelookup blocks.

- a In the model, add one or more AUTOSAR Blockset Curve Using Prelookup or Map Using Prelookup blocks. Each block immediately follows a Prelookup block with which it is paired. This example adds one Curve Using Prelookup block.



- b Open each Curve Using Prelookup or Map Using Prelookup block and configure it to generate a routine from the AUTOSAR 4.0 code replacement library (CRL). As you modify block settings, the block dialog box updates the name of the targeted AUTOSAR routine.



In the block dialog box, make these selections:

- To generate a floating-point routine, select **IFL (floating-point)**.
 - In the **Table Specification** tab, to specify table data using a lookup table object, set **Data Specification** to Lookup table object.
- c For each set of table data, in the model workspace, create and configure a `Simulink.LookupTable` object.

Simulink.LookupTable: Lcom_4_single

Number of table dimensions:

Table

Value	Data type	Dimensions	Min	Max	Unit	Field name	Description
[10 20 30 40]	single	[1 4]	[]	[]		Table	

Breakpoints

Specification:

	Name
1	Bp_4_single

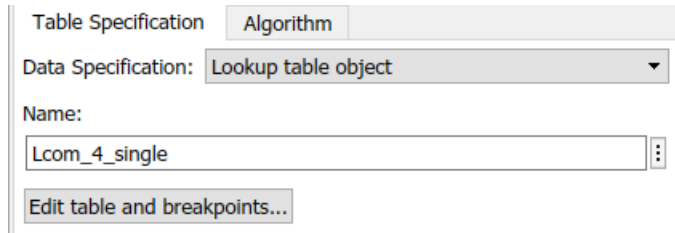
Argument

Code generation options

Data definition

Storage class:

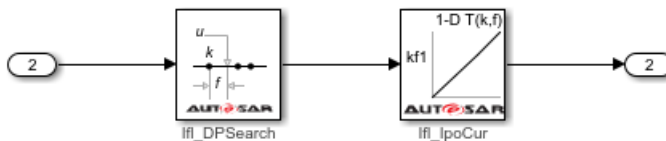
- d** In each Curve Using Prelookup or Map Using Prelookup block dialog box, **Table Specification** tab, enter a Simulink.LookupTable object name in the **Name** field.



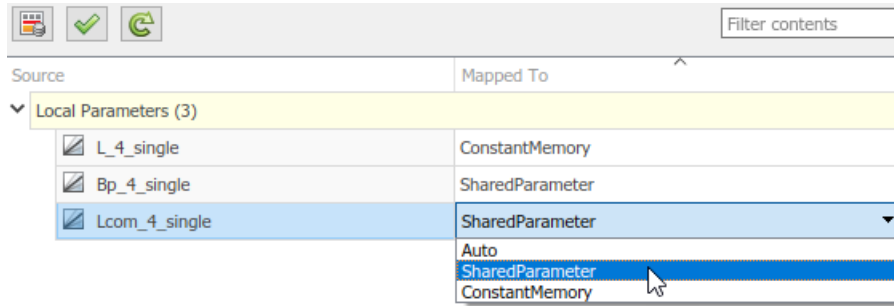
- e In the block dialog box, **Algorithm** tab, set **Integer Rounding Method** to Zero. Leave **Interpolation Method** set to Linear point-slope.

Each set of table data appears in the generated C code as a separate array variable. If the table size is tunable, each breakpoint vector appears as a structure. The structure contains a field to store the breakpoint data and, optionally, a field to store the length of the vector. The second field enables you to tune the effective size of the table. If the table size is not tunable, each breakpoint vector appears as an array.

- 3 Connect the Prelookup, Curve Using Prelookup, and Map Using Prelookup blocks.
 - Add AUTOSAR operating points to the lookup tables. Connect root-level inports to the Prelookup blocks. Alternatively, configure input signals to the Prelookup blocks with static global memory.
 - Connect outputs to the Curve Using Prelookup and Map Using Prelookup blocks.
 - Connect each Prelookup block to its matched Curve Using Prelookup or Map Using Prelookup block.

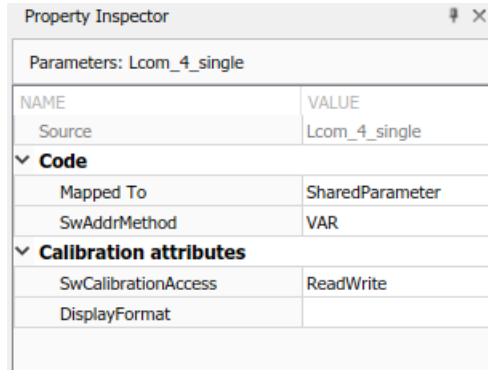


- 4 In the AUTOSAR code perspective, use the Code Mappings editor to map `Simulink.LookupTable` and `Simulink.Breakpoint` objects to AUTOSAR internal calibration parameters. In the **Parameters** tab, select each `Simulink.LookupTable` and `Simulink.Breakpoint` object that you created. Map each object to AUTOSAR parameter type `ConstantMemory`, `SharedParameter`, or `Auto`. To accept software mapping defaults, specify `Auto`.



In this example, COM_AXIS breakpoint object Bp_4_single and lookup table object Lcom_4_single are mapped to AUTOSAR SharedParameters. All instances of the AUTOSAR software component share the COM_AXIS parameters.

- For each parameter, if you select a parameter type other than Auto, use the Property Inspector to view or modify other code and calibration attributes. For more information on parameter properties, see “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74.



- Configure the model to generate C code based on the AUTOSAR 4.0 library. Open the Configuration Parameters dialog box and select **Code Generation > Interface**. Set the **Code replacement library** parameter to AUTOSAR 4.0. For more information, see “Code Generation with AUTOSAR Code Replacement Library” on page 5-15.
- Build the model. The generated C code contains the expected Ifl and Ifx lookup function calls and Rte data access function calls. For example, you can search the HTML code generation report for the Ifl or Ifx routine prefix.

```
/* Model step function */
void Runnable_Step(void)
{
    If1_DPResultF32_Type rtb_Prelookup;

    /* PreLookup: '<Root>/PreLookup' incorporates:
     * Inport: '<Root>/In2'
     */
    If1_DPSearch_f32(&rtb_Prelookup, Rte_IRead_Runnable_Step_In2_In2(),
                    (Rte_CData_Bp_4_single()->Nx, (Rte_CData_Bp_4_single()->Bp1);

    /* Outport: '<Root>/Out2' incorporates:
     * Interpolation_n-D: '<Root>/Curve Using PreLookup'
     */
    Rte_IWrite_Runnable_Step_Out2_Out2(If1_IpoCur_f32(&rtb_Prelookup,
                                                    Rte_CData_Lcom_4_single()));
}
```

The generated arxml files contain data types of category CURVE (1-D table data), MAP (2-D table data), and COM_AXIS (axis data). The data types have the data calibration properties that you configured.

See Also

Curve | Curve Using Prelookup | Map | Map Using Prelookup | Prelookup | Simulink.Breakpoint | Simulink.LookupTable | getParameter | mapParameter

Related Examples

- “Map Model Workspace Parameters to AUTOSAR Component Internal Parameters” on page 4-74

More About

- “Code Generation with AUTOSAR Code Replacement Library” on page 5-15
- “Model AUTOSAR Calibration Parameters and Lookup Tables” on page 2-49

Configure AUTOSAR CompuMethods

AUTOSAR software components use computation methods (CompuMethods) to convert between the internal values and physical representation of AUTOSAR data. Common uses for CompuMethods are linear data scaling and measurement and calibration.

Embedded Coder imports AUTOSAR CompuMethods described in `arxml` code and preserves them across round-trips between an AUTOSAR authoring tool (AAT) and Simulink. In Simulink, you can modify imported CompuMethods or create and configure new CompuMethods.

This topic provides examples of configuring AUTOSAR CompuMethods in Simulink.

In this section...

“Configure AUTOSAR CompuMethod Properties” on page 4-311

“Create AUTOSAR CompuMethods” on page 4-313

“Configure CompuMethod Direction for Linear Functions” on page 4-314

“Export CompuMethod Unit References” on page 4-316

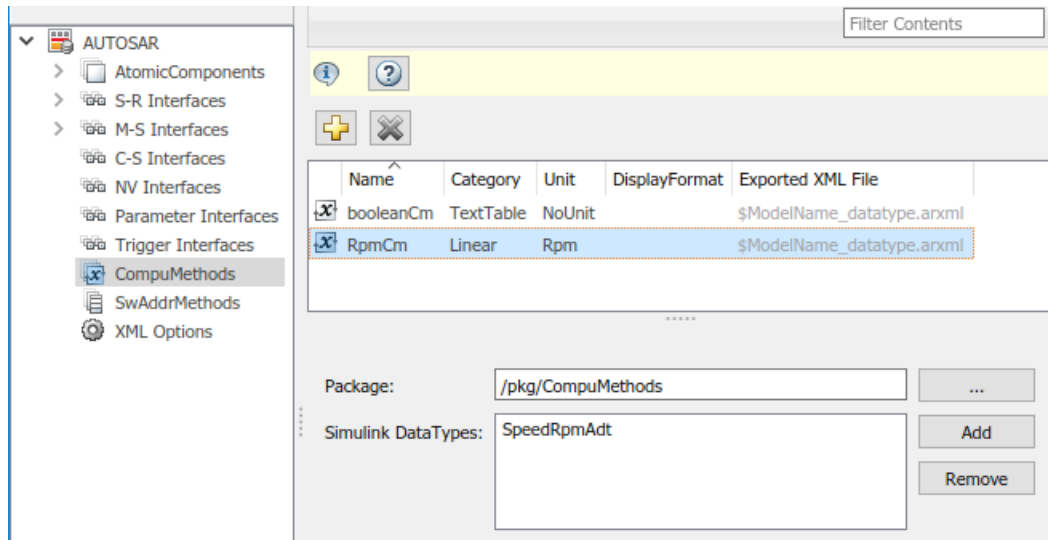
“Modify Linear Scaling for SCALE_LINEAR_AND_TEXTTABLE CompuMethod” on page 4-316

“Configure Rational Function CompuMethod for Dual-Scaled Parameter” on page 4-318

Configure AUTOSAR CompuMethod Properties

You can configure AUTOSAR CompuMethod properties in your model, either graphically or programmatically. The CompuMethod properties you can modify include name, category, unit, display format, AUTOSAR package, and Simulink data types.

To configure a CompuMethod using the graphical interface, open the AUTOSAR Dictionary and select the **CompuMethods** view. This view displays the modifiable CompuMethods in the model, whether imported from `arxml` code or created in Simulink.



Select a CompuMethod and edit the available fields.

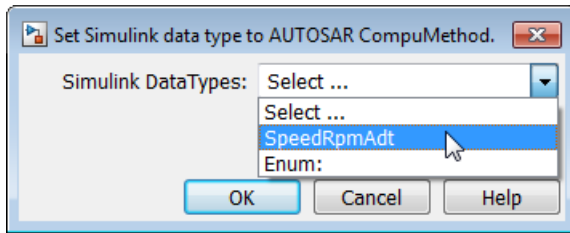
- **Name** — Specify name text
- **Category** — Select Identical, Linear, RatFunc, TextTable, or LinearAndTextTable (see “CompuMethod Categories for Data Types” on page 2-60)
- **Unit** — Select from units available in the model
- **DisplayFormat** — Optionally specify format to be used by measurement and calibration tools to display the data. Use an ANSI C printf format specifier string. For example, %2.1d specifies a signed decimal number, with a minimum width of two characters and maximum precision of one digit. The string produces a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.
- **Package** — Specify path of AUTOSAR package to be generated for CompuMethods
- **Simulink DataTypes** — Specify list of Simulink data types that reference the CompuMethod

To modify the AUTOSAR package for a CompuMethod, you can do either of the following:

- Enter a package path in the **Package** parameter field.
- To open the AUTOSAR Package Browser, click the button to the right of the **Package** field. Use the browser to navigate to an existing package or create and select a

package. When you select a package in the browser and click **Apply**, the CompuMethod **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.

To associate a CompuMethod with a Simulink data type used in the model, select a CompuMethod and click the **Add** button to the right of **Simulink DataTypes**. This action opens a dialog box with a list of available data types. In the list of values, select a `Simulink.NumericType` or `Simulink.AliasType`, or enter the name of a Simulink enumerated type. To add the type to the **Simulink DataTypes** list, click **OK**.




To set the **Simulink DataTypes** property programmatically, open the model and use an AUTOSAR property set function call similar to the following:

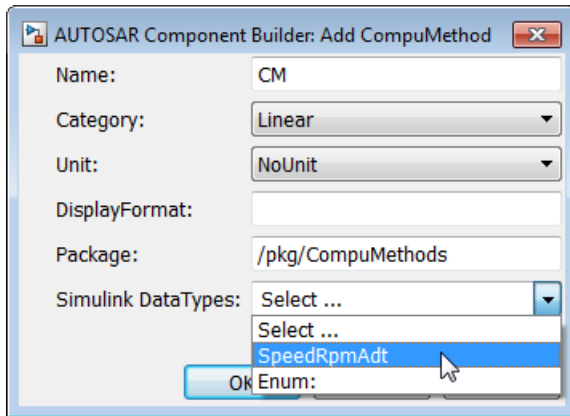
```
arProps=autosar.api.getAUTOSARProperties('cmSpeed');
set(arProps, '/pkg/CompuMethods/RpmCm', 'SLDataTypes', {'SpeedRpmAdt'})
sltypes=get(arProps, '/pkg/CompuMethods/RpmCm', 'SLDataTypes')

sltypes =
    'SpeedRpmAdt'
```

Create AUTOSAR CompuMethods

You can create AUTOSAR CompuMethods in your model, either graphically or programmatically. To create an AUTOSAR CompuMethod using the graphical interface, open the AUTOSAR Dictionary and select the **CompuMethods** view. To open the Add

CompuMethod dialog box, click the **Add** button . Configure the initial properties for the CompuMethod, such as name, category, unit, display format for calibration, AUTOSAR package to generate, and associated Simulink data type. When you click **OK**, the CompuMethods view in the AUTOSAR Dictionary is updated with the new CompuMethod.



When you generate code, the exported arxml code contains the CompuMethod definition and references to it.

Configure CompuMethod Direction for Linear Functions

For designs originated in Simulink, you can control properties for an exported CompuMethod, including the direction of CompuMethod conversion between internal and physical representations of a value. Using either the AUTOSAR Dictionary or the AUTOSAR property set function, you can specify one of the following CompuMethod direction values:

- `InternalToPhys` (default) — Generate CompuMethod sections for conversion of internal values into their physical representations.
- `PhysToInternal` — Generate CompuMethod sections for conversion of physical values into their internal representations.
- `Bidirectional` — Generate CompuMethod sections for both internal-to-physical and physical-to-internal conversion directions.

To specify CompuMethod direction in the MATLAB Command Window, use an AUTOSAR property set function call similar to the following:

```
hModel = 'autosar_swc_expfcns';
open_system(hModel);
arProps=autosar.api.getAUTOSARProperties(hModel);
set(arProps,'XmlOptions','CompuMethodDirection','Bidirectional');
get(arProps,'XmlOptions','CompuMethodDirection')
```


To specify CompuMethod direction in the AUTOSAR Dictionary, select **XML Options**. Select a value for parameter **CompuMethod Direction**. Click **Apply**.

CompuMethod Direction:

- InternalToPhys
- PhysToInternal
- Bidirectional

When you generate code for your model, the CompuMethods in the exported arxml code contain the requested directional sections. For example, here is a CompuMethod generated with the CompuMethod direction set to Bidirectional.

```
<COMPU-METHOD UUID="...">
  <SHORT-NAME>COMPU_EngSpdValue</SHORT-NAME>
  <CATEGORY>LINEAR</CATEGORY>
  <COMPU-INTERNAL-TO-PHYS>
  <COMPU-SCALES>
    <COMPU-SCALE>
      <SHORT-LABEL>intToPhys</SHORT-LABEL>
      <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0</LOWER-LIMIT>
      <UPPER-LIMIT INTERVAL-TYPE="CLOSED">24000</UPPER-LIMIT>
      <COMPU-RATIONAL-COEFFS>
        <COMPU-NUMERATOR>
          <V>0</V>
          <V>1</V>
        </COMPU-NUMERATOR>
        <COMPU-DENOMINATOR>
          <V>8</V>
        </COMPU-DENOMINATOR>
      </COMPU-RATIONAL-COEFFS>
    </COMPU-SCALE>
  </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
  <COMPU-PHYS-TO-INTERNAL>
  <COMPU-SCALES>
    <COMPU-SCALE>
      <SHORT-LABEL>physToInt</SHORT-LABEL>
      <LOWER-LIMIT INTERVAL-TYPE="CLOSED">0</LOWER-LIMIT>
      <UPPER-LIMIT INTERVAL-TYPE="CLOSED">3000</UPPER-LIMIT>
      <COMPU-RATIONAL-COEFFS>
        <COMPU-NUMERATOR>
          <V>0</V>
          <V>8</V>
        </COMPU-NUMERATOR>
        <COMPU-DENOMINATOR>
          <V>1</V>
        </COMPU-DENOMINATOR>
      </COMPU-RATIONAL-COEFFS>
    </COMPU-SCALE>
  </COMPU-SCALES>
  </COMPU-PHYS-TO-INTERNAL>
</COMPU-METHOD>
```

Note CompuMethods of category TEXTTABLE, which are generated for Boolean or enumerated data types, use only InternalToPhys, regardless of the direction parameter setting.

Export CompuMethod Unit References

The arxml importer preserves unit and physical dimension information found in imported CompuMethods. The software preserves CompuMethod unit and physical dimension information across round-trips between an AUTOSAR authoring tool (AAT) and Simulink.

For designs originated in Simulink, the exporter generates a unit reference for each CompuMethod. By convention, each CompuMethod references a unit named NoUnit. For example, here is a Boolean data type CompuMethod and the unit it references.

```
<COMPU-METHOD UUID="...">
  <SHORT-NAME>COMPU_Boolean</SHORT-NAME>
  <CATEGORY>TEXTTABLE</CATEGORY>
  <UNIT-REF DEST="UNIT">/mymodel_pkg/mymodel_dt/NoUnit</UNIT-REF>
  ...
</COMPU-METHOD>
<UNIT UUID="...">
  <SHORT-NAME>NoUnit</SHORT-NAME>
  <FACTOR-SI-TO-UNIT>1</FACTOR-SI-TO-UNIT>
  <OFFSET-SI-TO-UNIT>0</OFFSET-SI-TO-UNIT>
</UNIT>
```

Providing a unit for each exported CompuMethod helps support measurement and calibration tool use of exported AUTOSAR data.

Modify Linear Scaling for SCALE_LINEAR_AND_TEXTTABLE CompuMethod

You can import and export an AUTOSAR CompuMethod that uses LINEAR and TEXTTABLE scaling. Importing application data types that reference CompuMethods of category SCALE_LINEAR_AND_TEXTTABLE creates Simulink.NumericType or Simulink.AliasType data objects in the Simulink workspace. In Simulink, you can modify the LINEAR scaling for the CompuMethods. The TEXTTABLE scaling is read-only.

For example, here is a CompuMethod with one LINEAR scale and two TEXTTABLE scales.

```

<COMPU-METHOD>
  <SHORT-NAME>COMPU_myType</SHORT-NAME>
  <CATEGORY>SCALE_LINEAR_AND_TEXTTABLE</CATEGORY>
  <COMPU-INTERNAL-TO-PHYS>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR>
            <V>30</V>
            <V>2</V>
          </COMPU-NUMERATOR>
          <COMPU-DENOMINATOR>
            <V>1</V>
          </COMPU-DENOMINATOR>
        </COMPU-RATIONAL-COEFFS>
      </COMPU-SCALE>
      <COMPU-SCALE>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">350</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">350</UPPER-LIMIT>
        <COMPU-CONST>
          <VT>SensorError</VT>
        </COMPU-CONST>
      </COMPU-SCALE>
      <COMPU-SCALE>
        <LOWER-LIMIT INTERVAL-TYPE="CLOSED">351</LOWER-LIMIT>
        <UPPER-LIMIT INTERVAL-TYPE="CLOSED">351</UPPER-LIMIT>
        <COMPU-CONST>
          <VT>SignalNotAvailable</VT>
        </COMPU-CONST>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
</COMPU-METHOD>

```

When you import the CompuMethod into a model, the importer creates a Simulink.NumericType with linear scaling. To modify the linear scaling, open the Simulink.NumericType data object and modify its fields.

Simulink.NumericType: myType	
Data type mode:	Fixed-point: slope and bias scaling
Signedness:	Signed
Word length:	16
Slope:	2
Bias:	30

For read-only access to the TEXTTABLE scaling information, use AUTOSAR property get function calls similar to the following:

```

>> arProps=autosar.api.getAUTOSARProperties('mySWC');
>> % Get literals for COMPU_myType TEXTTABLE scales

```

```

>> get(arProps, '/simple_ar_package/simple_ar_dt/COMPU_myType', 'CellofEnums')
ans =
    'SensorError'    'SignalNotAvailable'
>> % Get internal values for COMPU_myType TEXTTABLE scales
>> get(arProps, '/simple_ar_package/simple_ar_dt/COMPU_myType', 'IntValues')
ans =
    350    351

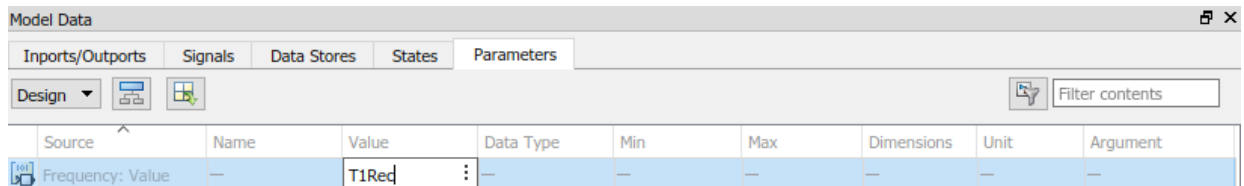
```


Configure Rational Function CompuMethod for Dual-Scaled Parameter

For an AUTOSAR dual-scaled parameter, which stores two scaled values of the same physical value, the software generates the `CompuMethod` category `RAT_FUNC`. The computation method can be a first-order rational function.

To configure and generate a dual-scaled parameter:

- 1 Open an AUTOSAR model. For the purposes of this example, create a Constant block from which to reference an AUTOSAR dual-scaled parameter. In the model, connect the Constant block to a Simulink output.
- 2 Open the Model Data Editor (on the **AUTOSAR** tab, select **Settings > Model Data Editor**) and select the **Parameters** tab. Find the parameter entry for the Constant block. Use the **Value** column to reference the name of a dual-scaled parameter. This example uses the parameter name `T1Rec`.



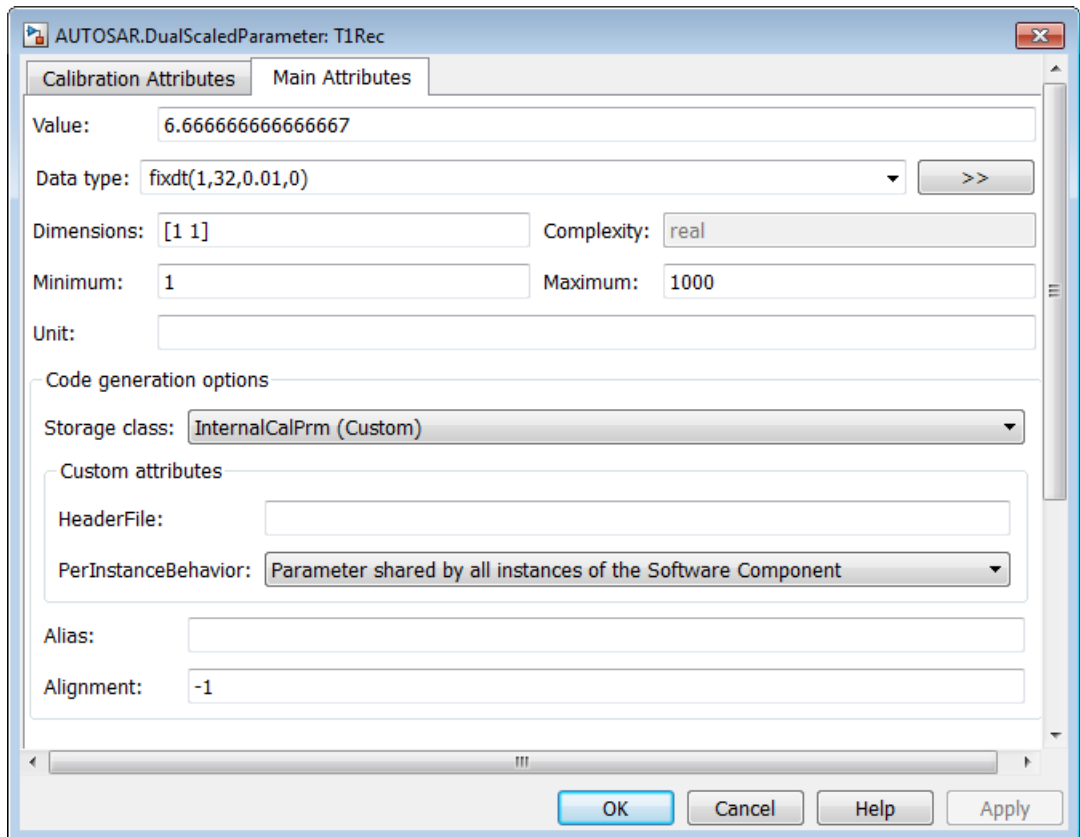
- 3 Create the `T1Rec` data object. In the Model Data Editor, to the right of the value `T1Rec`, click the action button  and select **Create**.

In the Create New Data dialog box, set **Value** to `AUTOSAR.DualScaledParameter` and click **Create**. An `AUTOSAR.DualScaledParameter` data object appears in the base workspace. The dual-scaled parameter property dialog box opens.

- 4 Configure the attributes of the dual-scaled parameter `T1Rec`. Execute the following MATLAB code. The code sets up a conversion from an internal calibration time value to a physical frequency (time reciprocal) value.

```
% Conversion from Time to Frequency
% F = 1/T
% In Other Words F = (0*T + 1)/(1*T+0);
T1Rec.CompuMethodName = 'CM3';
T1Rec.DataType = 'fixdt(1,32,0.01,0)';
T1Rec.CalToMainCompuNumerator=1;
T1Rec.CalToMainCompuDenominator=[1 0];
T1Rec.CalibrationMin = 0.001;
T1Rec.CalibrationMax = 1.0;
T1Rec.CalibrationValue = 0.1500;
T1Rec.CoderInfo.StorageClass = 'Custom';
T1Rec.CoderInfo.Alias = '';
T1Rec.CoderInfo.CustomStorageClass = 'InternalCalPrm';
T1Rec.CoderInfo.CustomAttributes.PerInstanceBehavior = ...
    'Parameter shared by all instances of the Software Component';
T1Rec.Description = '';
% T1Rec.Min = [];
% T1Rec.Max = [];
T1Rec.Unit = '';
T1Rec.CalibrationDocUnits = 'm/s2';
```

- 5 Inspect the property dialog box for the dual-scaled parameter T1Rec. Here are the main attributes set by the MATLAB code.



- 6 Here are the calibration attributes set by the MATLAB code. The attributes include **CompuMethod name** (T1Rec.CompuMethodName), which allows you to specify the name of the AUTOSAR CompuMethod for this data type.

AUTOSAR.DualScaledParameter: T1Rec

Calibration Attributes Main Attributes

CompuMethod name:

Calibration value:

Calibration minimum: Calibration maximum:

CalToMain compute numerator:

CalToMain compute denominator:

Calibration name:

Calibration units:

SwCalibrationAccess:

- 7 If CompuMethod direction is not already set to bidirectional in the AUTOSAR properties, use the AUTOSAR Dictionary, **XML Options** view, to set it.
- 8 Generate code from the model.

When you generate code from the model, the arxml exporter generates a CompuMethod of category RAT_FUNC.

```
<COMPU-METHOD UUID="...">
  <SHORT-NAME>CM3</SHORT-NAME>
  <CATEGORY>RAT_FUNC</CATEGORY>
  <UNIT-REF DEST="UNIT"/>/mymodel_pkg/mymodel_dt/m_s_/UNIT-REF>
  <COMPU-INTERNAL-TO-PHYS>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR>
            <V>-100</V>
          </COMPU-NUMERATOR>
          <COMPU-DENOMINATOR>
            <V>0</V>
            <V>-1</V>
          </COMPU-DENOMINATOR>
        </COMPU-RATIONAL-COEFFS>
      </COMPU-SCALE>
    </COMPU-SCALES>
  </COMPU-INTERNAL-TO-PHYS>
  <COMPU-PHYS-TO-INTERNAL>
    <COMPU-SCALES>
      <COMPU-SCALE>
        <COMPU-RATIONAL-COEFFS>
          <COMPU-NUMERATOR>
```

```

        <V>100</V>
      </COMPU-NUMERATOR>
    <COMPU-DENOMINATOR>
      <V>0</V>
      <V>1</V>
    </COMPU-DENOMINATOR>
  </COMPU-RATIONAL-COEFFS>
</COMPU-SCALE>
</COMPU-SCALES>
</COMPU-PHYS-TO-INTERNAL>
</COMPU-METHOD>

```

The CompuMethod is referenced from the application data type generated for T1Rec.

```

<APPLICATION-PRIMITIVE-DATA-TYPE UUID="...">
  <SHORT-NAME>T1Rec_DualScaled</SHORT-NAME>
  <CATEGORY>VALUE</CATEGORY>
  <SW-DATA-DEF-PROPS>
    <SW-DATA-DEF-PROPS-VARIANTS>
      <SW-DATA-DEF-PROPS-CONDITIONAL>
        <SW-CALIBRATION-ACCESS>READ-WRITE</SW-CALIBRATION-ACCESS>
        <COMPU-METHOD-REF DEST="COMPU-METHOD">/mymodel_pkg/mymodel_dt/CM3</COMPU-METHOD-REF>
        <DATA-CONSTR-REF DEST="DATA-CONSTR">/mymodel_pkg/mymodel_dt/ ApplDataTypes/
          DataConstrs/DC_T1Rec_DualScaled</DATA-CONSTR-REF>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
</APPLICATION-PRIMITIVE-DATA-TYPE>

```

The application data type T1Rec_DualScaled is referenced from the parameter data prototype generated for T1Rec.

```

<PARAMETER-DATA-PROTOTYPE UUID="...">
  <SHORT-NAME>T1Rec</SHORT-NAME>
  <SW-DATA-DEF-PROPS>
    <SW-DATA-DEF-PROPS-VARIANTS>
      <SW-DATA-DEF-PROPS-CONDITIONAL>
        <SW-CALIBRATION-ACCESS>READ-WRITE</SW-CALIBRATION-ACCESS>
        <SW-IMPL-POLICY>STANDARD</SW-IMPL-POLICY>
      </SW-DATA-DEF-PROPS-CONDITIONAL>
    </SW-DATA-DEF-PROPS-VARIANTS>
  </SW-DATA-DEF-PROPS>
  <TYPE-TREF DEST="APPLICATION-PRIMITIVE-DATA-TYPE">/mymodel_pkg/mymodel_dt/ ApplDataTypes/
    T1Rec_DualScaled</TYPE-TREF>
  ...
</PARAMETER-DATA-PROTOTYPE>

```

See Also

Related Examples

- “Import AUTOSAR Software Component” on page 3-19

- “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123
- “Configure AUTOSAR XML Options” on page 4-63
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “CompuMethod Categories for Data Types” on page 2-60
- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Internal Data Constraints Export

AUTOSAR applications use data constraints to implement limits on data types and provide a controlled range of possible values. Internal data constraints represent minimum and maximum values for implementation data types, reflecting the internal or machine view of the data.

By default, code generation does not export internal data constraint information for AUTOSAR implementation data types in a `xml` code. If you want to force export of internal data constraints for implementation data types, select the XML option **Internal DataConstraints Export**.

If you select **Internal DataConstraints Export**, the exporter generates internal data constraints into an AUTOSAR package with a default name, `DataConstrs`, at a fixed location under the AUTOSAR data type package. Optionally, use the XML option **Internal DataConstraints Package** to specify a different AUTOSAR package name and path.

To configure export of AUTOSAR internal data constraint information in your model:

- 1 Open the AUTOSAR Dictionary. On the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**.
- 2 Select **XML Options**. In the XML options view, under **Additional Options**, select **Internal DataConstraints Export**.
- 3 Optionally, under **Additional Packages**, enter a package path for **Internal DataConstraints Package**.

The screenshot shows a dialog box titled "XML Options" with a section for "Additional Options". The "Internal DataConstraints Package" field is set to "/pkg/misc/IDC". The "ImplementationDataType Reference" dropdown is set to "Allowed". The "SwCalibrationAccess DefaultValue" dropdown is set to "ReadWrite". The "CompuMethod Direction" dropdown is set to "InternalToPhys". The "Internal DataConstraints Export" checkbox is checked. There are "Help" and "Apply" buttons at the bottom right.

- 4 Build the model and inspect the generated code. Here is an example of an AUTOSAR internal data constraint exported to a `xml` code.

```

<AR-PACKAGE UUID="...">
  <SHORT-NAME>IDC</SHORT-NAME>
  <ELEMENTS>
    ...
    <DATA-CONSTR UUID="...">
      <SHORT-NAME>DC_SInt8</SHORT-NAME>
      <DATA-CONSTR-RULES>
        <DATA-CONSTR-RULE>
          <INTERNAL-CONSTRS>
            <LOWER-LIMIT INTERVAL-TYPE="CLOSED">-128</LOWER-LIMIT>
            <UPPER-LIMIT INTERVAL-TYPE="CLOSED">127</UPPER-LIMIT>
          </INTERNAL-CONSTRS>
        </DATA-CONSTR-RULE>
      </DATA-CONSTR-RULES>
    </DATA-CONSTR>
  </ELEMENTS>
</AR-PACKAGE>

```

Alternatively, you can programmatically configure the AUTOSAR XML options **Internal DataConstraints Export** and **Internal DataConstraints Package**. For example:

```

arProps = autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'XmlOptions', 'InternalDataConstraintExport', true);
set(arProps, 'XmlOptions', 'InternalDataConstraintPackage', '/pkg/misc/IDC');

```

For more information, see “Configure AUTOSAR XML Options” on page 4-63.

See Also

Related Examples

- “Configure AUTOSAR Release 4.x Data Types” on page 4-326
- “Model AUTOSAR Data Types” on page 2-53
- “Configure AUTOSAR Code Generation” on page 5-8

More About

- “Release 4.x Data Types” on page 2-56
- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Release 4.x Data Types

AUTOSAR Release 4.0 introduced a new approach to AUTOSAR data types, in which base data types are mapped to implementation data types and application data types. Application and implementation data types separate application-level physical attributes, such as real-world range of values, data structure, and physical semantics, from implementation-level attributes, such as stored-integer minimum and maximum and specification of a primitive-type (integer, Boolean, real, and so on). For information about modeling R4.x data types, see “Release 4.x Data Types” on page 2-56.

The software supports AUTOSAR R4.x data types in Simulink originated and round-trip workflows:

- For AUTOSAR components originated in Simulink, the software generates AUTOSAR application, implementation, and base types to preserve the information contained within Simulink data types.
- For round-trip workflows involving AUTOSAR components originated outside MATLAB, the `arxml` importer and exporter preserve data type information and mapping for each imported AUTOSAR data type.

For AUTOSAR R4.x data types originated in Simulink, you can control some aspects of data type export. For example, you can control when application data types are generated, or specify the AUTOSAR package and short name exported for AUTOSAR data type mapping sets.

In this section...
“Control Application Data Type Generation” on page 4-326
“Configure DataTypeMappingSet Package and Name” on page 4-327
“Initialize Data with ApplicationValueSpecification” on page 4-329

Control Application Data Type Generation

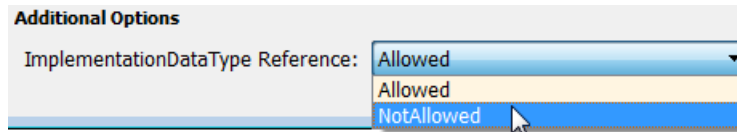
For AUTOSAR data types created in Simulink, by default, the software generates application base types only for fixed-point data types and enumerated data types with storage types. If you want to override the default behavior for generating application types, you can configure the `arxml` exporter to generate an application type, along with the implementation type and base type, for each exported AUTOSAR data type. Use the XML options parameter **ImplementationDataType Reference** (`XMLOptions` property `ImplementationDataTypeReference`), for which you can specify the following values:

- **Allowed** (default) — Allow direct reference of implementation types in the generated arxml code. If an application data type is not strictly required to describe an AUTOSAR data type, use an implementation data type reference.
- **NotAllowed** — Do not allow direct reference of implementation data types in the generated arxml code. Generate an application data type for each AUTOSAR data type.

To set the `ImplementationDataTypeReference` property in the MATLAB Command Window, use an AUTOSAR property `set` function call similar to the following:

```
hModel = 'autosar_swc_expfncs';
open_system(hModel);
arProps=autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'XmlOptions', 'ImplementationTypeReference', 'NotAllowed');
get(arProps, 'XmlOptions', 'ImplementationTypeReference')
```

To set the `ImplementationDataTypeReference` property in the AUTOSAR Dictionary, select **XML Options**. Select a value for parameter **ImplementationDataTypeReference**. Click **Apply**.



Configure DataTypeMappingSet Package and Name

For AUTOSAR software components created in Simulink, you can control the AUTOSAR package and short name exported for AUTOSAR data type mapping sets. To configure the data type mapping set package for export, set the `XmlOptions` property `DataTypeMappingPackage` using the AUTOSAR Dictionary or the AUTOSAR property `set` function.



```
hModel = 'autosar_swc_expfncs';
open_system(hModel);
arProps=autosar.api.getAUTOSARProperties(hModel);
```

```
set(arProps, 'XmlOptions', 'DataTypeMappingPackage', '/pkg/dt/DataTypeMappings');
get(arProps, 'XmlOptions', 'DataTypeMappingPackage')
```

The exported arxml code uses the specified package. The default mapping set short-name is the component name ASWC prefixed to `DataTypeMappingsSet`.

```
<DATA-TYPE-MAPPING-REFS>
  <DATA-TYPE-MAPPING-REF DEST="DATA-TYPE-MAPPING-SET">
    /pkg/dt/DataTypeMappings/ASWCDataTypeMappingsSet</DATA-TYPE-MAPPING-REF>
</DATA-TYPE-MAPPING-REFS>
...
<AR-PACKAGE UUID="...">
  <SHORT-NAME>DataTypeMappings</SHORT-NAME>
  <ELEMENTS>
    <DATA-TYPE-MAPPING-SET UUID="...">
      <SHORT-NAME>ASWCDataTypeMappingsSet</SHORT-NAME>
    ...
  </DATA-TYPE-MAPPING-SET>
</ELEMENTS>
</AR-PACKAGE>
```

You can specify a short name for a data type mapping set using the AUTOSAR property function `addPackageableElement`. The following example specifies a custom data type mapping set package and name using MATLAB commands.

```
% Add a new data type mapping set
modelName = 'autosar_swc_expfcns';
open_system(modelName);
propObj = autosar.api.getAUTOSARProperties(modelName);
newMappingSetPath = '/myPkg/mySubpkg/MyMappingSets';
newMappingSetName = 'MappingSetName';
newMappingSet = [newMappingSetPath '/' newMappingSetName];
addPackageableElement(propObj, 'DataTypeMappingSet', newMappingSetPath, newMappingSetName);

% Configure the component behavior to use the new data type mapping set
swc = get(propObj, 'XmlOptions', 'ComponentQualifiedNames');
ib = get(propObj, swc, 'Behavior', 'PathType', 'FullyQualified');
set(propObj, ib, 'DataTypeMapping', newMappingSet);

% Force generation of application data types
set(propObj, 'XmlOptions', 'ImplementationTypeReference', 'NotAllowed');

% Build
rtwbuild(modelName);
```

The exported arxml code uses the specified package and name, as shown below.

```
<INTERNAL-BEHAVIORS>
  <SWC-INTERNAL-BEHAVIOR UUID="...">
    <SHORT-NAME>IB</SHORT-NAME>
    <DATA-TYPE-MAPPING-REFS>
      <DATA-TYPE-MAPPING-REF DEST="DATA-TYPE-MAPPING-SET">
        /myPkg/mySubpkg/MyMappingSets/MappingSetName</DATA-TYPE-MAPPING-REF>
    </DATA-TYPE-MAPPING-REFS>
```

```
...  
</SWC-INTERNAL-BEHAVIOR>  
</INTERNAL-BEHAVIORS>
```

Initialize Data with ApplicationValueSpecification

To initialize AUTOSAR data objects typed by application data type, R4.1 requires AUTOSAR application value specifications (`ApplicationValueSpecifications`). Embedded Coder provides the following support:

- The `arxml` importer uses `ApplicationValueSpecifications` found in imported `arxml` files to initialize the corresponding data objects in the Simulink model.
- If you select AUTOSAR schema 4.0 or later for a model that contains AUTOSAR parameters typed by application data type, code generation exports `arxml` code that uses `ApplicationValueSpecifications` to specify initial values for AUTOSAR data.

For AUTOSAR parameters typed by implementation data type, code generation exports `arxml` code that uses `NumericalValueSpecifications` and (for enumerated types) `TextValueSpecifications` to specify initial values. If initial values for parameters specify multiple values, generated code uses `ArrayValueSpecifications`.

Automatic AUTOSAR Data Type Generation

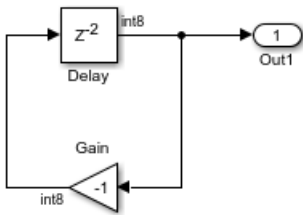
When you generate AUTOSAR-compliant C code for an AUTOSAR component model, Embedded Coder generates AUTOSAR platform data types in the code. AUTOSAR type generation allows you to generate AUTOSAR platform data types for top models, referenced models, and shared utilities without configuring Simulink data type replacement.

The AUTOSAR standard defines platform data types for use by AUTOSAR software components. In Simulink, you can model AUTOSAR data types used in elements such as data elements, operation arguments, calibration parameters, measurement variables, and inter-runnable variables. To model AUTOSAR data types, use corresponding Simulink built-in data types. For more information, see “Model AUTOSAR Data Types” on page 2-53.

When you build your AUTOSAR model, C code generation replaces Simulink data types with corresponding AUTOSAR data types, based on your AUTOSAR schema version.

Simulink Data Type	AUTOSAR Data Type	
	R4.x Platform Type	R2.x/3.x Primitive Type
boolean	boolean	Boolean
single	float32	Float
double	float64	Double
int8	sint8	Sint8
int16	sint16	Sint16
int32	sint32	Sint32
uint8	uint8	Uint8
uint16	uint16	Uint16
uint32	uint32	Uint32

For example, suppose that you create a simple AUTOSAR model containing Gain and Delay blocks, set the AUTOSAR schema version to 4.0 or higher, and set the Gain block parameter **Output data type** to `int8`. When you generate code, in place of Simulink data type `int8`, the AUTOSAR-compliant C code references AUTOSAR data type `sint8`.



```
void Runnable_Step(void)
{
    sint8 rtb_Delay;
    ...

    simple_DW.Delay_DSTATE[1] = (sint8)-rtb_Delay;
}
```

See Also

More About

- “Model AUTOSAR Data Types” on page 2-53

Configure and Map AUTOSAR Component Programmatically

In Simulink, as an alternative to graphical configuration, you can programmatically configure an AUTOSAR software component. The AUTOSAR property and map functions allow you to get, set, add, and remove the same component properties and mapping information displayed in the AUTOSAR Dictionary and Code Mappings editor views of the AUTOSAR component model.

In this section...
“AUTOSAR Property and Map Functions” on page 4-332
“Tree View of AUTOSAR Configuration” on page 4-333
“Properties of AUTOSAR Elements” on page 4-334
“Specify AUTOSAR Element Location” on page 4-338

AUTOSAR Property and Map Functions

You can use AUTOSAR property and map functions to programmatically configure the Simulink representation of an AUTOSAR software component. For example:

- Use the AUTOSAR property functions to add AUTOSAR elements, find elements, get and set properties of elements, delete elements, and define arxml packaging of elements.
- Use the AUTOSAR map functions to map Simulink model elements to AUTOSAR elements and return AUTOSAR mapping information for model elements.

The AUTOSAR property and map functions also validate syntax and semantics for requested AUTOSAR property and mapping changes.

For a complete list of property and map functions, see the functions listed for “Component Development”.

For example scripts, see “AUTOSAR Property and Map Function Examples” on page 4-340.

Note For information about functions for creating or importing an AUTOSAR software component, see “Component Creation”.

Tree View of AUTOSAR Configuration

The following tree view of an AUTOSAR configuration shows the types of AUTOSAR elements to which you can apply AUTOSAR property and map functions. This view corresponds with the AUTOSAR Dictionary tree display, but includes elements that might not be present in every configuration. Names shown in *italics* are user-selected.

- AUTOSAR
 - AtomicComponents
 - *MyComponent*
 - ReceiverPorts
 - SenderPorts
 - SenderReceiverPorts
 - ModeReceiverPorts
 - ModeSenderPorts
 - ClientPorts
 - ServerPorts
 - NvReceiverPorts
 - NvSenderPorts
 - NvSenderReceiverPorts
 - ParameterReceiverPorts
 - TriggerReceiverPorts
 - Runnables
 - IRV
 - Parameters
 - S-R Interfaces
 - *SRInterface1*
 - DataElements
 - M-S Interfaces
 - *MSInterface1*

- C-S Interfaces
 - *CSInterface1*
 - Operations
 - *operation1*
 - Arguments
- NV Interfaces
 - *NVInterface1*
 - DataElements
- Parameter Interfaces
 - *ParameterInterface1*
 - DataElements
- Trigger Interfaces
 - *TriggerInterface1*
 - Triggers
- CompuMethods
- XML Options

Properties of AUTOSAR Elements

The following table lists properties that are associated with AUTOSAR elements.

AUTOSAR Element Class	Properties
AtomicComponent	<ul style="list-style-type: none"> • ReceiverPorts (add/delete) • SenderPorts (add/delete) • SenderReceiverPorts (add/delete) • ModeReceiverPorts (add/delete) • ClientPorts (add/delete) • ServerPorts (add/delete) • NvReceiverPorts (add/delete) • NvSenderPorts (add/delete) • NvSenderReceiverPorts (add/delete) • ParameterReceiverPorts (add/delete) • TriggerReceiverPorts (add/delete) • Behavior (add/delete) • Kind • Name
ApplicationComponentBehavior	<ul style="list-style-type: none"> • Runnables (add/delete) • Events (add/delete) • PIM (add/delete) • IRV (add/delete) • Parameters (add/delete) • IncludedDataTypeSets • DataTypeMapping • Name

AUTOSAR Element Class	Properties
DataReceiverPort DataSenderPort DataSenderReceiverPort ClientPort ServerPort ModeReceiverPort NvDataReceiverPort NvDataSenderPort NvDataSenderReceiverPort ParameterReceiverPort TriggerReceiverPort	<ul style="list-style-type: none"> • Interface • Name
Runnable	<ul style="list-style-type: none"> • symbol • canBeInvokedConcurrently • SwAddrMethod • Name
TimingEvent	<ul style="list-style-type: none"> • Period • StartOnEvent • DisabledMode • Name
DataReceivedEvent DataReceiveErrorEvent OperationInvokedEvent	<ul style="list-style-type: none"> • Trigger • StartOnEvent • DisabledMode • Name
ModeSwitchEvent	<ul style="list-style-type: none"> • Trigger • Activation • StartOnEvent • DisabledMode • Name
InitEvent	<ul style="list-style-type: none"> • StartOnEvent • Name

AUTOSAR Element Class	Properties
IrvData	<ul style="list-style-type: none"> • Type • SwAddrMethod • SwCalibrationAccess • DisplayFormat • SwAlignment • Name
ParameterData	<ul style="list-style-type: none"> • Type • SwAddrMethod • SwCalibrationAccess • DisplayFormat • SwAlignment • Kind • Name
SenderReceiverInterface NvDataInterface ParameterInterface	<ul style="list-style-type: none"> • DataElements (add/delete) • IsService • Name
FlowData	<ul style="list-style-type: none"> • Type • SwAddrMethod • SwCalibrationAccess • DisplayFormat • SwAlignment • Name
ModeSwitchInterface	<ul style="list-style-type: none"> • ModeGroup (add/delete) • IsService • Name
ModeDeclarationGroupElement	<ul style="list-style-type: none"> • ModeGroup • SwCalibrationAccess • Name

AUTOSAR Element Class	Properties
ClientServerInterface	<ul style="list-style-type: none"> • Operations (add/delete) • IsService • Name
TriggerInterface	<ul style="list-style-type: none"> • Triggers (add/delete) • IsService • Name

Specify AUTOSAR Element Location

The AUTOSAR property functions typically require you to specify the name and location of an element. The location of an AUTOSAR element within a hierarchy of AUTOSAR packages and objects can be uniquely specified using a fully qualified path. A fully qualified path might include a package hierarchy and the element location within the object hierarchy, for example:

```
/pkgLevel1/pkgLevel2/pkgLevel3/grandParentName/parentName/childName
```

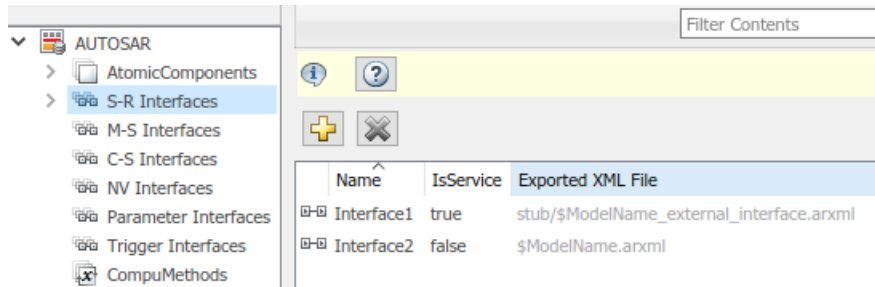
For AUTOSAR property functions other than `addPackageableElement`, you can specify a partially-qualified path that does not include the package hierarchy, for example:

```
grandParentName/parentName/childName
```

The following code sets the `IsService` property for the Sender-Receiver Interface located at path `Interface1` in the example model `autosar_swc_expfncs` to `true`. In this case, specifying the name `Interface1` is enough to locate the element.

```
hModel = 'autosar_swc_expfncs';
open_system(hModel);
arProps = autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'Interface1', 'IsService', true);
```

Here is the resulting display in the **S-R Interfaces** view in the AUTOSAR Dictionary.



If you added a Sender-Receiver Interface to a component package, you would specify a fully qualified path, for example:

```
hModel = 'autosar_swc_expfcns';
open_system(hModel);
arProps = autosar.api.getAUTOSARProperties(hModel);
addPackageableElement(arProps, 'SenderReceiverInterface', '/pkg/if', 'Interface3', ...
    'IsService', true);
```

A potential advantage of using a partially qualified path rather than a fully-qualified path is that it is easier to construct a partially qualified path from looking at the AUTOSAR Dictionary view of the AUTOSAR component. A potential disadvantage is that a partially qualified path could refer to more than one element in the AUTOSAR configuration. For example, the path s/r conceivably might designate both a data element of a Sender-Receiver Interface and a runnable of a component. When a conflict occurs, the software displays an error and lists the fully-qualified paths.

Most AUTOSAR elements have properties that are made up of multiple parts (composite). For example, an atomic software component has composite properties such as ReceiverPorts, SenderPorts, and InternalBehavior. For elements that have composite properties that you can manipulate, such as property ReceiverPorts of a component, child elements are named and are uniquely defined within the parent element. To locate a child element within a composite property, use the parent element path and the child name, without the property name. For example, if the qualified path of a parent atomic software component is /A/B/SWC, and a child receiver port is named RPort1, the location of the receiver port is /A/B/SWC/RPort1.

AUTOSAR Property and Map Function Examples

After creating a Simulink model representation of an AUTOSAR software component, you refine the AUTOSAR configuration. You can refine the AUTOSAR configuration graphically, using the AUTOSAR Dictionary and the Code Mappings editor, or programmatically, using the AUTOSAR property and map functions.

This topic provides examples of using AUTOSAR property and map functions to programmatically refine an AUTOSAR configuration. The examples assume that you have created a Simulink model with an initial AUTOSAR configuration, as described in “Component Creation”. (To graphically refine an AUTOSAR configuration, see “AUTOSAR Component Configuration” on page 4-3.)

Here is representative ordering of programmatic configuration tasks.

- 1 “Configure AUTOSAR Software Component” on page 4-341
 - a “Configure AUTOSAR Software Component Name and Type” on page 4-341
 - b “Configure AUTOSAR Ports” on page 4-342
 - c “Configure AUTOSAR Runnables and Events” on page 4-346
 - d “Configure AUTOSAR Inter-Runnable Variables” on page 4-351
- 2 “Configure AUTOSAR Interfaces” on page 4-353
 - a “Configure AUTOSAR Sender-Receiver Interfaces” on page 4-354
 - b “Configure AUTOSAR Client-Server Interfaces” on page 4-356
 - c “Configure AUTOSAR Mode-Switch Interfaces” on page 4-359
- 3 “Configure AUTOSAR XML Export” on page 4-361

For a list of AUTOSAR property and map functions, see the **Functions** list on the “AUTOSAR Programmatic Interfaces” page.

The examples use a function call format in which a handle to AUTOSAR properties or mapping information is passed as the first call argument:

```
arProps = autosar.api.getAUTOSARProperties(hModel);  
swc = get(arProps, 'XmlOptions', 'ComponentQualified_name');
```

The same calls can be coded in a method call format. The formats are interchangeable. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);  
swc = arProps.get('XmlOptions', 'ComponentQualified_name');
```

While configuring a model for AUTOSAR code generation, use the following functions to update and validate AUTOSAR model configurations:

- `autosar.api.syncModel` — Update Simulink to AUTOSAR mapping of specified model with modifications to Simulink entry-point functions, data transfers, and function callers.
- `autosar.api.validateModel` — Validate AUTOSAR properties and Simulink to AUTOSAR mapping of specified model.

The functions are equivalent to using the **Update**  and **Validate**  buttons in the Code Mappings editor.

Configure AUTOSAR Software Component

- “Configure AUTOSAR Software Component Name and Type” on page 4-341
- “Configure AUTOSAR Ports” on page 4-342
- “Configure AUTOSAR Runnables and Events” on page 4-346
- “Configure AUTOSAR Inter-Runnable Variables” on page 4-351

Configure AUTOSAR Software Component Name and Type

This example:

- 1 Opens a model.
- 2 Finds AUTOSAR software components.
- 3 Loops through components and lists property values.
- 4 Modifies the name and kind properties for a component.

```
% Open model
hModel = 'autosar_swc_expfcns';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Find AUTOSAR software components
aswcPaths = find(arProps,[],'AtomicComponent','PathType','FullyQualified');

% Loop through components and list Name and Kind property values
for ii=1:length(aswcPaths)
    aswcPath = aswcPaths{ii};
    swcName = get(arProps,aswcPath,'Name');
    swcKind = get(arProps,aswcPath,'Kind'); % Application, SensorActuator, etc.
```

```
    fprintf('Component %s: Name %s, Kind %s\n', aswcPath, swcName, swcKind);
end

Component /pkg/swc/ASWC: Name ASWC, Kind Application

% Modify component Name and Kind
aswcName = 'mySwc';
aswcKind = 'SensorActuator';
set(arProps, aswcPaths{1}, 'Name', aswcName);
aswcPaths = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');
set(arProps, aswcPaths{1}, 'Kind', aswcKind);
swcName = get(arProps, aswcPaths{1}, 'Name');
swcKind = get(arProps, aswcPaths{1}, 'Kind');
fprintf('Component %s: Name %s, Kind %s\n', aswcPaths{1}, swcName, swcKind);

Component /pkg/swc/mySwc: Name mySwc, Kind SensorActuator
```

Configure AUTOSAR Ports

There are three types of AUTOSAR ports:

- Require (In)
- Provide (Out)
- Combined Provide-Require (InOut)

AUTOSAR ports can reference the following kinds of AUTOSAR communication interfaces:

- Sender-Receiver
- Client-Server
- Mode-Switch

The properties and mapping that you can set for an AUTOSAR port vary according to the type of interface it references. These examples show how to use the AUTOSAR property and map functions to configure AUTOSAR ports for each type of interface.

- “Configure and Map Sender-Receiver Ports” on page 4-342
- “Configure Client-Server Ports” on page 4-344
- “Configure and Map Mode Receiver Ports” on page 4-344

Configure and Map Sender-Receiver Ports

This example:

- 1 Opens a model.
- 2 Finds AUTOSAR sender or receiver ports.

- 3 Loops through the ports and lists associated sender-receiver interfaces.
- 4 Modifies the associated interface for a port.
- 5 Maps a Simulink inport to an AUTOSAR receiver port.

See also “Configure AUTOSAR Sender-Receiver Interfaces” on page 4-354.

```
% Open model
hModel = 'autosar_swc_expfncs';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Find AUTOSAR ports - specify DataReceiverPort, DataSenderPort, or DataSenderReceiverPort
arPortType = 'DataReceiverPort';
aswcPath = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');
rPorts=find(arProps, aswcPath{1}, arPortType, 'PathType', 'FullyQualified')

rPorts =
    {'/pkg/swc/ASWC/RPort'}

% Loop through ports and list their associated interfaces
for ii=1:length(rPorts)
    rPort = rPorts{ii};
    portIf = get(arProps, rPort, 'Interface');
    fprintf('Port %s has S-R interface %s\n', rPort, portIf);
end

Port /pkg/swc/ASWC/RPort has S-R interface Interface1

% Set Interface property for AUTOSAR port
rPort = '/pkg/swc/ASWC/RPort';
set(arProps, rPort, 'Interface', 'Interface2')
portIf = get(arProps, rPort, 'Interface');
fprintf('Port %s has S-R interface %s\n', rPort, portIf);

Port /pkg/swc/ASWC/RPort has S-R interface Interface2

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Get AUTOSAR mapping info for Simulink inport
[arPortName, arDataElementName, arDataAccessMode]=getInport(slMap, 'RPort_DE2')

arPortName =
    'RPort'

arDataElementName =
    0x0 empty char array

arDataAccessMode =
    'ImplicitReceive'

% Map Simulink inport to AUTOSAR port, data element, and data access mode
mapInport(slMap, 'RPort_DE2', 'RPort', 'DE2', 'ExplicitReceive')
[arPortName, arDataElementName, arDataAccessMode]=getInport(slMap, 'RPort_DE2')

arPortName =
    RPort

arDataElementName =
```

DE2

```
arDataAccessMode =  
ExplicitReceive
```

Configure Client-Server Ports

This example:

- 1 Opens a model.
- 2 Finds AUTOSAR client or server ports.
- 3 Loops through the ports and lists associated client-server interfaces.
- 4 Modifies the associated interface for a port.

See also “Configure AUTOSAR Client-Server Interfaces” on page 4-356.

```
% Open model  
hModel = 'mControllerWithInterface_server';  
addpath (fullfile(matlabroot,'help/toolbox/autosar/examples'));  
open_system(hModel);  
  
% Use AUTOSAR property functions  
arProps = autosar.api.getAUTOSARProperties(hModel);  
  
% Find AUTOSAR ports - specify ServerPort or ClientPort  
arPortType = 'ServerPort';  
aswcPath = find(arProps,[],'AtomicComponent','PathType','FullyQualified');  
sPorts=find(arProps,aswcPath{1},arPortType,'PathType','FullyQualified');  
  
% Loop through ports and list their associated interfaces  
for ii=1:length(sPorts)  
    sPort = sPorts{ii};  
    portIf = get(arProps,sPort,'Interface');  
    fprintf('Port %s has C-S interface %s\n',sPort,portIf);  
end  
  
Port /pkg/swc/SWC_Controller/sPort has C-S interface CsIf1  
  
% Set Interface property for AUTOSAR port  
set(arProps,sPorts{1},'Interface','CsIf2')  
portIf = get(arProps,sPorts{1},'Interface');  
fprintf('Port %s has C-S interface %s\n',sPorts{1},portIf);  
  
Port /pkg/swc/SWC_Controller/sPort has C-S interface CsIf2
```

Configure and Map Mode Receiver Ports

This example:

- 1 Opens a model.
- 2 Finds AUTOSAR mode receiver ports.
- 3 Loops through the ports and lists associated mode-switch interfaces.

- 4 Modifies the associated interface for a port.
- 5 Maps a Simulink inport to an AUTOSAR mode receiver port.

See also “Configure AUTOSAR Mode-Switch Interfaces” on page 4-359.

```
% Add path to model and mode definition files and open model
addpath (fullfile(matlabroot, '/help/toolbox/autosar/examples'));
hModel = 'mAutosarMsConfigAfter';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Find AUTOSAR mode receiver ports
arPortType = 'ModeReceiverPort';
aswcPath = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');
mrPorts=find(arProps,aswcPath{1},arPortType, 'PathType', 'FullyQualified');

% Loop through ports and list their associated interfaces
for ii=1:length(mrPorts)
    mrPort = mrPorts{ii};
    portIf = get(arProps,mrPort,'Interface');
    fprintf('Port %s has M-S interface %s\n',mrPort,portIf);
end

Port /pkg/swc/ASWC/myMRPort has M-S interface myMsIf

% Set Interface property for AUTOSAR port
set(arProps,mrPorts{1},'Interface','MsIf2')
portIf = get(arProps,mrPort,'Interface');
fprintf('Port %s has M-S interface %s\n',mrPorts{1},portIf);

Port /pkg/swc/ASWC/myMRPort has M-S interface MsIf2

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Get AUTOSAR mapping info for Simulink inport
[arPortName,arDataElementName,arDataAccessMode]=getInport(slMap,'MRPort')

arPortName =
    'myMRPort'

arDataElementName =
    0x0 empty char array

arDataAccessMode =
    'ModeReceive'

% Map Simulink inport to AUTOSAR port, mode group, and data access mode
mapInport(slMap,'MRPort','myMRPort','mdgModes','ModeReceive')
[arPortName,arDataElementName,arDataAccessMode]=getInport(slMap,'MRPort')

arPortName =
    'myMRPort'

arDataElementName =
    'mdgModes'

arDataAccessMode =
    'ModeReceive'
```

Configure AUTOSAR Runnables and Events

The behavior of an AUTOSAR software component is implemented by one or more runnables. An AUTOSAR runnable is a schedulable entity that is directly or indirectly scheduled by the underlying AUTOSAR operating system. Each runnable is triggered by RTEEvents, events generated by the AUTOSAR run-time environment (RTE). For each runnable, you configure an event to which it responds. Here are examples of AUTOSAR events to which runnables respond.

- `TimingEvent` — Triggers a periodic runnable.
- `DataReceivedEvent` or `DataReceiveErrorEvent` — Triggers a runnable with a receiver port that is participating in sender-receiver communication.
- `OperationInvokedEvent` — Triggers a runnable with a server port that is participating in client-server communication.
- `ModeSwitchEvent` — Triggers a runnable with a mode receiver port that is participating in mode-switch communication.
- `InitEvent` (AUTOSAR schema 4.1 or higher) — Triggers a runnable that performs component initialization.
- `ExternalTriggerOccurredEvent` — Triggers a runnable with a trigger receiver port that is participating in external trigger event communication.
- “Configure AUTOSAR `TimingEvent` for Periodic Runnable” on page 4-346
- “Configure and Map Runnables” on page 4-348
- “Configure Events for Runnable Activation” on page 4-349
- “Gather Information for AUTOSAR Custom Scheduler Script” on page 4-350

Configure AUTOSAR `TimingEvent` for Periodic Runnable

This example:

- 1 Opens a model.
- 2 Finds AUTOSAR runnables.
- 3 Loops through runnables and lists properties.
- 4 Modifies the name and symbol for an AUTOSAR periodic runnable.
- 5 Loops through AUTOSAR timing events and lists associated runnables.
- 6 Renames an AUTOSAR timing event.
- 7 Maps a Simulink entry-point function to an AUTOSAR periodic runnable.


```

% Open model
hModel = 'autosar_swc_expfncs';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Find AUTOSAR runnables
swc = get(arProps,'XmlOptions','ComponentQualifiedNames');
ib = get(arProps,swc,'Behavior');
runnables = find(arProps,ib,'Runnable','PathType','FullyQualified');
runnables{2}

ans =
    '/pkg/swc/ASWC/IB/Runnable1'

% Loop through runnables and list property values
for ii=1:length(runnables)
    runnable = runnables{ii};
    rnName = get(arProps,runnable,'Name');
    rnSymbol = get(arProps,runnable,'symbol');
    rnCBIC = get(arProps,runnable,'canBeInvokedConcurrently');
    fprintf('Runnable %s: symbol %s, canBeInvokedConcurrently %u\n',...
        rnName,rnSymbol,rnCBIC);
end

Runnable Runnable_Init: symbol Runnable_Init, canBeInvokedConcurrently 0
Runnable Runnable1: symbol Runnable1, canBeInvokedConcurrently 0
Runnable Runnable2: symbol Runnable2, canBeInvokedConcurrently 0
Runnable Runnable3: symbol Runnable3, canBeInvokedConcurrently 0

% Modify Runnable1 name and symbol
set(arProps,runnables{2},'Name','myRunnable','symbol','myAlgorithm');
runnables = find(arProps,ib,'Runnable','PathType','FullyQualified');
rnName = get(arProps,runnables{2},'Name');
rnSymbol = get(arProps,runnables{2},'symbol');
rnCBIC = get(arProps,runnables{2},'canBeInvokedConcurrently');
fprintf('Runnable %s: symbol %s, canBeInvokedConcurrently %u\n',...
    rnName,rnSymbol,rnCBIC);

Runnable myRunnable: symbol myAlgorithm, canBeInvokedConcurrently 0

% Loop through AUTOSAR timing events and list runnable associations
events = find(arProps,ib,'TimingEvent','PathType','FullyQualified');
for ii=1:length(events)
    event = events{ii};
    eventStartOn = get(arProps,event,'StartOnEvent');
    fprintf('AUTOSAR event %s triggers %s\n',event,eventStartOn);
end

AUTOSAR event /pkg/swc/ASWC/IB/Event_t_ltic_A triggers ASWC/IB/myRunnable
AUTOSAR event /pkg/swc/ASWC/IB/Event_t_ltic_B triggers ASWC/IB/Runnable2
AUTOSAR event /pkg/swc/ASWC/IB/Event_t_l0tic triggers ASWC/IB/Runnable3

% Modify AUTOSAR event name
set(arProps,events{1},'Name','myEvent');
events = find(arProps,ib,'TimingEvent','PathType','FullyQualified');
eventStartOn = get(arProps,events{1},'StartOnEvent');
fprintf('AUTOSAR event %s triggers %s\n',events{1},eventStartOn);

AUTOSAR event /pkg/swc/ASWC/IB/myEvent triggers ASWC/IB/myRunnable

% Use AUTOSAR map functions
slMap=autosar.api.getSimuLinkMapping(hModel);

```

```
% Map Simulink exported function Runnable1 to renamed AUTOSAR runnable
mapFunction(slMap, 'Runnable1', 'myRunnable');
arRunnableName = getFunction(slMap, 'Runnable1')

arRunnableName =
    'myRunnable'
```

Configure and Map Runnables

This example:

- 1 Opens a model.
- 2 Adds AUTOSAR initialization and periodic runnables to the model.
- 3 Adds a timing event to the periodic runnable.
- 4 Maps Simulink initialization and step functions to the AUTOSAR runnables.

See also “Configure Events for Runnable Activation” on page 4-349.

```
% Open model
hModel = 'autosar_swc_counter';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Add AUTOSAR initialization and periodic runnables
initRunnable = 'myInitRunnable';
periodicRunnable = 'myPeriodicRunnable';
swc = get(arProps, 'XmlOptions', 'ComponentQualified_name')
ib = get(arProps, swc, 'Behavior')
add(arProps, ib, 'Runnables', initRunnable);
add(arProps, ib, 'Runnables', periodicRunnable);

% Add AUTOSAR timing event
eventName = 'myPeriodicEvent';
add(arProps, ib, 'Events', eventName, 'Category', 'TimingEvent', 'Period', 1, ...
    'StartOnEvent', [ib '/' periodicRunnable]);

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Map AUTOSAR runnables to Simulink initialize and step functions
mapFunction(slMap, 'InitializeFunction', initRunnable);
mapFunction(slMap, 'StepFunction', periodicRunnable);

% To pass validation, remove redundant initialize and step runnables in AUTOSAR configuration
runnables = get(arProps, ib, 'Runnables');
delete(arProps, [ib, '/Runnable_Init']);
delete(arProps, [ib, '/Runnable_Step']);
runnables = get(arProps, ib, 'Runnables')

swc =
    '/Company/Powertrain/Components/autosar_swc_counter'

ib =
    'autosar_swc_counter/ASWC_IB'
```

```

runnables =
    {'autosar_swc_counter/ASWC_IB/myInitRunnable'}
    {'autosar_swc_counter/ASWC_IB/myPeriodicRunnable'}

```

Configure Events for Runnable Activation

This example shows the property function syntax for adding an AUTOSAR `TimingEvent`, `DataReceivedEvent`, and `DataReceiveErrorEvent` to a runnable in a model. For a `DataReceivedEvent` or `DataReceiveErrorEvent`, you specify a trigger. The trigger name includes the name of the AUTOSAR receiver port and data element that receives the event, for example, `'RPort.DE1'`.

For `OperationInvokedEvent` syntax, see “Configure AUTOSAR Client-Server Interfaces” on page 4-356.

For `ModeSwitchEvent` syntax, see “Configure AUTOSAR Mode-Switch Interfaces” on page 4-359.

```

% Open model
hModel = 'autosar_swc_expfncs';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Specify AUTOSAR runnable to which to add event
swc = get(arProps,'XmlOptions','ComponentQualifiedNames');
ib = get(arProps,swc,'Behavior');
runnables = get(arProps,ib,'Runnables');
runnable = 'Runnable1';

% Add AUTOSAR timing event
timingEventName = 'myTimingEvent';
add(arProps,ib,'Events',timingEventName,'Category','TimingEvent',...
    'Period',1,'StartOnEvent',[ib '/' runnable]);

% Add AUTOSAR data received event
drEventName = 'myDREvent';
add(arProps,ib,'Events',drEventName,'Category','DataReceivedEvent',...
    'Trigger','RPort.DE1','StartOnEvent',[ib '/' runnable]);

% Add AUTOSAR data receive error event
dreEventName = 'myDREEvent';
add(arProps,ib,'Events',dreEventName,'Category','DataReceiveErrorEvent',...
    'Trigger','RPort.DE1','StartOnEvent',[ib '/' runnable]);

% To pass validation, remove redundant timing event in AUTOSAR configuration
events = get(arProps,ib,'Events');
delete(arProps,[ib,'/Event_t_ttic_A']);
events = get(arProps,ib,'Events')

swc =
    '/pkg/swc/ASWC'

ib =
    'ASWC/IB'

```

```
runnables =
    {'ASWC/IB/Runnable_Init'}    {'ASWC/IB/Runnable1'}
    {'ASWC/IB/Runnable2'}    {'ASWC/IB/Runnable3'}

events =
    {'ASWC/IB/Event_t_ltic_B'}    {'ASWC/IB/Event_t_l0tic'}    {'ASWC/IB/myTimingEvent'}
    {'ASWC/IB/myDREvent'}    {'ASWC/IB/myDREvent'}
```

Gather Information for AUTOSAR Custom Scheduler Script

This example:

- 1 Loops through events and runnables in an open model.
- 2 For each event or runnable, extracts information to use with a custom scheduler.

`hModel` specifies the name of an open AUTOSAR model.

```
% Example of how to extract timing information for runnables
% to prepare for hooking up a custom scheduler

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

swc = get(arProps, 'XmlOptions', 'ComponentQualifiedNames');

% Get AUTOSAR internal behavior
ib = get(arProps, swc, 'Behavior');

% Get AUTOSAR events and runnables
events = get(arProps, ib, 'Events');
runnables = get(arProps, ib, 'Runnables');

% Loop through events
for ii=1:length(events)
    event = events{ii};
    category = get(arProps, event, 'Category');

    switch category
        case 'TimingEvent'
            runnablePath = get(arProps, event, 'StartOnEvent');
            period = get(arProps, event, 'Period');
            eventName = get(arProps, event, 'Name');
            runnableName = get(arProps, runnablePath, 'Name');
            fprintf('Event %s triggers runnable %s with period %g\n', eventName, runnableName, period);
        otherwise
            % Not interested in other events
    end
end

% Loop through runnables
for ii=1:length(runnables)
    runnable = runnables{ii};
    runnableName = get(arProps, runnable, 'Name');
    runnableSymbol = get(arProps, runnable, 'symbol');
    fprintf('Runnable %s has symbol %s\n', runnableName, runnableSymbol);
end
```

Running the example code on the example model `autosar_swc_expfncs` generates the following output:

```
Event Event_t_ltic_A triggers runnable Runnable1 with period 1
Event Event_t_ltic_B triggers runnable Runnable2 with period 1
Event Event_t_l0tic triggers runnable Runnable3 with period 10
Runnable Runnable_Init has symbol Runnable_Init
Runnable Runnable1 has symbol Runnable1
Runnable Runnable2 has symbol Runnable2
Runnable Runnable3 has symbol Runnable3
```

Running the example code on the example model `matlabroot/help/toolbox/autosar/examples/mMultitasking_4rates.slx` generates the following output:

```
Event Event_Runnable_Step triggers runnable Runnable_Step with period 1
Event Event_Runnable_Step1 triggers runnable Runnable_Step1 with period 2
Event Event_Runnable_Step2 triggers runnable Runnable_Step2 with period 4
Event Event_Runnable_Step3 triggers runnable Runnable_Step3 with period 8
Runnable Runnable_Init has symbol Runnable_Init
Runnable Runnable_Step has symbol Runnable_Step
Runnable Runnable_Step1 has symbol Runnable_Step1
Runnable Runnable_Step2 has symbol Runnable_Step2
Runnable Runnable_Step3 has symbol Runnable_Step3
```

Configure AUTOSAR Inter-Runnable Variables

In an AUTOSAR software component with multiple runnables, inter-runnable variables (IRVs) are used to communicate data between runnables. In Simulink, you model IRVs using data transfer lines that connect subsystems. In an application with multiple rates, the data transfer lines might include Rate Transition blocks to handle transitions between differing rates.

These examples show how to use the AUTOSAR property and map functions to configure AUTOSAR IRVs without or with rate transitions.

- “Configure Inter-Runnable Variable for Data Transfer Line” on page 4-351
- “Configure Inter-Runnable Variable for Data Transfer with Rate Transition” on page 4-352

Configure Inter-Runnable Variable for Data Transfer Line

This example:

- 1 Opens a model.
- 2 Adds an AUTOSAR inter-runnable variable (IRV) to the model.
- 3 Maps a Simulink data transfer to the IRV.

```
% Open model
hModel = 'autosar_swc_expfncs';
```

```
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Get AUTOSAR internal behavior and add IRV myIrv with SwCalibrationAccess ReadWrite
irvName = 'myIrv';
swCalibValue = 'ReadWrite';
swc = get(arProps,'XmlOptions','ComponentQualifiedNames');
ib = get(arProps,swc,'Behavior');
irvs = get(arProps,ib,'IRV');
add(arProps,ib,'IRV',irvName,'SwCalibrationAccess',swCalibValue);
irvs = get(arProps,ib,'IRV');

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Map Simulink signal irv1 to AUTOSAR IRV myIrv with access mode Explicit
irvAccess = 'Explicit';
[arIrvName,arDataAccessMode] = getDataTransfer(slMap,'irv1');
mapDataTransfer(slMap,'irv1',irvName,irvAccess);
[arIrvName,arDataAccessMode] = getDataTransfer(slMap,'irv1');

% To pass validation, remove redundant IRV in AUTOSAR configuration
irvs = get(arProps,ib,'IRV');
delete(arProps,[ib,'/IRV1']);
irvs = get(arProps,ib,'IRV')

swc =
    '/pkg/swc/ASWC'

ib =
    'ASWC/IB'

irvs =
    {'ASWC/IB/IRV1'}    {'ASWC/IB/IRV2'}
    {'ASWC/IB/IRV3'}    {'ASWC/IB/IRV4'}

arIrvName =
    'myIrv'

arDataAccessMode =
    'Explicit'

irvs =
    {'ASWC/IB/IRV2'}    {'ASWC/IB/IRV3'}
    {'ASWC/IB/IRV4'}    {'ASWC/IB/myIrv'}
```

Configure Inter-Runnable Variable for Data Transfer with Rate Transition

This example:

- 1 Opens a model with multiple rates.
- 2 Adds an AUTOSAR inter-runnable variable (IRV) to the model.
- 3 Maps a Simulink Rate Transition block to the IRV.

```
% Open model
hModel = 'mMultitasking_4rates';
addpath (fullfile(matlabroot,'/help/toolbox/autosar/examples'));
```

```

open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Get AUTOSAR internal behavior and add IRV myIrv with SwCalibrationAccess ReadWrite
irvName = 'myIrv';
swCalibValue = 'ReadWrite';
swc = get(arProps,'XmlOptions','ComponentQualifiedNames');
ib = get(arProps,swc,'Behavior');
irvs = get(arProps,ib,'IRV');
add(arProps,ib,'IRV',irvName,'SwCalibrationAccess',swCalibValue);
irvs = get(arProps,ib,'IRV');

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Map Simulink RT block RateTransition2 to AUTOSAR IRV myIrv with access mode Explicit
irvAccess = 'Explicit';
[arIrvName,arDataAccessMode] = getDataTransfer(slMap,'mMultitasking_4rates/RateTransition2');
mapDataTransfer(slMap,'mMultitasking_4rates/RateTransition2',irvName,irvAccess);
[arIrvName,arDataAccessMode] = getDataTransfer(slMap,'mMultitasking_4rates/RateTransition2');

% To pass validation, remove redundant IRV in AUTOSAR configuration
irvs = get(arProps,ib,'IRV');
delete(arProps,[ib,'/IRV3']);
irvs = get(arProps,ib,'IRV')

swc =
    '/mMultitasking_4rates_pkg/mMultitasking_4rates_sw/mMultitasking_4rates'

ib =
    'mMultitasking_4rates/Behavior'

irvs =
    {'mMultitasking_4rates/Behavior/IRV1'}    {'mMultitasking_4rates/Behavior/IRV2'}
    {'mMultitasking_4rates/Behavior/IRV3'}

arIrvName =
    'myIrv'

arDataAccessMode =
    'Explicit'

irvs =
    {'mMultitasking_4rates/Behavior/IRV1'}    {'mMultitasking_4rates/Behavior/IRV2'}
    {'mMultitasking_4rates/Behavior/myIrv'}

```

Configure AUTOSAR Interfaces

AUTOSAR software components can use ports and interfaces to implement the following forms of communication:

- Sender-receiver (S-R)
- Client-server (C-S)
- Mode-switch (M-S) — introduced in AUTOSAR Release 4.0

- Nonvolatile (NV) data — introduced in AUTOSAR Release 4.0

These examples show how to use AUTOSAR property and map functions to configure AUTOSAR ports, interfaces, and related elements for S-R, C-S, and M-S communication. The techniques shown for configuring S-R ports and interfaces also broadly apply to NV communication.

- “Configure AUTOSAR Sender-Receiver Interfaces” on page 4-354
- “Configure AUTOSAR Client-Server Interfaces” on page 4-356
- “Configure AUTOSAR Mode-Switch Interfaces” on page 4-359

Configure AUTOSAR Sender-Receiver Interfaces

- “Configure and Map Sender-Receiver Interface” on page 4-354
- “Configure Sender-Receiver Data Element Properties” on page 4-355

Configure and Map Sender-Receiver Interface

This example:

- 1 Opens a model.
- 2 Adds an AUTOSAR sender-receiver interface to the model.
- 3 Adds data elements.
- 4 Creates sender and receiver ports.
- 5 Maps Simulink inports and outports to AUTOSAR receiver and sender ports.

See also “Configure AUTOSAR Runnables and Events” on page 4-346.

```
% Open model
hModel = 'autosar_swc_expfncs';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Add AUTOSAR S-R interface
ifName = 'mySrIf';
ifPkg = get(arProps,'XmlOptions','InterfacePackage')
addPackageableElement(arProps,'SenderReceiverInterface',ifPkg,ifName,'IsService',false);
ifPaths=find(arProps,[],'SenderReceiverInterface','PathType','FullyQualified')

% Add AUTOSAR S-R data elements with ReadWrite calibration access
de1 = 'myDE1';
de2 = 'myDE2';
swCalibValue= 'ReadWrite';
add(arProps, [ifPkg '/' ifName],'DataElements',de1,'SwCalibrationAccess',swCalibValue);
add(arProps, [ifPkg '/' ifName],'DataElements',de2,'SwCalibrationAccess',swCalibValue);
```



```

% Add AUTOSAR receiver and sender ports with S-R interface name
rPortName = 'myRPort';
pPortName = 'myPPort';
aswcPath = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');
add(arProps, aswcPath{1}, 'ReceiverPorts', rPortName, 'Interface', ifName);
add(arProps, aswcPath{1}, 'SenderPorts', pPortName, 'Interface', ifName);

% Use AUTOSAR map functions
slMap=autosar.api.getSimuLinkMapping(hModel);

% Map Simulink inport RPort_DE2 to AUTOSAR receiver port myRPort and data element myDE2
rDataAccessMode = 'ImplicitReceive';
[arPortName, arDataElementName, arDataAccessMode]=getInport(slMap, 'RPort_DE2')
mapInport(slMap, 'RPort_DE2', rPortName, de2, rDataAccessMode);
[arPortName, arDataElementName, arDataAccessMode]=getInport(slMap, 'RPort_DE2')

% Map Simulink outpost PPort_DE1 to AUTOSAR sender port myPPort and data element myDE1
sDataAccessMode = 'ImplicitSend';
[arPortName, arDataElementName, arDataAccessMode]=getOutput(slMap, 'PPort_DE1')
mapOutport(slMap, 'PPort_DE1', pPortName, de1, sDataAccessMode);
[arPortName, arDataElementName, arDataAccessMode]=getOutput(slMap, 'PPort_DE1')

ifPkg =
    '/pkg/if'

ifPaths =
    {'/pkg/if/Interface1'}    {'/pkg/if/Interface2'}    {'/pkg/if/mySrIf'}

arPortName =
    'RPort'
arDataElementName =
    'DE2'
arDataAccessMode =
    'ImplicitReceive'

arPortName =
    'myRPort'
arDataElementName =
    'myDE2'
arDataAccessMode =
    'ImplicitReceive'

arPortName =
    'PPort'
arDataElementName =
    'DE1'
arDataAccessMode =
    'ImplicitSend'

arPortName =
    'myPPort'
arDataElementName =
    'myDE1'
arDataAccessMode =
    'ImplicitSend'

```

Configure Sender-Receiver Data Element Properties

This example loops through AUTOSAR sender-receiver (S-R) interfaces and data elements to configure calibration properties for S-R data elements.

```
% Open model
hModel = 'autosar_swc_expfncs';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Configure SwCalibrationAccess for AUTOSAR data elements in S-R interfaces
srIfs = find(arProps,[],'SenderReceiverInterface','PathType','FullyQualified')

% Loop through S-R interfaces and get data elements
for i=1:length(srIfs)
    srIf = srIfs{i};
    dataElements = get(arProps,srIf,'DataElements','PathType','FullyQualified')

% Loop through data elements for each S-R interface and set SwCalibrationAccess
    swCalibValue = 'ReadWrite';
    for ii=1:length(dataElements)
        dataElement = dataElements{ii};
        set(arProps,dataElement,'SwCalibrationAccess',swCalibValue)
        get(arProps,dataElement,'SwCalibrationAccess');
    end
end

srIfs =
    {'/pkg/if/Interface1'}    {'/pkg/if/Interface2'}

dataElements =
    {'/pkg/if/Interface1/DE1'}    {'/pkg/if/Interface1/DE2'}

dataElements =
    {'/pkg/if/Interface2/DE1'}    {'/pkg/if/Interface2/DE2'}
    {'/pkg/if/Interface2/DE3'}    {'/pkg/if/Interface2/DE4'}
```

Configure AUTOSAR Client-Server Interfaces

- “Configure Server Properties” on page 4-356
- “Configure Client Properties” on page 4-358

Configure Server Properties

This example:

- 1 Opens a model.
- 2 Adds an AUTOSAR client-server interface to the model.
- 3 Adds an operation.
- 4 Creates a server port.
- 5 Creates a server runnable.
- 6 Maps a Simulink function to the AUTOSAR server runnable.

```
% Open model
hModel = 'mControllerWithInterface_server';
addpath (fullfile(matlabroot,'help/toolbox/autosar/examples'));
```

```

open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Add AUTOSAR C-S interface
ifName = 'myCsIf';
ifPkg = get(arProps, 'XmlOptions', 'InterfacePackage')
addPackageableElement(arProps, 'ClientServerInterface', ifPkg, ifName, 'IsService', false);
ifPaths=find(arProps, [], 'ClientServerInterface', 'PathType', 'FullyQualified');

% Add AUTOSAR operation to C-S interface
csOp = 'readData';
add(arProps, [ifPkg '/' ifName], 'Operations', csOp);

% Add AUTOSAR arguments to C-S operation with Direction and SwCalibrationAccess properties
args = {'Op', 'In'; 'Data', 'Out'; 'ERR', 'Out'; 'NegCode', 'Out'}
swCalibValue = 'ReadOnly';
for i=1:length(args)
    add(arProps, [ifPkg '/' ifName '/' csOp], 'Arguments', args{i,1}, 'Direction', args{i,2}, ...
        'SwCalibrationAccess', swCalibValue);
end
get(arProps, [ifPkg '/' ifName '/' csOp], 'Arguments')

% Add AUTOSAR server port with C-S interface name
sPortName = 'mySPort';
aswcPath = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');
add(arProps, aswcPath{1}, 'ServerPorts', sPortName, 'Interface', ifName);

% Add AUTOSAR server runnable with symbol name that matches Simulink function name
serverRunnable = 'Runnable_myReadData';
serverRunnableSymbol = 'readData';
swc = get(arProps, 'XmlOptions', 'ComponentQualifiedname')
ib = get(arProps, swc, 'Behavior')
runnables = get(arProps, ib, 'Runnables');
% To avoid symbol conflict, remove existing runnable with symbol name readData
delete(arProps, 'SWC_Controller/ControllerWithInterface_ar/Runnable_readData')
add(arProps, ib, 'Runnables', serverRunnable, 'symbol', serverRunnableSymbol);
runnables = get(arProps, ib, 'Runnables');

% Add AUTOSAR operation invoked event
oiEventName = 'Event_myReadData';
add(arProps, ib, 'Events', oiEventName, 'Category', 'OperationInvokedEvent', ...
    'Trigger', 'mySPort.readData', 'StartOnEvent', [ib '/' serverRunnable]);

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Map Simulink function readData to AUTOSAR runnable Runnable_myReadData
mapFunction(slMap, 'readData', serverRunnable);
arRunnableName=getFunction(slMap, 'readData')

ifPkg =
    '/ControllerWithInterface_ar_pkg/ControllerWithInterface_ar_if'

args =
    {'Op'      } {'In' }
    {'Data'   } {'Out'}
    {'ERR'    } {'Out'}
    {'NegCode'} {'Out'}

ans =
    {'myCsIf/readData/Op' } {'myCsIf/readData/Data' }

```

```
    {'myCsIf/readData/ERR'}    {'myCsIf/readData/NegCode'}  
  
swc =  
    '/pkg/swc/SWC_Controller'  
  
ib =  
    'SWC_Controller/ControllerWithInterface_ar'  
  
arRunnableName =  
    'Runnable_myReadData'
```

Configure Client Properties

This example:

- 1 Opens a model.
- 2 Adds an AUTOSAR client-server interface to the model.
- 3 Adds an operation.
- 4 Creates a client port.
- 5 Maps a Simulink function caller to the AUTOSAR client port and operation.

```
% Open model  
hModel = 'mControllerWithInterface_client';  
addpath (fullfile(matlabroot, '/help/toolbox/autosar/examples'));  
open_system(hModel);  
  
% Use AUTOSAR property functions  
arProps = autosar.api.getAUTOSARProperties(hModel);  
  
% Add AUTOSAR C-S interface  
ifName = 'myCsIf';  
ifPkg = get(arProps, 'XmlOptions', 'InterfacePackage');  
addPackageableElement(arProps, 'ClientServerInterface', ifPkg, ifName, 'IsService', false);  
ifPaths=find(arProps, [], 'ClientServerInterface', 'PathType', 'FullyQualified')
```

```
% Add AUTOSAR operation to C-S interface  
csOp = 'readData';  
add(arProps, [ifPkg '/' ifName], 'Operations', csOp);  
  
% Add AUTOSAR arguments to C-S operation with Direction and SwCalibrationAccess properties  
args = {'Op', 'In'; 'Data', 'Out'; 'ERR', 'Out'; 'NegCode', 'Out'}  
swCalibValue = 'ReadOnly';  
for i=1:length(args)  
    add(arProps, [ifPkg '/' ifName '/' csOp], 'Arguments', args{i,1}, 'Direction', args{i,2}, ...  
        'SwCalibrationAccess', swCalibValue);  
end  
get(arProps, [ifPkg '/' ifName '/' csOp], 'Arguments')
```

```
% Add AUTOSAR client port with C-S interface name  
cPortName = 'myCPort';  
aswcPath = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');  
add(arProps, aswcPath{1}, 'ClientPorts', cPortName, 'Interface', ifName);  
  
% Use AUTOSAR map functions  
slMap=autosar.api.getSimulinkMapping(hModel);
```

```

% Map Simulink function caller readData to AUTOSAR client port and operation
[arPort,arOp] = getFunctionCaller(sLMMap,'readData');
mapFunctionCaller(sLMMap,'readData',cPortName,csOp);
[arPort,arOp] = getFunctionCaller(sLMMap,'readData')

ifPaths =
    {'/pkg/if/csInterface'}    {'/pkg/if/myCsIf'}

args =
    {'Op'      }    {'In'  }
    {'Data'   }    {'Out' }
    {'ERR'    }    {'Out' }
    {'NegCode'}    {'Out' }

ans =
    {'myCsIf/readData/Op'}    {'myCsIf/readData/Data'}
    {'myCsIf/readData/ERR'}  {'myCsIf/readData/NegCode'}

arPort =
    'myCPort'

arOp =
    'readData'

```

Configure AUTOSAR Mode-Switch Interfaces

This example:

- 1 Opens a model.
- 2 Declares an AUTOSAR mode declaration group.
- 3 Adds a mode-switch interface to the model.
- 4 Adds a mode receiver port.
- 5 Adds a ModeSwitchEvent to a runnable.
- 6 Maps a Simulink inport to the AUTOSAR mode receiver port and mode group.

```

% Add path to model and mode definition files and open model
addpath (fullfile(matlabroot,'/help/toolbox/autosar/examples'));
hModel = 'mAutosarMsConfig';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% File mdgModes.m declares AUTOSAR mode declaration group mdgModes for use with the M-S interface.
% See matlabroot/help/toolbox/autosar/examples/mdgModes.m, which must be on the MATLAB path.
% The enumerated mode values are:
%   STARTUP(0)
%   RUN(1)
%   SHUTDOWN(2)
% Separate code, below, defines mode declaration group information for XML export.

% Apply data type mdgModes to Simulink inport MRPort
set_param([hModel,'/MRPort'],'OutDataTypeStr','Enum: mdgModes')
get_param([hModel,'/MRPort'],'OutDataTypeStr');
% Apply data type mdgModes and value STARTUP to Runnable1_subsystem/Enumerated Constant

```

```

set_param([hModel, '/Runnable1_subsystem/Enumerated Constant'], 'OutDataTypeStr', 'Enum: mdgModes')
set_param([hModel, '/Runnable1_subsystem/Enumerated Constant'], 'Value', 'mdgModes.STARTUP')

% Add AUTOSAR M-S interface and set its ModeGroup to mdgModes
ifName = 'myMsIf';
modeGroup = 'mdgModes';
ifPkg = get(arProps, 'XmlOptions', 'InterfacePackage');
addPackageableElement(arProps, 'ModeSwitchInterface', ifPkg, ifName, 'IsService', true);
add(arProps, [ifPkg '/' ifName], 'ModeGroup', modeGroup)
ifPaths=find(arProps, [], 'ModeSwitchInterface', 'PathType', 'FullyQualified')

% Add AUTOSAR mode-receiver port with M-S interface name
mrPortName = 'myMRPort';
aswcPath = find(arProps, [], 'AtomicComponent', 'PathType', 'FullyQualified');
add(arProps, aswcPath{1}, 'ModeReceiverPorts', mrPortName, 'Interface', ifName);

% Define AUTOSAR ModeSwitchEvent for runnable
msRunnable = 'Runnable1';
msEventName = 'myMSEvent';
swc = get(arProps, 'XmlOptions', 'ComponentQualifiedNames');
ib = get(arProps, swc, 'Behavior');
runnables = get(arProps, ib, 'Runnables')
add(arProps, ib, 'Events', msEventName, 'Category', 'ModeSwitchEvent', ...
    'Activation', 'OnTransition', ...
    'StartOnEvent', [ib '/' msRunnable]);
% Separate code, below, sets ModeSwitchEvent port and trigger values.

% To pass validation, remove redundant timing event in AUTOSAR configuration
events = get(arProps, ib, 'Events');
delete(arProps, [ib, '/Event_t_tlic_A'])
events = get(arProps, ib, 'Events')

% Export mode declaration group information to AUTOSAR data type package in XML
mdgPkg = get(arProps, 'XmlOptions', 'DataTypePackage');
mdgPath = [mdgPkg '/' modeGroup]
initMode = [mdgPath '/STARTUP']
addPackageableElement(arProps, 'ModeDeclarationGroup', mdgPkg, modeGroup, 'OnTransitionValue', 100)
% Add modes to ModeDeclarationGroup and set InitialMode
add(arProps, mdgPath, 'Mode', 'STARTUP', 'Value', 0)
add(arProps, mdgPath, 'Mode', 'RUN', 'Value', 1)
add(arProps, mdgPath, 'Mode', 'SHUTDOWN', 'Value', 2)
set(arProps, mdgPath, 'InitialMode', initMode)
% Set ModeGroup for M-S interface
set(arProps, [ifPkg '/' ifName '/' modeGroup], 'ModeGroup', mdgPath)

% Set port and trigger for AUTOSAR ModeSwitchEvent
expTrigger = {[mrPortName '.STARTUP'], [mrPortName '.SHUTDOWN']}
set(arProps, [ib '/' msEventName], 'Trigger', expTrigger)

% Use AUTOSAR map functions
slMap=autosar.api.getSimulinkMapping(hModel);

% Map Simulink inport MRPort to AUTOSAR mode receiver port myMRPort and mode group mdgModes
msDataAccessMode = 'ModeReceive';
[arPortName, arDataElementName, arDataAccessMode]=getInport(slMap, 'MRPort');
mapInport(slMap, 'MRPort', mrPortName, modeGroup, msDataAccessMode);
[arPortName, arDataElementName, arDataAccessMode]=getInport(slMap, 'MRPort')

% To pass validation, set inport Runnable1 sample time to -1 (inherited)
set_param([hModel, '/Runnable1'], 'SampleTime', '-1')

ifPaths =
    {'/pkg/if/myMsIf'}

```

```

runnables =
    {'ASWC/Behavior/Runnable_Init'}    {'ASWC/Behavior/Runnable1'}
    {'ASWC/Behavior/Runnable2'}    {'ASWC/Behavior/Runnable3'}

events =
    {'ASWC/Behavior/Event_t_1tic_B'}    {'ASWC/Behavior/Event_t_10tic'}
    {'ASWC/Behavior/myMSEvent'}

mdgPath =
    '/pkg/dt/mdgModes'

initMode =
    '/pkg/dt/mdgModes/STARTUP'

expTrigger =
    {'myMRPort.STARTUP'}    {'myMRPort.SHUTDOWN'}

arPortName =
    'myMRPort'
arDataElementName =
    'mdgModes'
arDataAccessMode =
    'ModeReceive'

```

Configure AUTOSAR XML Export

- “Configure XML Export Options” on page 4-361
- “Configure AUTOSAR Package Paths” on page 4-362

Configure XML Export Options

This example configures AUTOSAR XML export parameter **Exported XML file packaging** (`ArxmlFilePackaging`).

To configure AUTOSAR package paths, see “Configure AUTOSAR Package Paths” on page 4-362.

```

% Open model
hModel = 'autosar_swc_counter';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Set exported AUTOSAR XML file packaging to Single file
get(arProps,'XmlOptions','ArxmlFilePackaging')
set(arProps,'XmlOptions','ArxmlFilePackaging','SingleFile');
get(arProps,'XmlOptions','ArxmlFilePackaging')

ans =
    'Modular'

ans =
    'SingleFile'

```

Configure AUTOSAR Package Paths

This example configures an AUTOSAR package path for XML export. For other AUTOSAR package path property names, see “Configure AUTOSAR Packages and Paths” on page 4-113.

To configure other XML export options, see “Configure XML Export Options” on page 4-361.

```
% Open model
hModel = 'autosar_sw_counter';
open_system(hModel);

% Use AUTOSAR property functions
arProps = autosar.api.getAUTOSARProperties(hModel);

% Specify AUTOSAR application data type package path for XML export
get(arProps,'XmlOptions','ApplicationDataTypePackage')
set(arProps,'XmlOptions','ApplicationDataTypePackage','/Company/Powertrain/DataTypes/ADTs');
get(arProps,'XmlOptions','ApplicationDataTypePackage')

ans =
    '/Company/Powertrain/DataTypes/AppDataTypes'

ans =
    '/Company/Powertrain/DataTypes/ADTs'
```

See Also

get | set

Related Examples

- “Configure and Map AUTOSAR Component Programmatically” on page 4-332

More About

- “AUTOSAR Component Configuration” on page 4-3

Limitations and Tips

The following limitations apply to AUTOSAR component development.

In this section...
“AUTOSAR Client Block in Referenced Model” on page 4-363
“Use the Merge Block for Inter-Runnable Variables” on page 4-363

AUTOSAR Client Block in Referenced Model

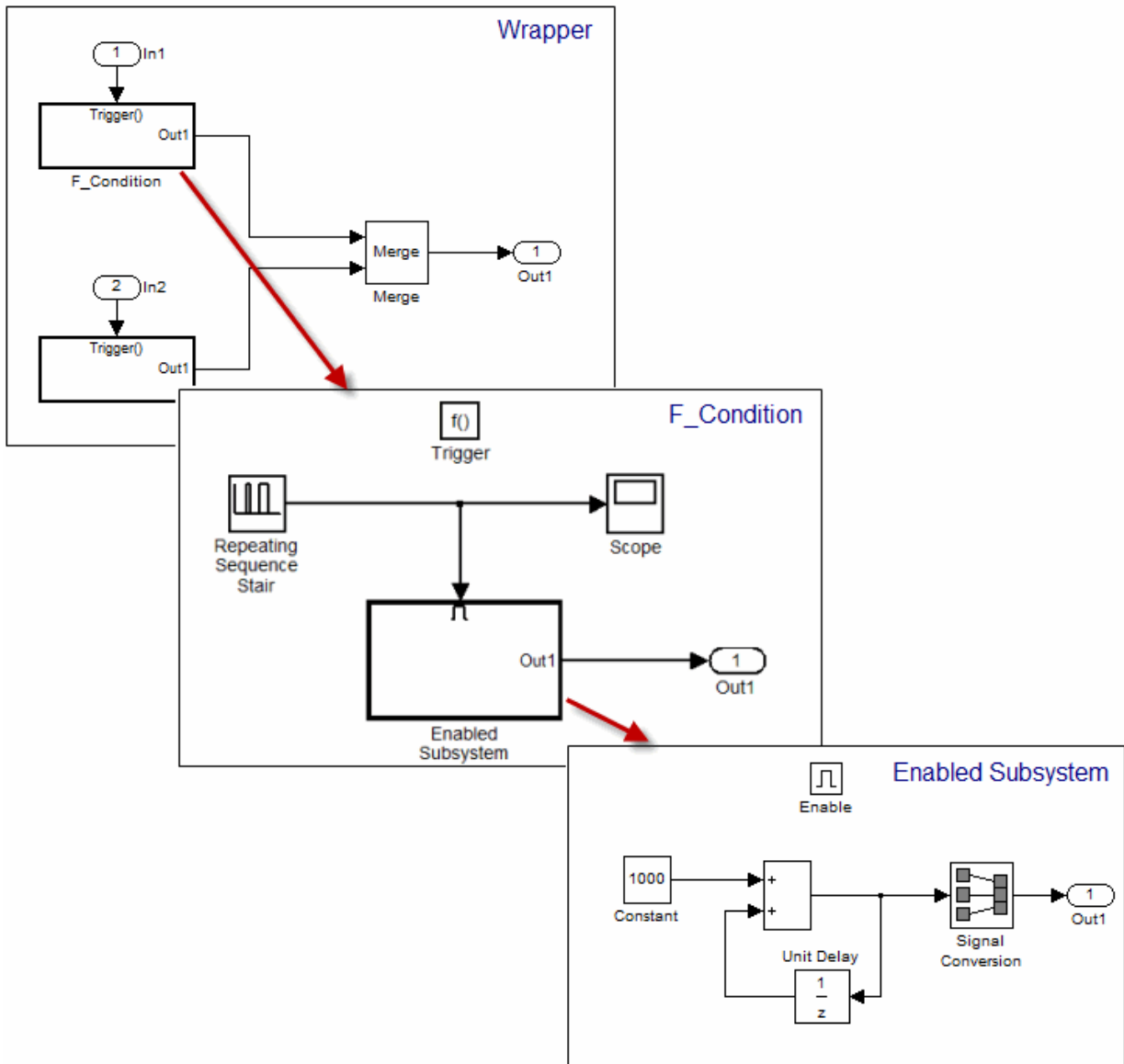
The software does not support the use of an AUTOSAR client block, such as Function Caller or Invoke AUTOSAR Server Operation, in a referenced model.

Use the Merge Block for Inter-Runnable Variables

You can use the Merge block to merge inter-runnable variables. However, you must do the following:

- Connect the output signal of the Merge block to either one root outport or one or more subsystems.
- If the output signal of the Merge block is connected to the inputs of one or more subsystems, assign the same signal name to the Merge block's output and inputs.

In addition, the signal from the function-call subsystem outport that enters a Merge block must not be conditionally computed. Consider the following example.



The output from the subsystem F_condition is the conditional output from Enabled Subsystem. When you try to validate or build the model, the software generates an error.

If you use an S-Function block instead of the Enabled Subsystem block, the software generates a *warning* when you validate or build the model.

AUTOSAR Code Generation

- “Generate AUTOSAR C Code and XML Descriptions” on page 5-2
- “Configure AUTOSAR Code Generation” on page 5-8
- “Code Generation with AUTOSAR Code Replacement Library” on page 5-15
- “Verify AUTOSAR C or C++ Code with SIL and PIL” on page 5-18
- “Import and Simulate AUTOSAR Code from Previous Releases” on page 5-19
- “Limitations and Tips” on page 5-20

Generate AUTOSAR C Code and XML Descriptions

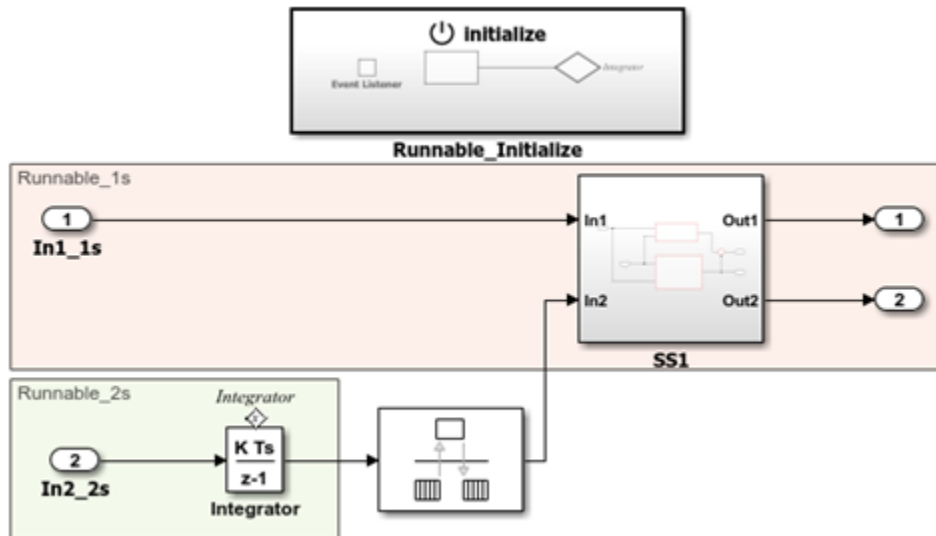
Generate AUTOSAR-compliant C code and export AUTOSAR XML (arxml) descriptions from AUTOSAR component model

If you have Simulink Coder and Embedded Coder software, you can build AUTOSAR component models. Building a classic component model generates algorithmic C code and exports arxml descriptions that comply with AUTOSAR Classic Platform specifications. Use the generated C code and arxml descriptions for testing in Simulink or integration into an AUTOSAR run-time environment.

Prepare AUTOSAR Component Model for Code Generation

Open a component model from which you want to generate AUTOSAR C code and arxml descriptions. This example uses AUTOSAR example model `autosar_swc`.

```
open_system('autosar_swc');
```



Optionally, to refine model configuration settings for code generation, you can use the Embedded Coder Quick Start (recommended). This example uses the Embedded Coder Quick Start. From the **Apps** tab, open the AUTOSAR Component Designer app. On the **AUTOSAR** tab, click **Quick Start**.

Work through the quick-start procedure. In the Output window, select output option **C code compliant with AUTOSAR**.

Select the output for your generated code.

C code

C code compliant with AUTOSAR

C++ code

C++ code compliant with AUTOSAR Adaptive Platform

The quick-start software takes the following steps to configure an AUTOSAR software component model:

- 1 Configures code generation settings for the model. If the AUTOSAR target is not selected, the software sets model configuration parameter **System target file** to `autosar.tlc` and **Generate XML for schema version** to a default value.
- 2 If no AUTOSAR mapping exists, the software creates a mapped AUTOSAR software component for the model.
- 3 Performs a model build.

In the last window, when you click **Finish**, your model opens in the AUTOSAR code perspective.

The screenshot displays the AUTOSAR SW Component editor interface. The main workspace shows a block diagram with the following components and connections:

- Runnable_Initialize**: Contains an **Initialize** block (power icon) and an **Assigner** block (diamond icon).
- Runnable_1s**: Contains an **In1_1s** input port (circled with '1') connected to the **In1** input of the **SS1** block. It also contains an **Out1** output port (circled with '1') connected to the **Out1** output of the **SS1** block.
- Runnable_2s**: Contains an **In2_2s** input port (circled with '2') connected to the **In2** input of the **SS1** block. It also contains an **Out2** output port (circled with '2') connected to the **Out2** output of the **SS1** block.
- Integrator**: Contains an **Integrator** block with **K Ts** and **z-1** parameters. It is connected to the **SS1** block.

The **Property Inspector** on the right shows the properties for the selected **In1_1s** input port:

NAME	VALUE
Source	In1_1s

The **Code** section shows:

DataAccessMode	ImplicitReceive
Port	ReceivePort
Element	In1

The **Communication attributes** section shows:

AliveTimeout	60
HandleNeverReceived	false
InitValue	0

The **Code Mappings - AUTOSAR SW Component** window at the bottom shows the following table:

Source	DataAccessMode	Port	Element
In1_1s	ImplicitReceive	ReceivePort	In1
In2_2s	ImplicitReceive	ReceivePort	In2

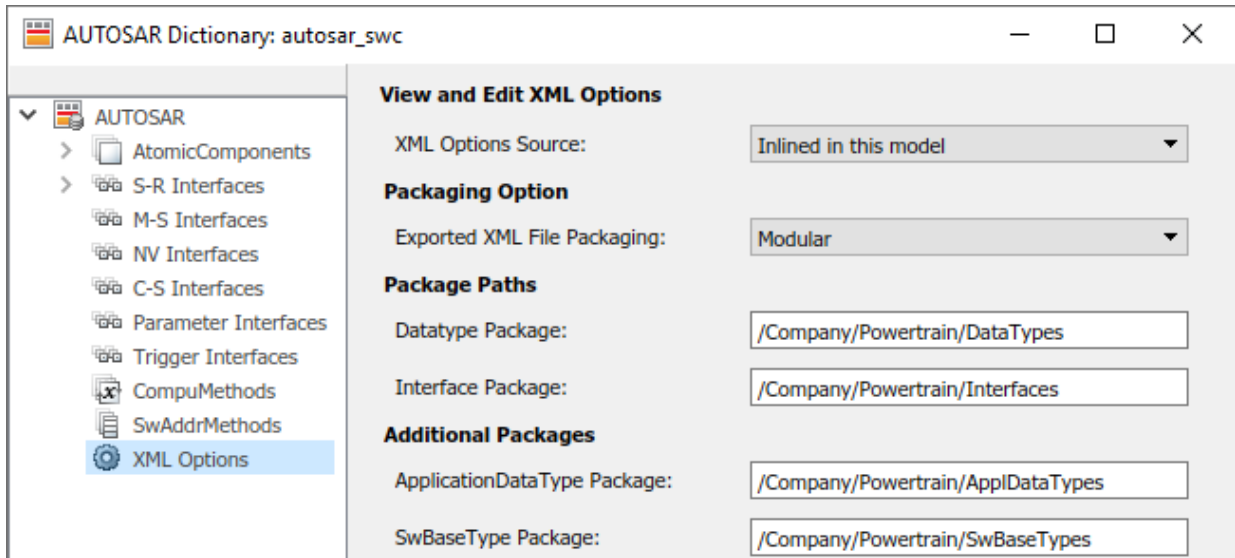
Inspect XML Options in AUTOSAR Dictionary

Before generating code, open the AUTOSAR Dictionary and examine the settings of AUTOSAR XML export parameters. In the **AUTOSAR** tab, click **Settings > AUTOSAR Dictionary**. In the AUTOSAR Dictionary, select **XML Options**.

The XML options view in the AUTOSAR Dictionary displays XML export parameters and their values. You can configure:

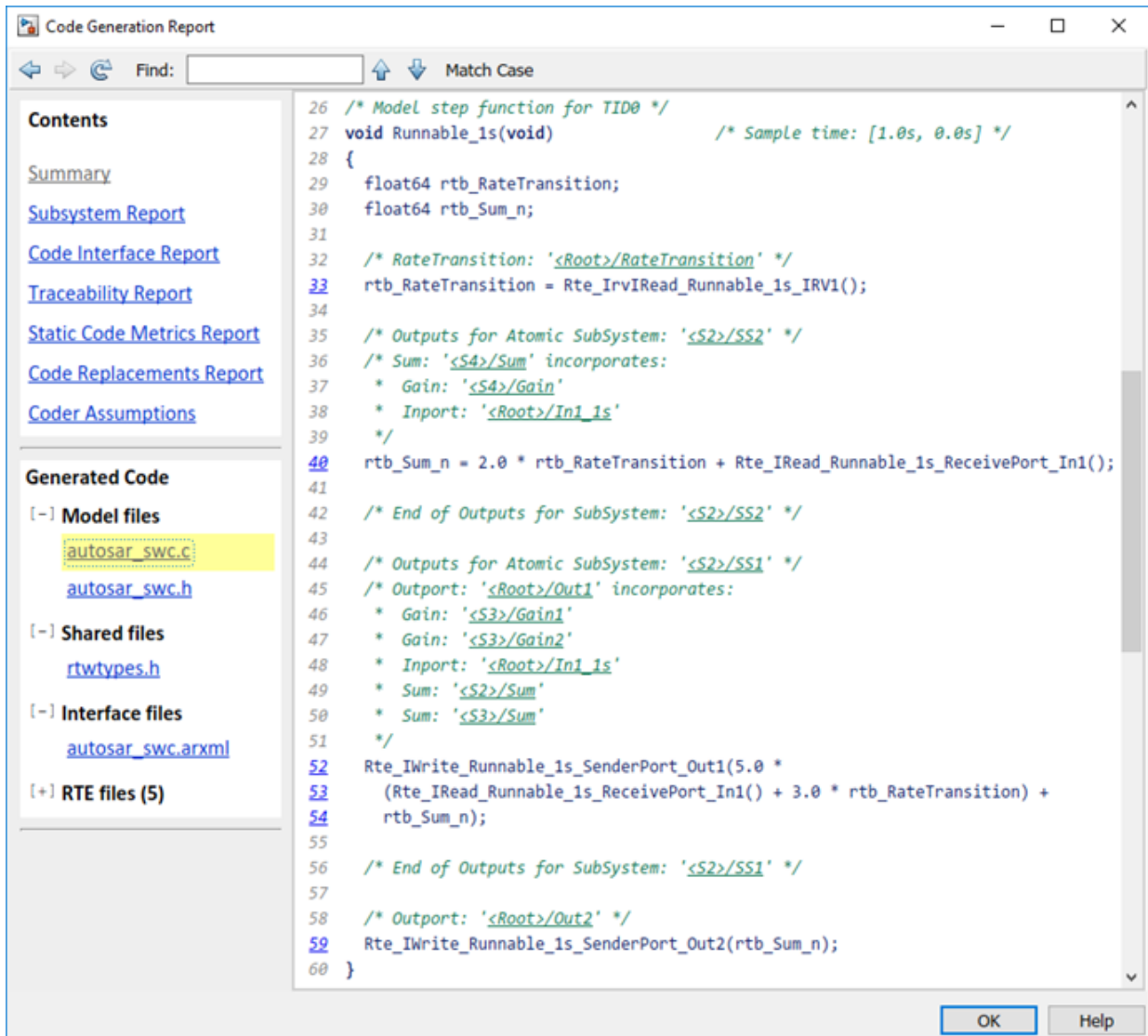
- XML file packaging for AUTOSAR elements created in Simulink
- AUTOSAR package paths
- Aspects of exported AUTOSAR XML content

This example sets **Exported XML file packaging** to **Single file**, so that arxml is exported into a single file, *modelName.arxml*.



Generate AUTOSAR C Code and XML Descriptions

To generate AUTOSAR C code and XML software descriptions that comply with Classic Platform specifications, build the model. In the model window, press **Ctrl+B**. The build process generates C code and arxml descriptions to the model build folder, `autosar_swC_autosar_rtw`. When the build completes, a code generation report opens.



Related Links

- “Code Generation”
- “AUTOSAR Component Configuration” on page 4-3

- "AUTOSAR Blockset"

Configure AUTOSAR Code Generation

To generate AUTOSAR-compliant C code and arxml component descriptions from a model configured for the AUTOSAR Classic Platform:

- 1 Examine AUTOSAR code generation parameters on the **Code Generation > AUTOSAR Code Generation Options** pane of the Configuration Parameters dialog box.
- 2 Examine AUTOSAR XML export options using the AUTOSAR Dictionary or AUTOSAR property functions.
- 3 Build the model.

In this section...

“Select an AUTOSAR Schema” on page 5-8

“Specify Maximum SHORT-NAME Length” on page 5-9

“Configure AUTOSAR Compiler Abstraction Macros” on page 5-10

“Root-Level Matrix I/O” on page 5-11

“Inspect AUTOSAR XML Options” on page 5-12

“Generate AUTOSAR C and XML Files” on page 5-12

Select an AUTOSAR Schema

The software supports the following AUTOSAR Classic Platform schema versions for import and export of arxml files and generation of AUTOSAR-compatible C code.

Schema Version Value	Schema Revisions Supported for Import	Export Schema Revision
4.3 (default)	4.3.0, 4.3.1	4.3.1
4.2	4.2.1, 4.2.2	4.2.2
4.1	4.1.1, 4.1.2, 4.1.3	4.1.3
4.0	4.0.1, 4.0.2, 4.0.3	4.0.3
3.2	3.2.1, 3.2.2	3.2.2
3.1	3.1.1, 3.1.2, 3.1.3, 3.1.4	3.1.4

Schema Version Value	Schema Revisions Supported for Import	Export Schema Revision
3.0	3.0.1, 3.0.2, 3.0.3, 3.0.4, 3.0.5, 3.0.6	3.0.2
2.1	2.1 (XSD rev 0014, 0015, 0017, 0018)	2.1 (XSD rev 0017)

Selecting the AUTOSAR system target file for your model for the first time sets the schema version parameter to the default value, 4.3.

When you import arxml code into Simulink, the arxml importer detects the schema version and sets the schema version parameter in the model. For example, if you import arxml code based on schema 4.0 revision 4.0.1, 4.0.2, or 4.0.3, the importer sets the schema version parameter to 4.0.

When you export your AUTOSAR software component, code generation exports XML that is compliant with the current schema version value. For example, if **Generate XML file for schema version** equals 4.0, export uses the export schema revision listed above for schema 4.0, that is, revision 4.0.3.

If you need to change the schema version, you must do so before exporting your AUTOSAR software component. To select a schema version, on the **Code Generation > AUTOSAR Code Generation Options** pane of the Configuration Parameters dialog box, from the **Generate XML file for schema version** drop-down list, select the schema version that you require.

Note The AUTOSAR model parameters on the **AUTOSAR Code Generation Options** pane must be set to the same values for top and referenced models. This guideline applies to **Generate XML file for schema version**, **Maximum SHORT-NAME length**, **Use AUTOSAR compiler abstraction macros**, and **Support root-level matrix I/O using one-dimensional arrays**.

Specify Maximum SHORT-NAME Length

The AUTOSAR standard specifies that the maximum length of SHORT-NAME XML elements is 128 characters, for schema version 4.x or later, or 32 characters, for earlier schema versions. Even for earlier schema versions, your AUTOSAR authoring tool may support the use of longer SHORT-NAME elements, for example, to name ports and interfaces.

Use the **Maximum SHORT-NAME length** parameter to specify a maximum length for SHORT-NAME elements exported by the code generator. On the **Code Generation > AUTOSAR Code Generation Options** pane of the Configuration Parameters dialog box, in the **Maximum SHORT-NAME length** field, specify a positive number of characters less than or equal to 128. The default is 128 characters.

Configure AUTOSAR Compiler Abstraction Macros

Compilers for 16-bit platforms (for example, Cosmic and Metrowerks for S12X or Tasking for ST10) use special keywords to deal with the limited 16-bit addressing range. The location of data and code beyond the 64k border is selected explicitly by special keywords. However, if such keywords are used directly within the source code, then software must be ported separately for each microcontroller family. That is, the software is not platform-independent.

AUTOSAR specifies C macros to abstract compiler directives (near/far memory calls) in a platform-independent manner. These compiler directives, derived from the 16-bit platforms, enable better code efficiencies for 16-bit micro-controllers without separate porting of source code for each compiler. This approach allows your system integrator, rather than your software component implementer, to choose the location of data and code for each software component.

For more information on AUTOSAR compiler abstraction, see www.autosar.org.

To configure AUTOSAR compiler macro generation, in the **Code Generation > AUTOSAR Code Generation Options** pane of the Configuration Parameters dialog box, select **Use AUTOSAR compiler abstraction macros**.

When you build the model, the software applies compiler abstraction macros to global data and function definitions in the generated code.

For data, the macros are in the following form:

- `CONST(consttype, memclass) varname;`
- `VAR(type, memclass) varname;`

where

- *consttype* and *type* are data types
- *memclass* is a macro string `SWC_VAR` (*SWC* is the software component identifier)

- *varname* is the variable identifier

For functions (model and subsystem), the macros are in the following form:

- `FUNC(type, memclass) funcname(void)`

where

- *type* is the data type of the return argument
- *memclass* is a macro string. This string can be either `SWC_CODE` for runnables (external functions), or `SWC_CODE_LOCAL` for internal functions (*SWC* is the software component identifier).

Example 5.1. Example

If you do *not* select **Use AUTOSAR compiler abstraction macros**, the code generator produces the following code:

```
/* Block signals (auto storage) */
BlockIO rtB;

/* Block states (auto storage) */
D_Work rtDWork;

/* Model step function */
void Runnable_Step(void)
```

However, if you select **Use AUTOSAR compiler abstraction macros**, the code generator produces macros in the code:

```
/* Block signals (auto storage) */
VAR(BlockIO, SWC1_VAR) rtB;

/* Block states (auto storage) */
VAR(D_Work, SWC1_VAR) rtDWork;

/* Model step function */
FUNC(void, SWC1_CODE) Runnable_Step(void)
```

Root-Level Matrix I/O

The software supports matrix I/O at the root-level by generating code that implements matrices as one-dimensional arrays. However, this behavior is not the default. To configure root-level matrix I/O, on the **Code Generation > AUTOSAR Code Generation Options** pane of the Configuration Parameters dialog box, select **Support root-level matrix I/O using one-dimensional arrays**.

Inspect AUTOSAR XML Options

Examine the XML options that you configured by using the AUTOSAR Dictionary. If you have not yet configured them, see “Configure AUTOSAR XML Options” on page 4-63.

Generate AUTOSAR C and XML Files

After configuring AUTOSAR code generation and XML options, generate code. To generate C code and export XML descriptions, build the component model (**Ctrl+B**).

The build process generates AUTOSAR-compliant C code and AUTOSAR XML descriptions to the model build folder. The exported XML files include:

- One or more *modelname*.arxml* files, based on whether you set **Exported XML file packaging** to `Single file` or `Modular`.
- If you imported `arxml` files into Simulink, updated versions of the same files.

The following table shows which *modelname*.arxml* files are generated, based on the value of the **Exported XML file packaging** option configured in the AUTOSAR Dictionary.

Exported XML File Packaging Value	Exported File Name	By Default Contains...
Single file	<i>modelname.arxml</i>	All AUTOSAR elements.
Modular	<i>modelname_component.arxml</i>	Software components. This is the main <code>arxml</code> file exported for the Simulink model. In addition to AUTOSAR software components, the file includes elements for which AUTOSAR packages (AR-PACKAGES) are not configured, and AR-PACKAGES that do not align with the package paths in the other exported <code>arxml</code> files. For more information on AR-PACKAGES and their location in modular exported <code>arxml</code> files, see “Configure AUTOSAR Packages” on page 4-111.

Exported XML File Packaging Value	Exported File Name	By Default Contains...
	<i>modelname_datatype.arxml</i>	Data types and related elements.
	<i>modelname- _implementation.arxml</i>	Software component implementation.
	<i>modelname_interface.arxml</i>	Interfaces, including S-R, C-S, M-S, NV, and other interfaces.
	<i>modelname_behavior.arxml</i>	Software component internal behavior (generated only for schema 3.x or earlier).

You can merge the AUTOSAR XML component descriptions back into an AUTOSAR authoring tool. The AUTOSAR component information is partitioned into separate files to facilitate merging. The partitioning attempts to minimize the number of merges that you must do. You do not need to merge the data type file into the authoring tool because data types are usually defined early in the design process. You must, however, merge the internal behavior file because this information is part of the model implementation.

To help support the round trip of AUTOSAR elements between an AAT and the Simulink model-based design environment, the code generator preserves AUTOSAR elements and their UUIDs across *arxml* import and export. For more information, see “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.

For an example of how to generate AUTOSAR-compliant C code and export AUTOSAR XML component descriptions from a Simulink model, see “Generate AUTOSAR C Code and XML Descriptions” on page 5-2.

See Also

Generate XML file for schema version | Maximum SHORT-NAME length | Support root-level matrix I/O using one-dimensional arrays | Use AUTOSAR compiler abstraction macros

Related Examples

- “Configure AUTOSAR XML Options” on page 4-63
- “Generate AUTOSAR C Code and XML Descriptions” on page 5-2

More About

- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38

Code Generation with AUTOSAR Code Replacement Library

If your model is configured for AUTOSAR code generation, you can use the AUTOSAR 4.0 code replacement library to produce functions that closely align with the AUTOSAR standard. The AUTOSAR 4.0 code replacement library is intended for use with AUTOSAR schema version 4.0 or later.

Code Replacement Library for AUTOSAR Code Generation

The AUTOSAR 4.0 code replacement library enables you to customize the code generator to produce C or C++ code that closely aligns with the AUTOSAR standard. Considering using the code replacement library if:

- You want to use service routines provided in the library.
- You have replacement code for the service routines.
- The replacement code follows the AUTOSAR file naming convention, that is, routines for any given specification are in one header file (for example, `Mfl.h` or `Mfx.h`)
- You have a build harness setup that can compile and link the AUTOSAR library with the generated code. For more information about building code for AUTOSAR, see “Code Generation”.

Note MATLAB and Simulink lookup table indexing differs from AUTOSAR MAP indexing. MATLAB takes the linear algebra approach—row ($u1$) and column ($u2$). AUTOSAR (and ASAM) takes the Cartesian coordinate approach—x-axis ($u2$) and y-axis ($u1$), where $u1$ and $u2$ are input arguments to Simulink 2-D lookup table blocks. Due to the difference, the code replacement software transposes the input arguments for AUTOSAR MAP routines.

For more information on code replacement and code replacement libraries, see “What Is Code Replacement?” (Embedded Coder) and “Code Replacement Libraries” (Embedded Coder).

Find Supported AUTOSAR Library Routines

To explore the AUTOSAR library routines supported by the AUTOSAR code replacement library, use the **Code Replacement Viewer**. To open the viewer, at the command prompt, enter `crviewer`.

For more information, see “Choose a Code Replacement Library” (Embedded Coder).

Configure Code Generator to Use AUTOSAR 4.0 Code Replacement Library

To configure the code generator for your model to use the AUTOSAR code replacement library, open the Configuration Parameters dialog box. Select **Code Generation > Interface > Code replacement library > AUTOSAR 4.0**.

For more information on code replacement and code replacement libraries, see “What Is Code Replacement?” (Embedded Coder) and “Code Replacement Libraries” (Embedded Coder).

Code Replacement Library Checks

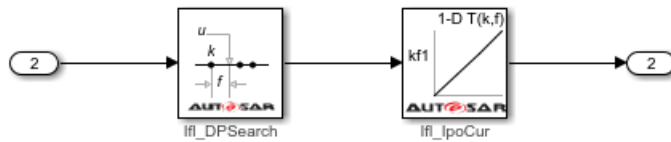
Code replacement requires that the combination of types for input, breakpoint, table, and output types are compatible with the AUTOSAR specification. Floating-point (IFL) replacement only supports single types while fixed-point (IFX) replacement supports `uint8`, `uint16`, `int8`, `int16` and associated fixed-point types. When using these routine blocks, the type combination requirements vary and are enforced as required.

AUTOSAR Code Replacement Library example for IFX/IFL Function Replacement

This example shows how to replace code generated for Simulink lookup table blocks with functions that are compatible with AUTOSAR floating-point interpolation (IFL) library routines. If you want to replace code with fixed-point interpolation (IFX) library routines, you can change the type and reconfigure the block.

- 1 Create your Simulink model by using any of these AUTOSAR lookup table blocks: Prelookup, Curve Using Prelookup, Map Using Prelookup, Curve, or Map.

For example:



- 2 Configure the code generator for your model to use the AUTOSAR 4.0 code replacement library. In the Configuration Parameters dialog box, select **Code Generation > Interface > Code replacement library > AUTOSAR 4.0**. Alternatively, from the command line or programmatically, use `set_param` to set the `CodeReplacementLibrary` parameter to 'AUTOSAR 4.0'.
- 3 Optionally, you can configure the model for the code generator to produce a code generation report that summarizes which blocks trigger code replacements. In the Configuration Parameters dialog box, in the **Code Generation > Report** pane, select the option **Summarize which blocks triggered code replacements**. Alternatively, from the command line or programmatically, use `set_param` to set the `GenerateCodeReplacementReport` parameter to 'on'.
- 4 Build the model and review the generated code for expected code replacements.

For example:

```

/* Model step function */
void Runnable_Step(void)
{
    If1_DPResultF32_Type rtb_Prelookup;

    /* PreLookup: '<Root>/PreLookup' incorporates:
     * Inport: '<Root>/In2'
     */
    If1_DPSearch_f32(&rtb_Prelookup, Rte_IRead_Runnable_Step_In2_In2(),
        (Rte_CData_Bp_4_single())->Nx, (Rte_CData_Bp_4_single())->Bp1);

    /* Output: '<Root>/Out2' incorporates:
     * Interpolation_n-D: '<Root>/Curve Using PreLookup'
     */
    Rte_IWrite_Runnable_Step_Out2_Out2(If1_IpoCur_f32(&rtb_Prelookup,
        Rte_CData_Lcom_4_single()));
}

```

Verify AUTOSAR C or C++ Code with SIL and PIL

You can carry out model-based verification of AUTOSAR software components using software-in-the-loop (SIL) and processor-in-the-loop (PIL) simulations. Use SIL for verification of generated source code on your host computer, and PIL for verification of object code on your production target hardware. For example:

- You can run a top model that is configured for an AUTOSAR system target file (`autosar.tlc` or `autosar_adaptive.tlc`) using the Software-in-the-Loop (SIL) and Processor-in-the-Loop (PIL) simulation modes.
- You can use Model block SIL or PIL to test AUTOSAR top-model code. In the Model block, set parameter **Code interface** to `Top model`.

For more information, see “Simulation with Top Model” (Embedded Coder) and “Simulation with Model Blocks” (Embedded Coder).

Note You can create a SIL or PIL block for a component configured for the AUTOSAR system target file. For more information about configuring and running simulations with SIL or PIL blocks, see “Simulation with Blocks From Subsystems” (Embedded Coder). However, SIL and PIL block verification does not support code generated for Simulink Function and Function Caller blocks, for example, in AUTOSAR client-server configurations.

Import and Simulate AUTOSAR Code from Previous Releases

You can import into the current release AUTOSAR component code that you generated in a previous release. To observe the interaction of code from a previous release with components implemented in the current release, run software-in-the-loop (SIL) or processor-in-the-loop (PIL) simulations with the imported code.

For more information, see:

- “Workflow” (Embedded Coder)
- “Import AUTOSAR Code from Previous Releases” (Embedded Coder)

Limitations and Tips

The following limitations apply to AUTOSAR code generation.

In this section...
“Generate Code Only Check Box” on page 5-20
“AUTOSAR Compiler Abstraction Macros” on page 5-20
“Relative File Paths in AUTOSAR Code Descriptors (Schema Versions 3.x and Earlier)” on page 5-21

Generate Code Only Check Box

If you do not select the **Generate code only** check box, the software produces an error message when you build the model. The message states that you can build an executable with the AUTOSAR system target file only if you:

- Configure the model to create a software-in-the-loop (SIL) or processor-in-the-loop (PIL) block
- Run the model in SIL or PIL simulation mode
- Provide a custom template makefile

AUTOSAR Compiler Abstraction Macros

The software does not generate AUTOSAR compiler abstraction macros for data or functions arising from the following:

- Model blocks
- Stateflow
- MATLAB Coder
- Shared utility functions
- Custom storage classes
- Local or temporary variables

Relative File Paths in AUTOSAR Code Descriptors (Schema Versions 3.x and Earlier)

When you build a Simulink model for an AUTOSAR system target file, using AUTOSAR schema version 3.x or earlier, the code generator produces a `CODE-DESCRIPTORS` element within the `SWC_IMPLEMENTATION` element. The `CODE-DESCRIPTORS` element contains `XFILE` elements that provide descriptions of the generated code.

For example, if you build the model `autosar_swc_counter`, the generated file `autosar_swc_counter_implementation.arxml` has the following `XFILE` element:

```
<XFILE>
  <SHORT-NAME>autosar_swc_counter_c</SHORT-NAME>
  <CATEGORY>GeneratedFile</CATEGORY>
  <URL>autosar_swc_counter_autosar_rtw\autosar_swc_counter.c</URL>
  <TOOL>Embedded Coder</TOOL>
  <TOOL-VERSION>n.n</TOOL-VERSION>
</XFILE>
```

However, the `URL` element does not specify an absolute path. The path is *relative* to the build folder. Therefore, before you use the AUTOSAR XML in a run-time environment to generate code, you must place the XML in the parent folder.

AUTOSAR Adaptive Software Component Modeling

- “Model AUTOSAR Adaptive Software Components” on page 6-2
- “Create and Configure AUTOSAR Adaptive Software Component” on page 6-7
- “Import AUTOSAR Adaptive Software Descriptions” on page 6-15
- “Import AUTOSAR Adaptive Components to Simulink” on page 6-17
- “Reuse AUTOSAR Adaptive Elements in Component Model” on page 6-22
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43
- “Configure AUTOSAR Adaptive Software Components” on page 6-47
- “Model AUTOSAR Adaptive Service Communication” on page 6-57
- “Configure Memory Allocation for AUTOSAR Adaptive Service Data” on page 6-61
- “Configure AUTOSAR Adaptive Service Instance Identification” on page 6-63
- “Generate AUTOSAR Adaptive C++ Code and XML Descriptions” on page 6-65
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

Model AUTOSAR Adaptive Software Components

In Simulink, you can flexibly model the structure and behavior of software components for the AUTOSAR Adaptive Platform.

The AUTOSAR Adaptive Platform defines a service-oriented architecture for automotive components that must flexibly adapt to external events and conditions. Compared to the AUTOSAR Classic Platform, the Adaptive Platform requires:

- High-performance computing, potentially with multiple cores and heterogeneous processor types.
- Fast communication, potentially with Ethernet or networks on chips.
- Strong service-based interaction among components.
- Ability to adapt running automotive applications to external events and information sources (potentially for highly automated driving), as well as external communication, monitoring, and live software updates.

An AUTOSAR adaptive system potentially contains multiple interconnected adaptive software components. You deploy adaptive software components in the run-time environment defined by the Adaptive Platform, AUTOSAR Runtime for Adaptive Applications (ARA).

An AUTOSAR adaptive software component provides and consumes services. The adaptive service architecture is flexible, scalable, and distributed. Services can be discovered dynamically and can run on local or remote Electronic Control Units (ECUs). Each software component contains:

- An automotive algorithm, which performs tasks in response to received events.
- Required and provided ports, each associated with a service interface, through which events are received and sent.
- Service interfaces, which provide the framework for event-based communication, and their associated events and namespaces.

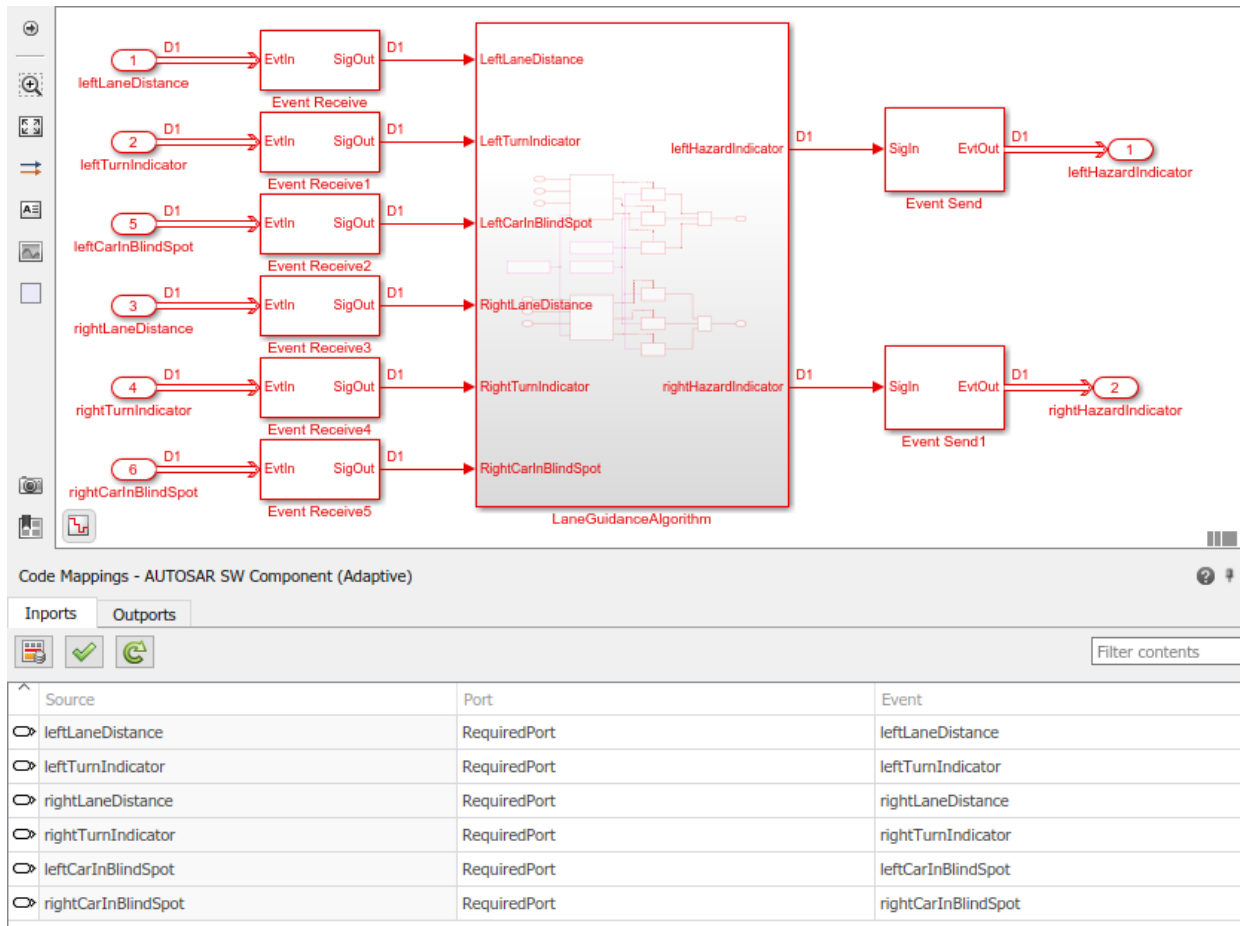
To model an AUTOSAR adaptive software component in Simulink, you start with a model that contains an automotive algorithm. From that model, you generate an AUTOSAR Dictionary that defines service interfaces, and an AUTOSAR code perspective that maps Simulink model elements to AUTOSAR component elements. As you further develop and refine the adaptive component in Simulink, you can iteratively simulate and build the model.

When you complete the component implementation, you can combine the adaptive software component model with other component models in an application-level simulation container model. The end goal is to deploy the component as part of an application in the ARA environment.

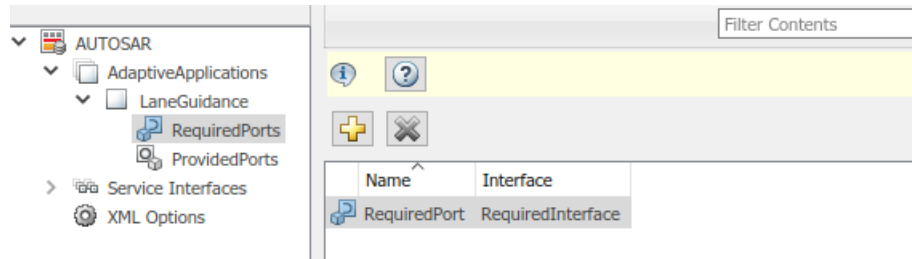
Here is the high-level workflow for modeling software components based on the AUTOSAR Adaptive Platform.

- 1** Open a Simulink model that either is empty or contains a functional algorithm.
- 2** Using the Model Configuration Parameters dialog box, configure the model for adaptive AUTOSAR code generation. Set **System target file** to `autosar_adaptive.tlc`.
- 3** Develop the model algorithmic content for use in an AUTOSAR adaptive software component. If the model is empty, construct or copy in an algorithm. Possible sources for algorithms include algorithmic elements in other Simulink models. Examples include subsystems, referenced models, MATLAB Function blocks, and C Caller blocks.
- 4** At the top level of the model, set up event-based communication.
 - After each root inport, add an Event Receive block, which converts an input event to a signal while preserving the signal values and data type.
 - Before each root outport, add an Event Send block, which converts an input signal to an event while preserving the signal values and data type.
- 5** Map the algorithm model to an AUTOSAR adaptive software component. For example, in the **Apps** tab, click **AUTOSAR Component Designer**. Because the model is unmapped, the AUTOSAR Component Quick Start opens.

Work through the quick-start procedure. Click **Finish** to map the model. The model opens in the AUTOSAR code perspective.



- 6 Using the AUTOSAR code perspective and the AUTOSAR Dictionary (or equivalent AUTOSAR map and property functions), further refine the AUTOSAR adaptive model configuration.
- In the AUTOSAR code perspective, examine the mapping of Simulink inports and outports to AUTOSAR required and provided ports and events.
 - In the AUTOSAR Dictionary, examine the AUTOSAR properties for RequiredPorts, ProvidedPorts, and Service Interfaces.



You can expand service interface nodes to examine their associated AUTOSAR events and define namespaces for interface C++ code.

- 7 Build the AUTOSAR adaptive software component model. Building the model generates:
 - C++ files that implement the model algorithms for the AUTOSAR Adaptive Platform and provide shared data type definitions.
 - AUTOSAR XML descriptions of the AUTOSAR adaptive software component and a model class header file.
 - C++ files that implement a main program module.
 - CMakeLists.txt file that supports CMake generation of executables.

For more information, see “Configure AUTOSAR Adaptive Software Components” on page 6-47.

See Also

Event Receive | Event Send

Related Examples

- “Configure AUTOSAR Adaptive Software Components” on page 6-47
- “Create and Configure AUTOSAR Adaptive Software Component” on page 6-7
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Model AUTOSAR Adaptive Service Communication” on page 6-57
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

More About

- “Comparison of AUTOSAR Classic and Adaptive Platforms” on page 1-4

Create and Configure AUTOSAR Adaptive Software Component

Create an AUTOSAR adaptive software component model from an algorithm model.

AUTOSAR Blockset software supports AUTomotive Open System ARchitecture (AUTOSAR), an open and standardized automotive software architecture. Automobile manufacturers, suppliers, and tool developers jointly develop AUTOSAR components. To develop AUTOSAR adaptive components in Simulink, follow this general workflow:

- 1 Create a Simulink representation of an AUTOSAR adaptive component.
- 2 Develop the component by refining the AUTOSAR configuration and creating algorithmic model content.
- 3 Generate arxml descriptions and algorithmic C++ code for testing in Simulink or integration into an AUTOSAR run-time environment. (AUTOSAR code generation requires Simulink Coder and Embedded Coder.)

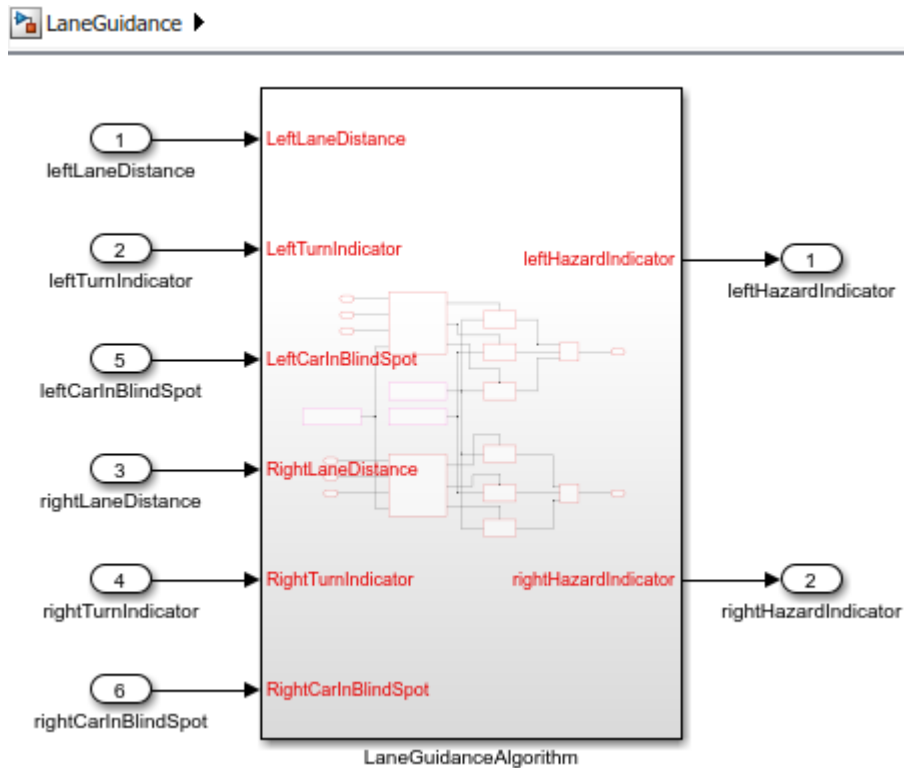
Create AUTOSAR Adaptive Software Component in Simulink

To create an initial Simulink representation of an AUTOSAR adaptive software component, you take one of these actions:

- Create an AUTOSAR adaptive software component using an existing Simulink model.
- Import an AUTOSAR adaptive software component description from arxml files into a new Simulink model. (See example “Import AUTOSAR Adaptive Components to Simulink” on page 6-17.)

To create an AUTOSAR adaptive software component using an existing model, first open a Simulink component model for which an AUTOSAR software component is not mapped. This example uses AUTOSAR example model LaneGuidance.

```
open_system('LaneGuidance');
```



In the model window, on the **Modeling** tab, select **Model Settings**. In the Configuration Parameters dialog box, **Code Generation** pane, set the system target file to `autosar_adaptive.tlc`. Click **OK**.

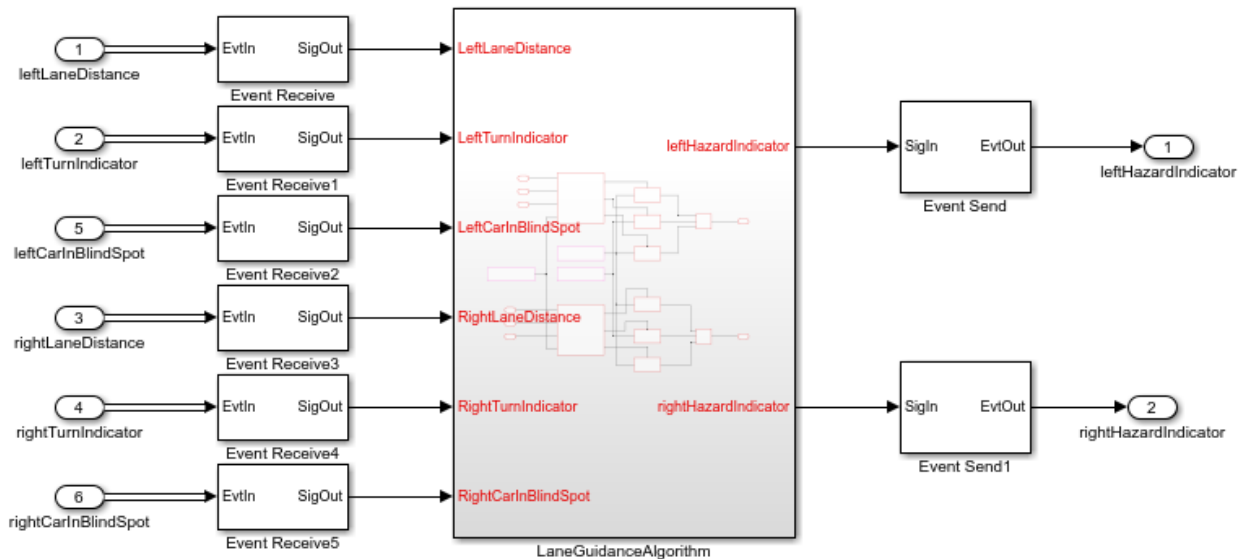
At the top level of the model, set up event-based communication. An AUTOSAR adaptive software component provides and consumes services. Each component contains:

- An algorithm that performs tasks in response to received events
- Required and provided ports, each associated with a service interface
- Service interfaces, with associated events and associated namespaces

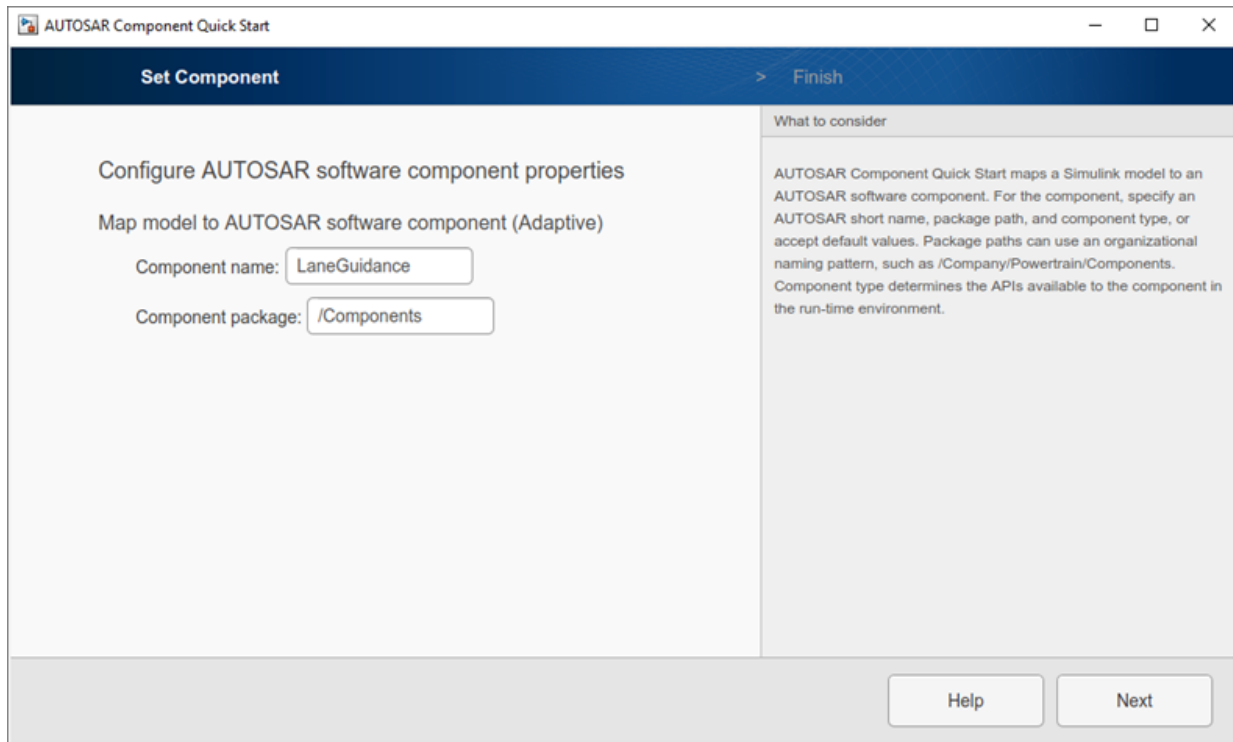
AUTOSAR Blockset provides Event Receive and Event Send blocks to make the necessary event and signal connections.

- After each root inport, add an Event Receive block, which converts an input event to a signal while preserving the signal values and data type.
- Before each root outport, add an Event Send block, which converts an input signal to an event while preserving the signal values and data type.

(To expedite the block insertion, you can copy the event blocks from AUTOSAR example model `autosar_LaneGuidance`.)



To configure the model as a mapped AUTOSAR adaptive software component, open the AUTOSAR Component Quick Start. On the **Apps** tab, click **AUTOSAR Component Designer**. The AUTOSAR Component Quick Start opens.



To configure the model for AUTOSAR adaptive software component development, work through the quick-start procedure. This example accepts default settings for the options in the Quick Start **Set Component** pane.

In the **Finish** pane, when you click **Finish**, your model opens in the AUTOSAR code perspective.

Configure AUTOSAR Adaptive Software Component in Simulink

The AUTOSAR code perspective displays your model, a Property Inspector panel, and directly below the model, the Code Mappings editor.

The screenshot displays the Simulink model for the LaneGuidance component. The model includes several input blocks (1-6) connected to the LaneGuidanceAlgorithm block, which in turn connects to Event Send and Event Send1 blocks. The Code Mappings editor is open, showing the following mappings:

Source	Port	Event
leftLaneDistance	RequiredPort	leftLaneDistance
leftTurnIndicator	RequiredPort	leftTurnIndicator
rightLaneDistance	RequiredPort	rightLaneDistance
rightTurnIndicator	RequiredPort	rightTurnIndicator
leftCarInBlindSpot	RequiredPort	leftCarInBlindSpot
rightCarInBlindSpot	RequiredPort	rightCarInBlindSpot

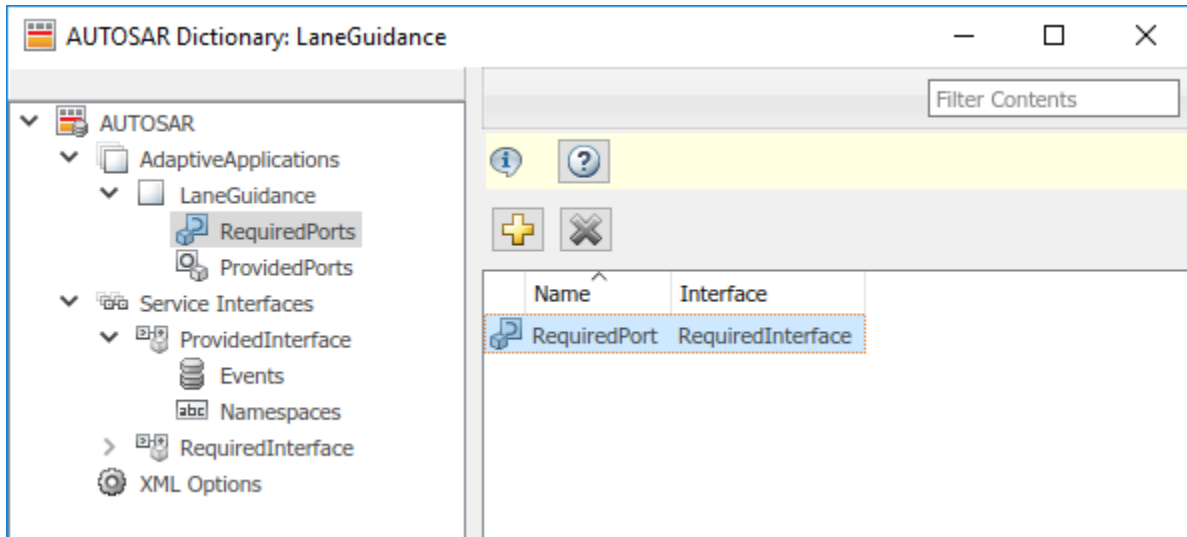
Next you use the Code Mappings editor and the AUTOSAR Dictionary to further develop the AUTOSAR adaptive component.

The Code Mappings editor displays model inports and outputs. Use the editor to map Simulink inports and outputs to AUTOSAR required ports and provided ports (defined in the AUTOSAR standard) from a Simulink model perspective.

Open each Code Mapping tab and examine the mapped model elements. To modify the AUTOSAR mapping for an element, select an element and modify its associated properties. When you select an element, it is highlighted in the model, and the Property Inspector displays its code attributes.

To configure the AUTOSAR properties of the mapped AUTOSAR adaptive software component, open the AUTOSAR Dictionary. In the Code Mappings editor, click the

AUTOSAR Dictionary button, which is the leftmost icon. The AUTOSAR Dictionary opens in the AUTOSAR view that corresponds to the Simulink element that you last selected and mapped in the Code Mappings editor. If you selected and mapped a Simulink inport, the dictionary opens in RequiredPorts view and displays the AUTOSAR port to which you mapped the inport.



The AUTOSAR Dictionary displays the mapped AUTOSAR adaptive component and its elements, communication interfaces, and XML options. Use the dictionary to configure AUTOSAR elements and properties from an AUTOSAR component perspective.

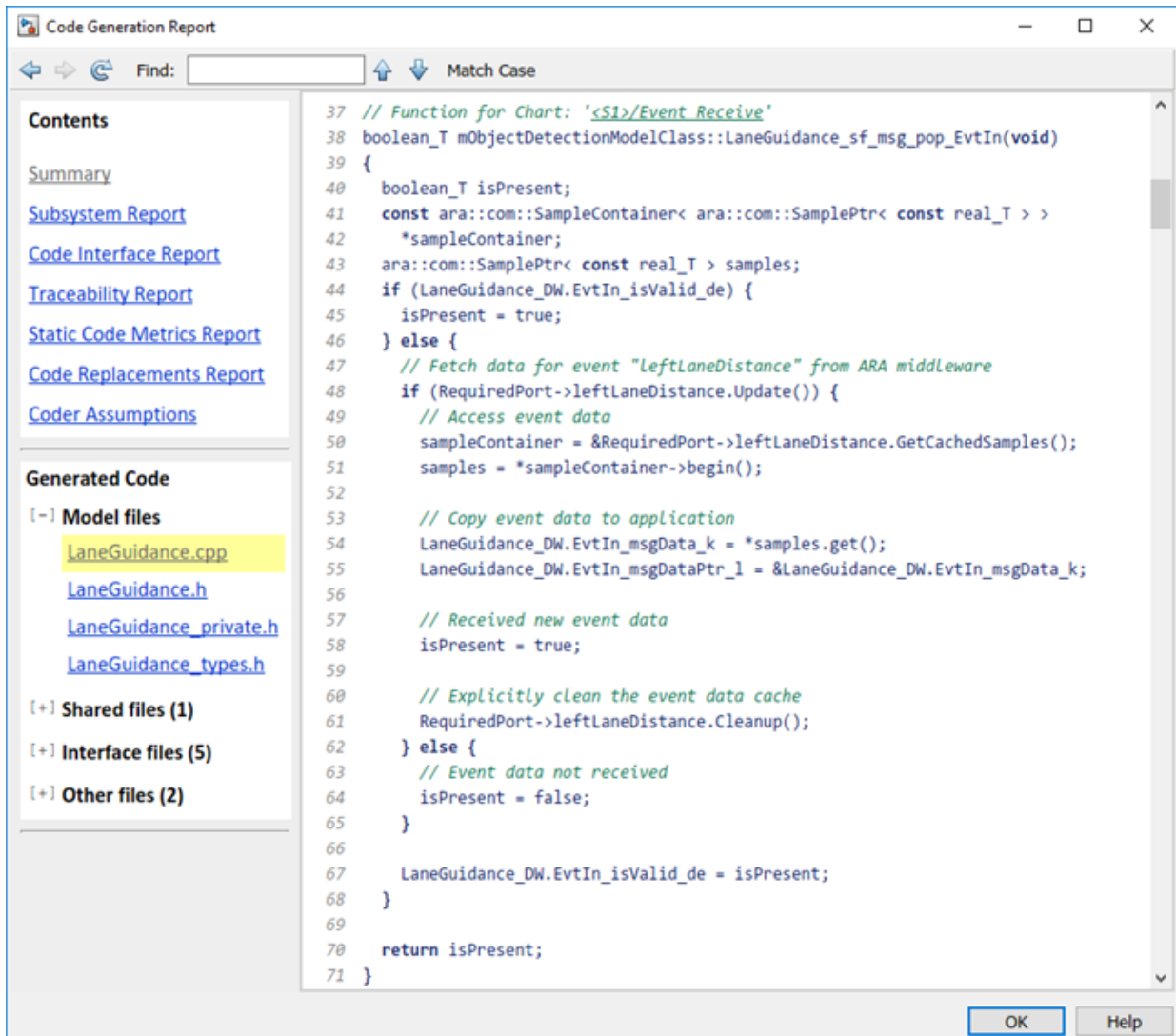
Open each node and examine its AUTOSAR elements. To modify an AUTOSAR element, select an element and modify its associated properties. AUTOSAR XML and AUTOSAR-compliant C code generated from the model reflect your modifications.

Generate C++ Code and ARXML Descriptions (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, you can build the AUTOSAR adaptive model. Building the AUTOSAR model generates AUTOSAR-compliant C++ code and exports AUTOSAR XML (arxml) descriptions. In the model window, press **Ctrl+B** or, on the **AUTOSAR** tab, select **Generate Code**.

When the build completes, a code generation report opens. Examine the report. Verify that your Code Mappings editor and AUTOSAR Dictionary changes are reflected in the C

++ code and arxml descriptions. For example, use the **Find** field to search for the names of the Simulink model elements and AUTOSAR component elements that you modified.



Related Links

- “AUTOSAR Component Configuration” on page 4-3
- “Code Generation” (Adaptive Platform)
- “AUTOSAR Blockset”

Import AUTOSAR Adaptive Software Descriptions

You can import AUTOSAR XML (arxml) descriptions of adaptive software components, service interfaces, and data types into Simulink. Use the arxml importer to:

- Create an initial Simulink representation of an AUTOSAR adaptive software component.
- Update a mapped AUTOSAR adaptive component model with shared arxml definitions of service interfaces and data types.

You can participate in round-trip exchanges of adaptive component arxml descriptions between Simulink and other development environments.

To create an initial Simulink representation of AUTOSAR adaptive software component from an arxml component description, use the arxml importer function `createComponentAsModel`. For example:

```
ar = arxml.importer('myAdaptiveSWC.arxml')
createComponentAsModel(ar, '/Company/Components/Swc')
```

For a detailed example, see “Import AUTOSAR Adaptive Components to Simulink” on page 6-17.

To update a mapped AUTOSAR adaptive component model with shared arxml definitions, use the arxml importer function `updateAUTOSARProperties`. For example:

```
modelName = 'my_adaptive_swc';
open_system(modelName);
ar = arxml.importer('ServiceInterfaces.arxml');
updateAUTOSARProperties(ar, modelName);
```

For a detailed example, see “Reuse AUTOSAR Adaptive Elements in Component Model” on page 6-22.

See Also

`createComponentAsModel` | `updateAUTOSARProperties`

Related Examples

- “Import AUTOSAR Adaptive Components to Simulink” on page 6-17
- “Reuse AUTOSAR Adaptive Elements in Component Model” on page 6-22

- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

More About

- “AUTOSAR arxml Importer” on page 3-17
- “Workflows for AUTOSAR” on page 1-13

Import AUTOSAR Adaptive Components to Simulink

Create Simulink® models from XML descriptions of AUTOSAR adaptive software components.

Import AUTOSAR Adaptive Components from XML Files to Simulink

Use the MATLAB function `createComponentAsModel` to import AUTOSAR XML (arxml) adaptive software component descriptions and create Simulink models.

First, parse the arxml description files and list the components they contain.

```
ar = arxml.importer({'fusion_app.arxml', 'radarService_app_mod.arxml', 'radar_svc_mod.arxml'});
names = getComponentNames(ar)

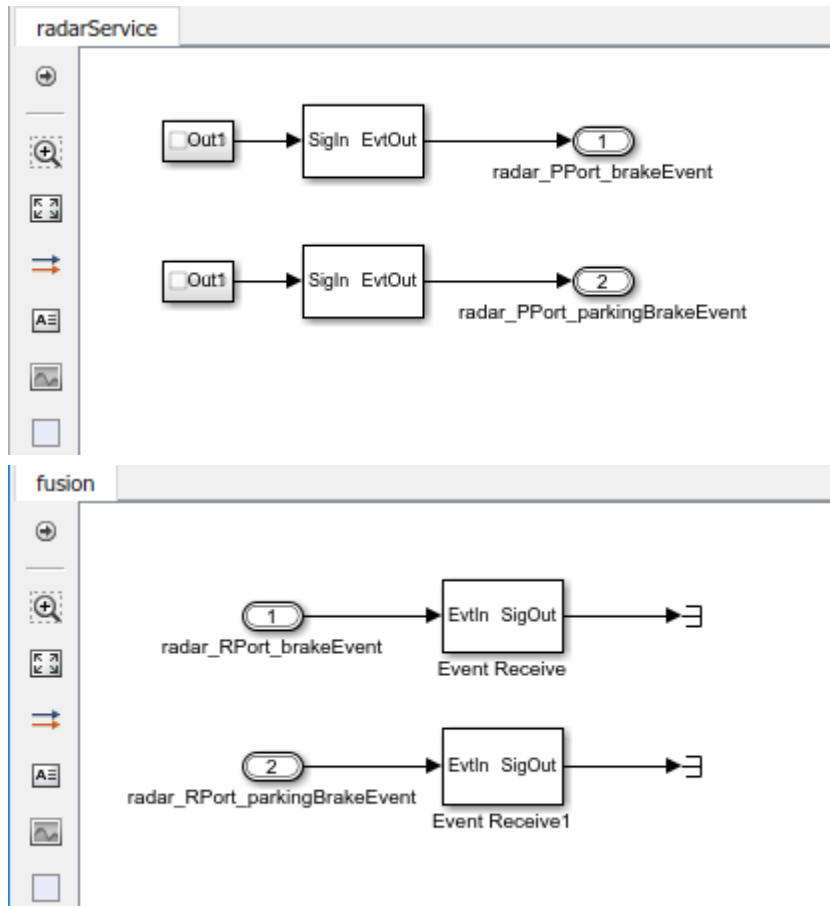
names = 2x1 cell array
    {'/RadarFusion/fusion'      }
    {'/RadarFusion/radarService'}
```

For each listed adaptive software component, use `createComponentAsModel` to create a Simulink representation. These commands create models named `fusion` and `radarService`.

```
createComponentAsModel(ar, '/RadarFusion/fusion');
createComponentAsModel(ar, '/RadarFusion/radarService');
```

Each created model contains:

- Simulink elements configured to model AUTOSAR adaptive component elements.
- An AUTOSAR dictionary, which stores the imported AUTOSAR adaptive element definitions.
- A mapping of the Simulink model elements to the AUTOSAR adaptive component elements.



In each model:

- Simulink ports represent AUTOSAR adaptive component provide and require ports.
- After each root inport, an Event Receive block converts an input event to a signal while preserving the signal values and data type.
- Before each root outport, an Event Send block converts an input signal to an event while preserving the signal values and data type.
- The ports are stubbed with Ground and Terminator blocks so that the model can immediately be updated and simulated.

Configure AUTOSAR Adaptive Software Component in Simulink

After you create an AUTOSAR adaptive software component model, use the **AUTOSAR Component Designer** app to refine the configuration of the AUTOSAR adaptive component.

Open an adaptive component model. On the **Apps** tab, select **AUTOSAR Component Designer**. The **AUTOSAR** tab opens.

To view the mapping of Simulink model elements to AUTOSAR adaptive component elements, open the Code Mappings and Property Inspector panes. Use this view to map model elements to AUTOSAR component elements from a Simulink model perspective.

The screenshot displays the Simulink AUTOSAR Component Designer interface. The main workspace shows a Simulink model with two input ports: 'radar_RPort_brakeEvent' (labeled 1) and 'radar_RPort_parkingBrakeEvent' (labeled 2). Each port is connected to an 'EvtIn SigOut' block, which then connects to an output port.

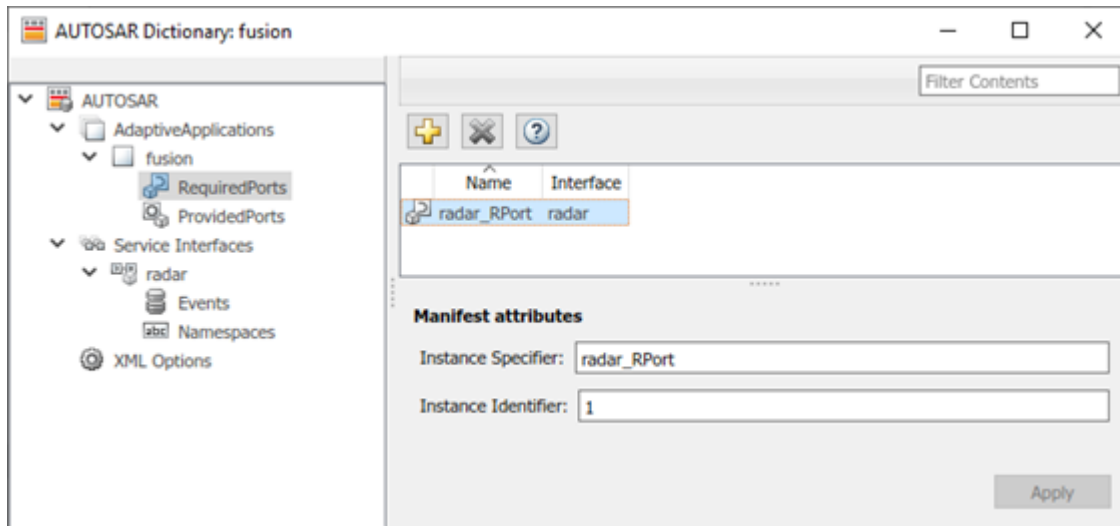
The **Code Mappings - AUTOSAR SW Component (Adaptive)** pane is open, showing the mapping between Simulink elements and AUTOSAR elements:

Source	Port	Event
radar_RPort_brakeEvent	radar_RPort	brakeEvent
radar_RPort_parkingBrakeEvent	radar_RPort	parkingBrakeEvent

The **Property Inspector** pane is also open, showing the properties for the selected 'radar_RPort_brakeEvent' input:

NAME	VALUE
Source	radar_RPort_brakeEvent
Design	
Data Type	Bus: RadarObjects
Min	[]
Max	[]
Dimensions	1
Complexity	real
Sample Time	-1
Unit	inherit
Code	
Port	radar_RPort
Event	brakeEvent

To view AUTOSAR adaptive element definitions, on the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**. The dictionary opens. Use this view to configure AUTOSAR elements from an AUTOSAR component perspective.

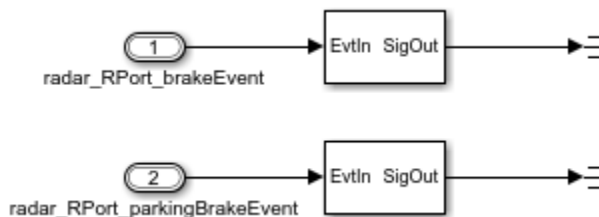


For more information, see “AUTOSAR Component Configuration” on page 4-3.

Develop AUTOSAR Adaptive Component Algorithms, Simulate, and Generate Code

After you create an AUTOSAR adaptive software component model and refine the configuration, you develop the component. Create algorithmic model content that implements the component requirements.

For example, the `fusion` component model that you created contains an initial stub implementation of the component behavior.



To implement the component requirements, replace the Terminator blocks with blocks that implement Simulink algorithms.

As you develop AUTOSAR adaptive components, you can:

- Simulate the component model individually or in a containing composition or test harness.
- Generate arxml component description files and algorithmic C++ code for testing in Simulink or integration into an AUTOSAR run-time environment. (AUTOSAR code generation requires Simulink Coder and Embedded Coder.)

For more information, see “Component Development” and “Code Generation”.

Related Links

- `createComponentAsModel`
- “Component Creation”
- “AUTOSAR Component Configuration” on page 4-3
- “Component Development”
- “Code Generation”

Reuse AUTOSAR Adaptive Elements in Component Model

Import and reference AUTOSAR XML (arxml) element definitions for the Adaptive Platform

Add AUTOSAR Adaptive Element Definitions to Model

When developing an AUTOSAR adaptive software component in Simulink, you can reuse existing arxml element definitions that are common to many components. After you create an AUTOSAR adaptive component model, you import the definitions from arxml files that are dedicated to describing AUTOSAR elements, not components. To help implement the component behavior, you want to reuse predefined elements such as services interfaces, with their associated events and namespaces, and data types.

Suppose that you are developing an AUTOSAR adaptive software component model. You want to import predefined adaptive platform type elements that are shared by multiple product lines and teams. This example uses AUTOSAR importer function `updateAUTOSARProperties` to import definitions from shared descriptions file `Adaptive_PlatformTypes.arxml` into example model `autosar_LaneGuidance`.

```
modelName = 'autosar_LaneGuidance';
open_system(modelName);
ar = arxml.importer('Adaptive_PlatformTypes.arxml');
updateAUTOSARProperties(ar,modelName);

### Updating model autosar_LaneGuidance
### Saving original model as autosar_LaneGuidance_backup.slx
### Creating HTML report autosar_LaneGuidance_update_report.html
```

The function copies the elements in the specified arxml files to the AUTOSAR Dictionary of the specified model. If you import data types, the function also creates data objects, in a data dictionary (if available) or in the base workspace, for the imported types.

The function generates an HTML report listing the workspace changes and the element additions. Here are the Simulink workspace changes, reflecting creation of data objects to represent previously undefined adaptive platform types.

Automatic Workspace Changes

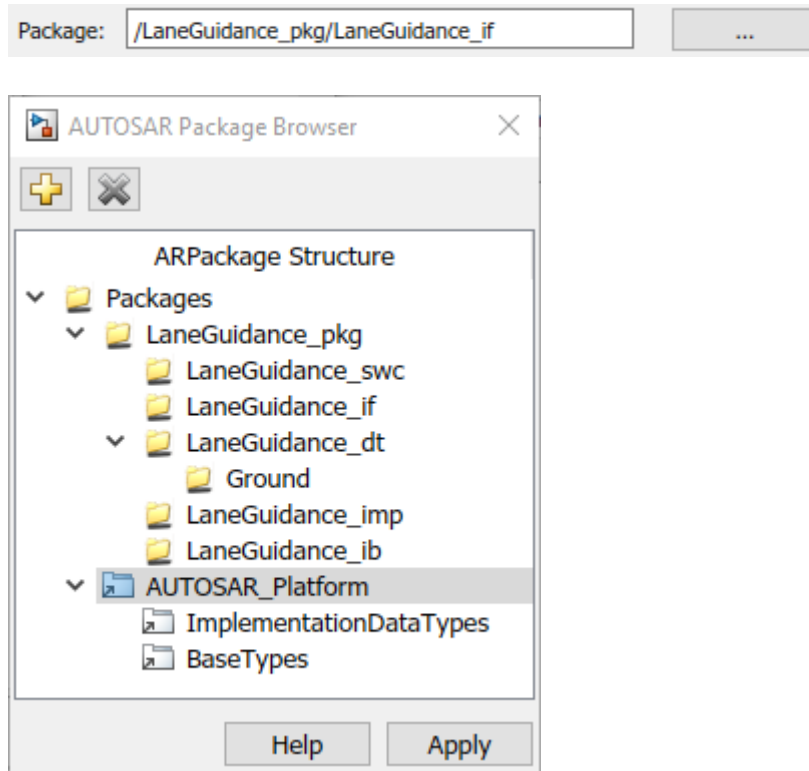
Added	Simulink.NumericType sint64
Added	Simulink.NumericType uint64
Added	Simulink.AliasType sint8_least
Added	Simulink.AliasType sint16_least
Added	Simulink.AliasType sint32_least
Added	Simulink.AliasType uint8_least
Added	Simulink.AliasType uint16_least
Added	Simulink.AliasType uint32_least

Here are the AUTOSAR element additions. Notice that the function created a new AUTOSAR package named `AUTOSAR_Platform`. Based on the imported adaptive platform types, the function populated the package with AUTOSAR software base types and AUTOSAR implementation data types.

Automatic AUTOSAR Element Changes

Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint32
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint16
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint8
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint64
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint32
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint8
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint16
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint64
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint8_least
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint16_least
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint8_least
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint16_least
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/sint32_least
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/uint32_least
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/boolean
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/float32
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/void
Added	SwBaseType /AUTOSAR_Platform/BaseTypes/float64
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/uint32
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/uint16
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/uint64
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/sint16_least
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/sint8_least
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/sint32
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/sint64
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/uint8
Added	Boolean /AUTOSAR_Platform/ImplementationDataTypes/boolean
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/sint16
Added	Integer /AUTOSAR_Platform/ImplementationDataTypes/sint8
Added	Package /AUTOSAR_Platform
Added	Package /AUTOSAR_Platform/ImplementationDataTypes

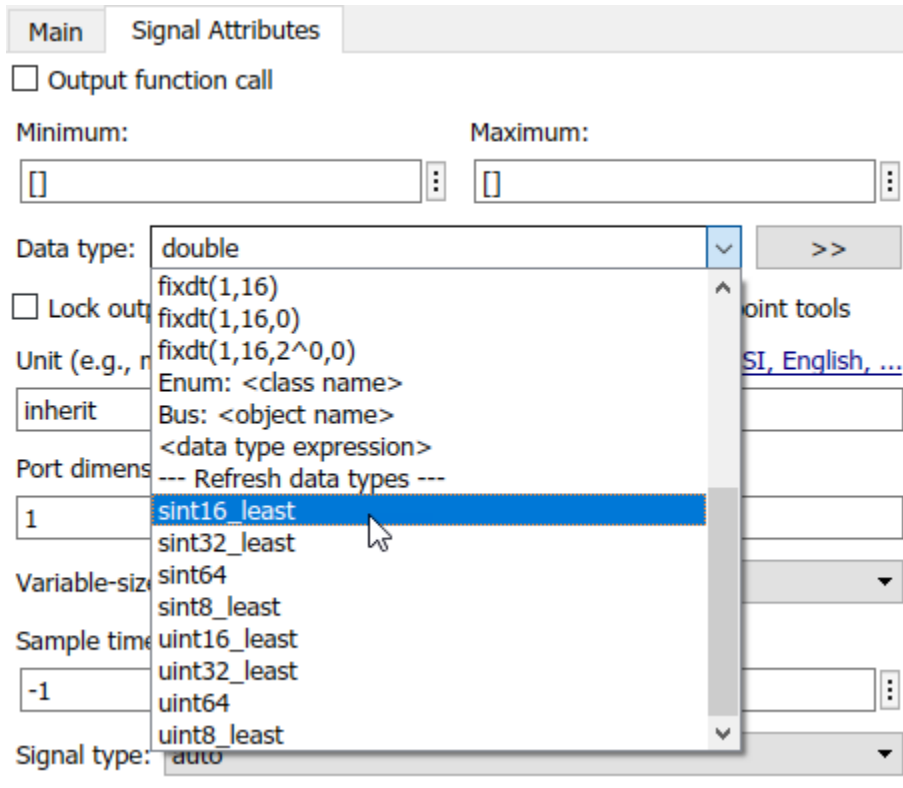
The package changes are reflected in the AUTOSAR Dictionary views of the package tree. If you open the AUTOSAR Dictionary and navigate to an individual service interface, you can click the horizontal ellipsis to the right of the **Package** field to view the current package tree.



Reference and Configure Imported AUTOSAR Adaptive Elements

After importing AUTOSAR elements into the adaptive software component model, you can reference and configure the elements in the same manner as any AUTOSAR Dictionary element.

If you imported data types, you can reference the types from your model blocks. For example, open a Simulink port block in your model and select the **Signal Attributes** tab. Expand the **Data type** list of values and notice that the imported data types are available for selection.



If you have Simulink Coder and Embedded Coder software, you can generate AUTOSAR-compliant C++ code and export arxml descriptions from the adaptive component model. The C++ code reflects references from model blocks to the imported adaptive elements. Export preserves the file structure and content of the shared descriptions files from which you imported definitions. In arxml files other than the shared description files, arxml descriptions reference the shared element definitions where required.

Related Links

- `updateAUTOSARProperties`
- “Reuse AUTOSAR Element Descriptions” on page 3-41
- “AUTOSAR arxml Importer” on page 3-17

Configure AUTOSAR Adaptive Elements and Properties

In Simulink, you can use the AUTOSAR Dictionary and the Code Mappings editor separately or together to graphically configure an AUTOSAR adaptive software component and map Simulink model elements to AUTOSAR component elements. For more information, see “AUTOSAR Component Configuration” on page 4-3.

Use the AUTOSAR Dictionary to configure AUTOSAR elements from an AUTOSAR perspective. Using a tree format, the AUTOSAR Dictionary displays a mapped AUTOSAR adaptive component and its elements, communication interfaces, and XML options. Use the tree to select AUTOSAR elements and configure their properties. The properties that you modify are reflected in exported `arxml` descriptions and potentially in generated AUTOSAR-compliant C++ code.

In this section...

“AUTOSAR Elements Configuration Workflow” on page 6-27

“Configure AUTOSAR Adaptive Software Components” on page 6-28

“Configure AUTOSAR Required and Provided Ports” on page 6-31

“Configure AUTOSAR Service Communication Interfaces” on page 6-34

“Configure AUTOSAR Adaptive XML Options” on page 6-38


AUTOSAR Elements Configuration Workflow

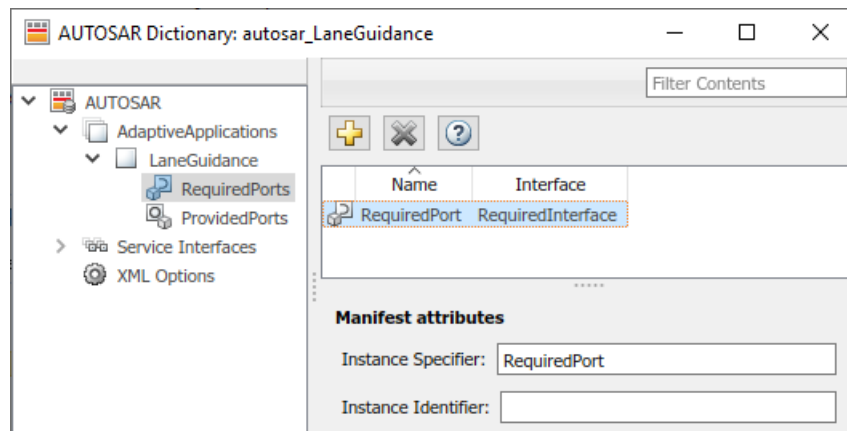
To configure AUTOSAR component elements for the Adaptive Platform in Simulink:


- 1 Open a model for which AUTOSAR system target file `autosar_adaptive.tlc` is selected.
- 2 Create or open a mapped view of the AUTOSAR model. In the model window, do one of the following:
 - From the **Apps** tab, open the AUTOSAR Component Designer app.
 - Click the perspective control in the lower-right corner and select **Code**.

If the model has not yet been mapped to an AUTOSAR software component, the AUTOSAR Component Quick Start opens. Work through the quick-start procedure and click **Finish**. For more information, see “Create Mapped AUTOSAR Component with Quick Start” on page 3-2.

The model opens in the AUTOSAR code perspective. This perspective displays a help panel, a Property Inspector dialog box, and, directly under the model, the Code Mappings editor.

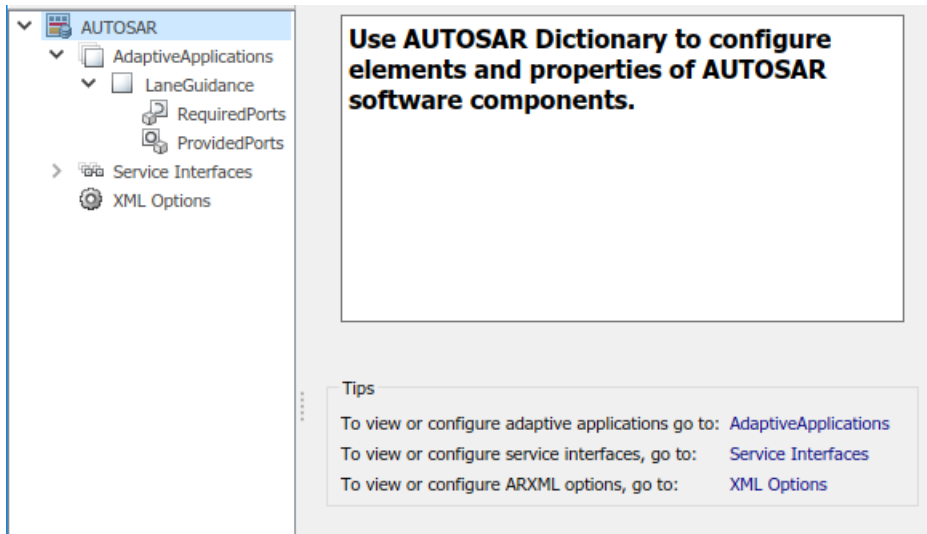
- 3 Open the AUTOSAR Dictionary. Either click the **AUTOSAR Dictionary** button  in the Code Mappings editor or, in the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**.




- 4 To configure AUTOSAR elements and properties, navigate the AUTOSAR Dictionary tree. You can add elements, remove elements, or select elements to view and modify their properties. Use the **Filter Contents** field (where available) to selectively display some elements, while omitting others, in the current view.
- 5 After configuring AUTOSAR adaptive elements and properties, open the Code Mappings editor. Use Code Mapping tabs to map Simulink elements to new or modified AUTOSAR elements.
- 6 To validate the AUTOSAR component configuration, click the **Validate** button . If errors are reported, address them and then retry validation.

Configure AUTOSAR Adaptive Software Components

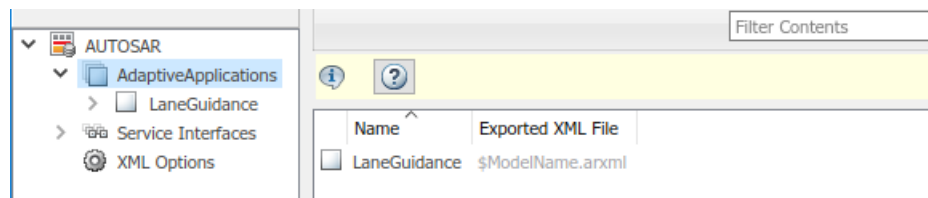
AUTOSAR adaptive software components contain AUTOSAR elements defined in the AUTOSAR standard, such as required ports and provided ports. In the AUTOSAR Dictionary, component elements appear in a tree format under the component that owns them. To access component elements and their properties, you expand the component name.



To configure AUTOSAR adaptive software component elements and properties:

- 1 Open a model for which a mapped AUTOSAR adaptive software component has been created. For more information, see “Component Creation”.
- 2 From the **Apps** tab, open the AUTOSAR Component Designer app.
- 3 Open the AUTOSAR Dictionary. Either click the **AUTOSAR Dictionary** button  in the Code Mappings editor or, in the **AUTOSAR** tab, select **Settings > AUTOSAR Dictionary**.
- 4 In the leftmost pane of the AUTOSAR Dictionary, under **AUTOSAR**, select **AdaptiveApplications**.

The adaptive applications view in the AUTOSAR Dictionary displays adaptive software components. You can rename an AUTOSAR adaptive component by clicking its name and then editing the name text.



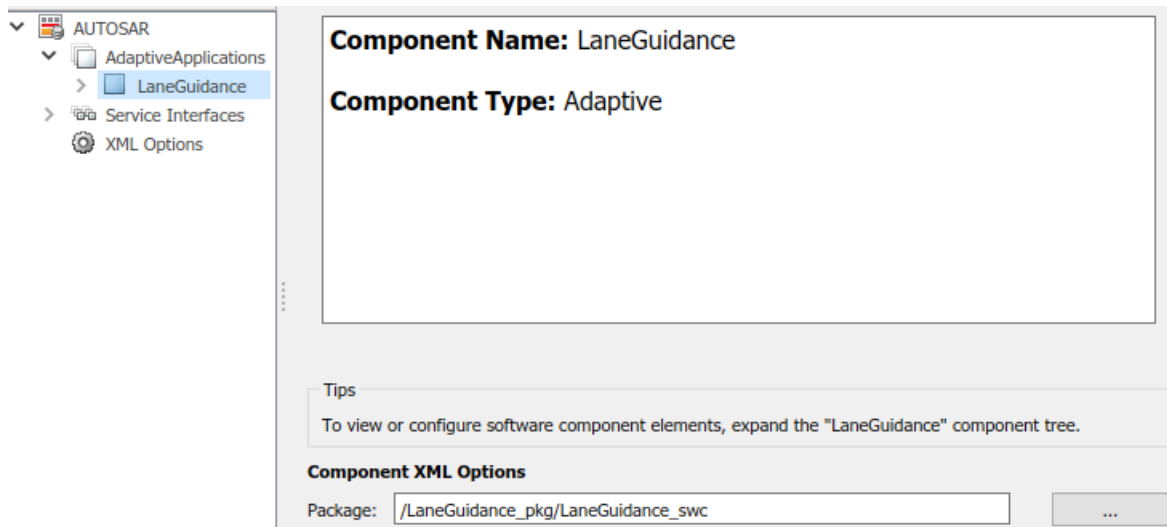
- 5 In the leftmost pane of the AUTOSAR Dictionary, expand **AdaptiveApplications** and select an AUTOSAR adaptive component.

The component view in the AUTOSAR Dictionary displays the name and type of the selected component, and component options for a rxml file export. You can modify the AUTOSAR package to be generated for the component.

To specify the AUTOSAR package path, you can do either of the following:

- Enter a package path in the **Package** parameter field. Package paths can use an organizational naming pattern, such as /CompanyName/Powertrain.
- To open the AUTOSAR Package Browser, click the button to the right of the **Package** field. Use the browser to navigate to an existing package or create a package. When you select a package in the browser and click **Apply**, the component **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.

For more information about component XML options, see “Configure AUTOSAR Packages” on page 4-111.



Configure AUTOSAR Required and Provided Ports



An AUTOSAR adaptive software component contains service communication ports defined in the AUTOSAR standard, including required and provided ports. In the AUTOSAR Dictionary, communication ports appear in a tree format under the component that owns them and under a port type name. To access port elements and their properties, you expand the component name and expand the port type name.

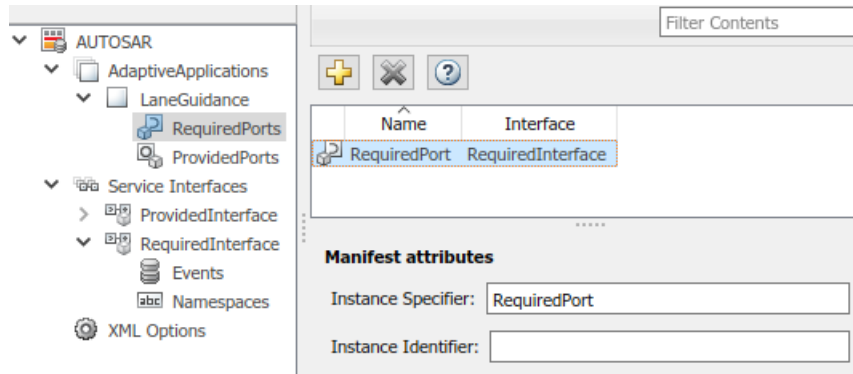
The AUTOSAR Dictionary views of required and provided ports support modeling AUTOSAR service interface communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR required and provided ports, service interfaces, service interface events, and C++ namespaces in your model. For more information, see “Model AUTOSAR Adaptive Service Communication” on page 6-57.

To configure AUTOSAR required and provided port elements, open a model for which a mapped AUTOSAR adaptive software component has been created and open the AUTOSAR Dictionary.

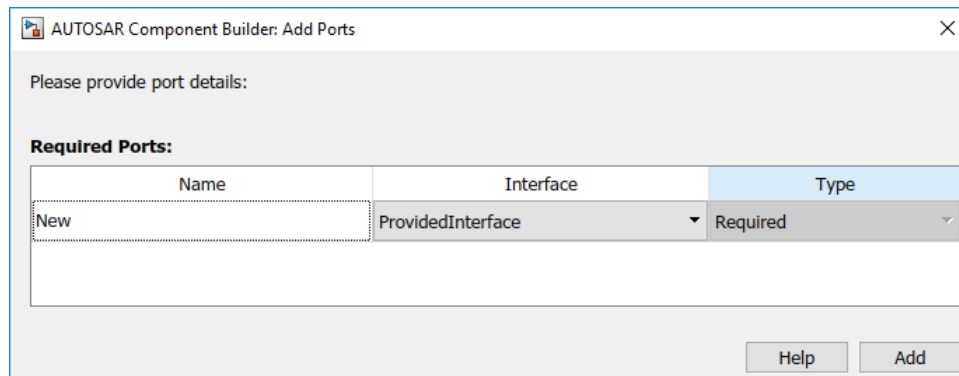
- 1 In the leftmost pane of the AUTOSAR Dictionary, expand the component name and select **RequiredPorts**.

The required ports view in the AUTOSAR Dictionary lists required ports and their properties. You can:

- Select an AUTOSAR required port, and view and optionally reselect its associated service interface.
- Rename an AUTOSAR required port by clicking its name and then editing the name text.
- To configure adaptive service instance identification for a port, select the port and view its **Manifest attributes**. Based on the service instance form selected in XML options, examine the value for **Instance Specifier** or **Instance Identifier**. You can enter a value or accept an existing value. For more information, see “Configure AUTOSAR Adaptive Service Instance Identification” on page 6-63.
- To add a port, click the **Add** button  and use the Add Ports dialog box.
- To remove a port, select the port and then click the **Delete** button .



The Add Ports dialog box lets you add a required port and associate it with an existing service interface. To add the port and return to the required ports view, click **Add**.





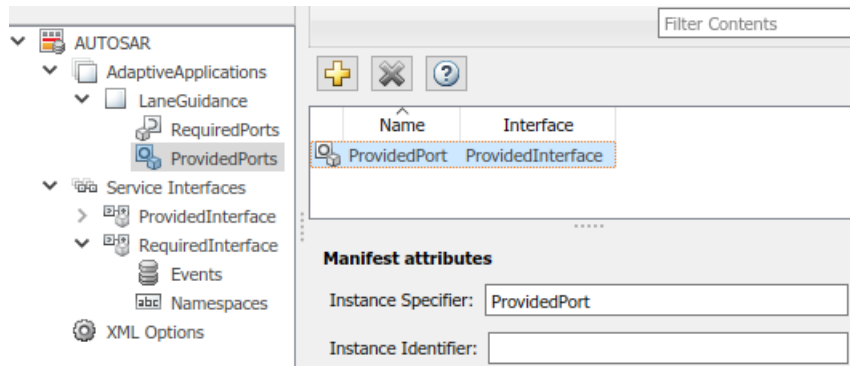
- 2 In the leftmost pane of the AUTOSAR Dictionary, select **ProvidedPorts**.

The provided ports view in the AUTOSAR Dictionary lists provided ports and their properties. You can:

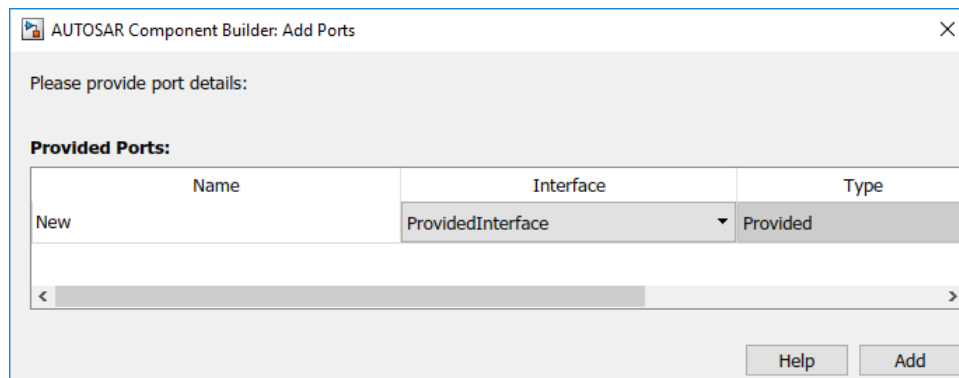
- Select an AUTOSAR provided port, and view and optionally reselect its associated service interface.
- Rename an AUTOSAR provided port by clicking its name and then editing the name text.
- To configure adaptive service instance identification for a port, select the port and view its **Manifest attributes**. Based on the service instance form selected in XML

options, examine the value for **Instance Specifier** or **Instance Identifier**. You can enter a value or accept an existing value. For more information, see “Configure AUTOSAR Adaptive Service Instance Identification” on page 6-63.

- To add a port, click the **Add** button  and use the Add Ports dialog box.
- To remove a port, select the port and then click the **Delete** button .



The Add Ports dialog box lets you add a provided port and associate it with an existing service interface. To add the port and return to the provided ports view, click **Add**.



Configure AUTOSAR Service Communication Interfaces



An AUTOSAR software component uses communication interfaces defined in the AUTOSAR standard, including adaptive service interfaces. In the AUTOSAR Dictionary, communication interfaces appear in a tree format under the interface type name. To access interface elements and their properties, you expand the interface type name.

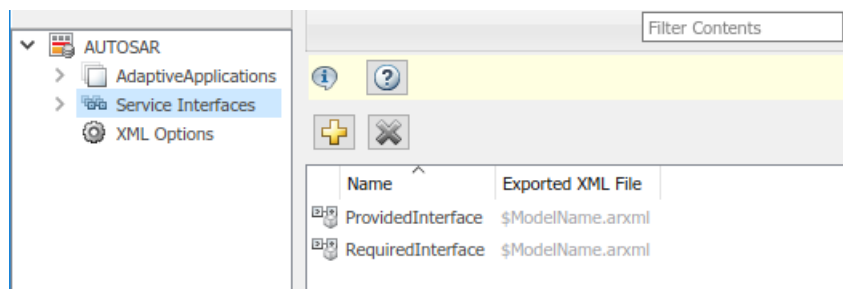
The **Service Interfaces** view in the AUTOSAR Dictionary supports modeling AUTOSAR adaptive service communication in Simulink. You use the AUTOSAR Dictionary to configure AUTOSAR required and provided ports, service interfaces, service interface events, and C++ namespaces in your model. For more information, see “Model AUTOSAR Adaptive Service Communication” on page 6-57.

To configure AUTOSAR service interface elements and properties, open a model for which a mapped AUTOSAR adaptive software component has been created and open the AUTOSAR Dictionary.

- 1 In the leftmost pane of the AUTOSAR Dictionary, select **Service Interfaces**.

The service interfaces view in the AUTOSAR Dictionary lists AUTOSAR service interfaces and their properties. You can:

- Select a service interface and rename it by editing its name text.
- To add one or more service interfaces, click the **Add** button  and use the Add Interfaces dialog box.
- To remove a service interface, select the interface and then click the **Delete** button .



In the Add Interfaces dialog box, specify the name of the interface, the number of associated events it contains, and the path of the Interface package. To add the interface and return to the service interfaces view, click **Add**.

AUTOSAR Component Builder: Add Interfaces

Please provide interface details:

Interface package: /LaneGuidance_pkg/LaneGuidance_if

Service Interfaces:

Name	Number of Events
New	1

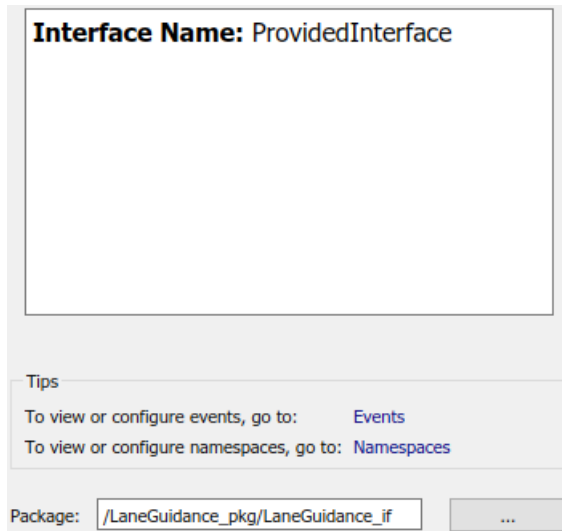
Help Add

- 2 In the leftmost pane of the AUTOSAR Dictionary, expand **Service Interfaces** and select a service interface from the list.

The service interface view in the AUTOSAR Dictionary displays the name of the selected service interface and the AUTOSAR package to be generated for the interface.



To modify the AUTOSAR package for the interface, you can do either of the following:

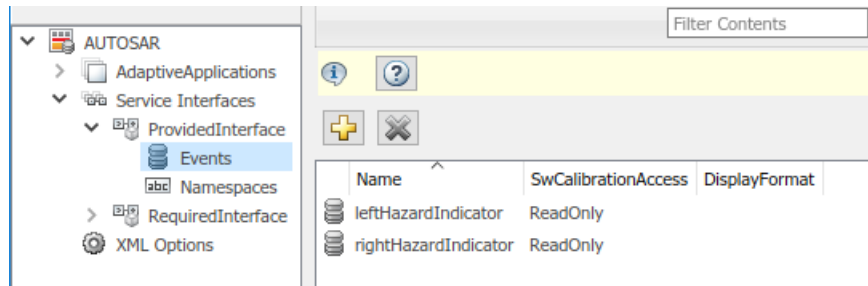
- Enter a package path in the **Package** parameter field.
- To open the AUTOSAR Package Browser, click the button to the right of the **Package** field. Use the browser to navigate to an existing package or create a package. When you select a package in the browser and click **Apply**, the interface **Package** parameter value is updated with your selection. For more information about the AUTOSAR Package Browser, see “Configure AUTOSAR Package for Component, Interface, CompuMethod, or SwAddrMethod” on page 4-123.



- 3 In the leftmost pane of the AUTOSAR Dictionary, expand the selected interface and select **Events**.



The events view in the AUTOSAR Dictionary lists AUTOSAR service interface events and their properties. You can:

- Select a service interface event and edit the name value.
- Specify the level of measurement and calibration tool access to service interface events. Select an event and set its **SwCalibrationAccess** value to **ReadOnly**, **ReadWrite**, or **NotAccessible**.
- Optionally specify the format to be used by measurement and calibration tools to display the event. In the **DisplayFormat** field, enter an ANSI C `printf` format specifier string. For example, `%2.1d` specifies a signed decimal number. The number has a minimum width of two characters and a maximum precision of one digit, producing a displayed value such as 12.2. For more information about constructing a format specifier string, see “Configure DisplayFormat” on page 4-287.
- To add an event, click the **Add** button .
- To remove an event, select the event and then click the **Delete** button .

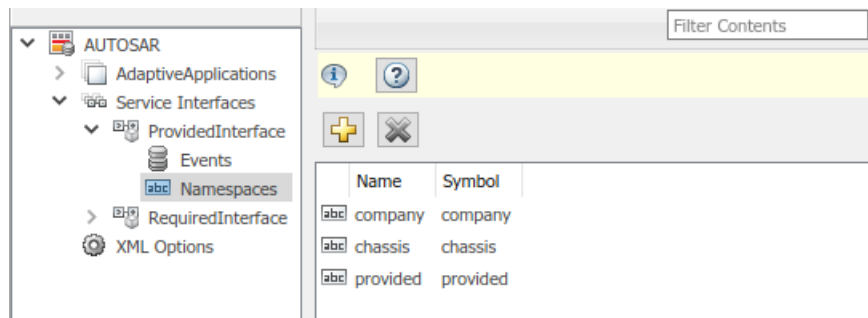


- 4 In the leftmost pane of the AUTOSAR Dictionary, below **Events**, select **Namespaces**.

The namespaces view in the AUTOSAR Dictionary allows you to define a unique namespace for each service interface. The code generator uses the defined namespace when producing C++ code for the interface. To modify or construct a namespace specification, you can:

- Select a namespace element and edit the name value.
- To add a namespace element to the namespace specification, click the **Add** button .
- To remove a namespace element, select the element and then click the **Delete** button .

For example, this namespaces view defines namespace `company::chassis::provided` for service interface `ProvidedInterface`.

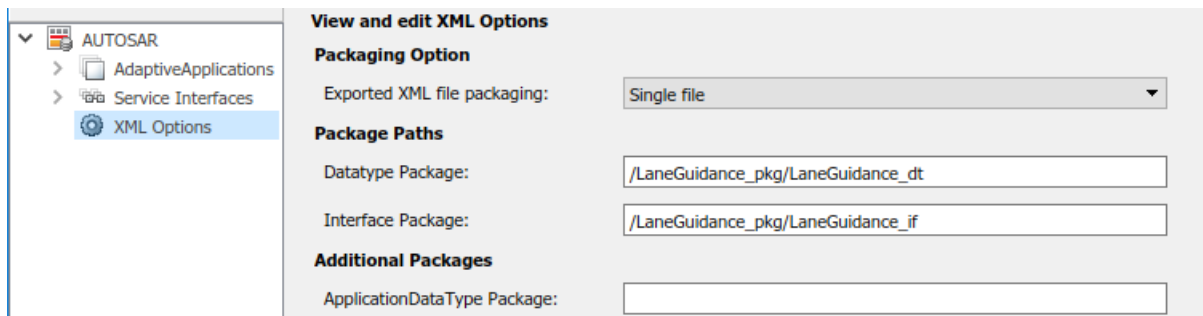


Configure AUTOSAR Adaptive XML Options

To configure AUTOSAR adaptive XML options for an XML export, open a model for which a mapped AUTOSAR adaptive software component has been created and open the AUTOSAR Dictionary. Select **XML Options**.

The XML options view in the AUTOSAR Dictionary displays XML export parameters and their values. You can configure:

- XML file packaging for AUTOSAR elements created in Simulink
- AUTOSAR package paths
- Aspects of exported AUTOSAR XML content



- “Exported XML File Packaging” on page 6-38
- “AUTOSAR Package Paths” on page 6-39
- “Additional XML Options” on page 6-40

Exported XML File Packaging

In the XML options view, you can specify the granularity of XML file packaging for AUTOSAR elements created in Simulink. (Imported AUTOSAR XML files retain their file structure, as described in “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.) Select one of the following values for **Exported XML file packaging**.

- **Single file** — Exports XML into a single file, *modelname.arxml*.
- **Modular** — Exports XML into multiple files, named according to the type of information contained.

Exported File Name	By Default Contains...
<i>modelname_component.arxml</i>	Software components. The <i>modelname_component.arxml</i> file is the main arxml file exported for the Simulink model. In addition to AUTOSAR software components, the file includes elements for which AUTOSAR packages (AR-PACKAGEs) are not configured. The file also includes AR-PACKAGEs that do not align with the package paths in the other exported arxml files. For more information on AR-PACKAGEs and their location in modular exported arxml files, see “AR-PACKAGE Location in Exported ARXML Files” on page 4-119.
<i>modelname_datatype.arxml</i>	Data types and related elements.
<i>modelname_interface.arxml</i>	Interfaces, including adaptive service interfaces.

Alternatively, you can programmatically configure exported XML file packaging by calling the AUTOSAR `set` function. For property `ArxmlFilePackaging`, specify either `SingleFile` or `Modular`. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'XmlOptions', 'ArxmlFilePackaging', 'SingleFile');
```

For the Adaptive Platform, model builds also generate XML manifests for AUTOSAR executables and service instances. For more information, see “Generate AUTOSAR Adaptive C++ and XML Files” on page 6-70.

AUTOSAR Package Paths

In the XML options view, you can configure AUTOSAR packages (AR-PACKAGEs), which contain groups of AUTOSAR elements and reside in a hierarchical AR-PACKAGE structure. (The AR-PACKAGE structure for a component is logically distinct from the arxml file partitioning selected with the XML option **Exported XML file packaging** or imported from AUTOSAR XML files.) For more information about AUTOSAR packages, see “Configure AUTOSAR Packages” on page 4-111.

Inspect and modify the AUTOSAR package paths grouped under the headings **Package Paths** and **Additional Packages**.

Package Paths	
Datatype Package:	<input type="text" value="/LaneGuidance_pkg/LaneGuidance_dt"/>
Interface Package:	<input type="text" value="/LaneGuidance_pkg/LaneGuidance_if"/>
Additional Packages	
ApplicationDataType Package:	<input type="text"/>
SwBaseType Package:	<input type="text"/>
ConstantSpecification Package:	<input type="text" value="/LaneGuidance_pkg/LaneGuidance_dt/Ground"/>
Physical DataConstraints Package:	<input type="text" value="/LaneGuidance_pkg/LaneGuidance_dt/ApplDataTypes/DataConstrs"/>
Unit Package:	<input type="text" value="/LaneGuidance_pkg/LaneGuidance_dt"/>
SwRecordLayout Package:	<input type="text"/>
Internal DataConstraints Package:	<input type="text"/>

Alternatively, you can programmatically configure an AUTOSAR package path by calling the AUTOSAR set function. Specify a package property name and a package path. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);  
set(arProps, 'XmlOptions', 'ApplicationDataTypePackage', ...  
    '/Company/Powertrain/DataTypes/ApplDataTypes');
```

For more information about AUTOSAR package property names and defaults, see “Configure AUTOSAR Packages and Paths” on page 4-113.

Additional XML Options

In the XML options view, under the heading **Additional Options**, you can configure aspects of exported AUTOSAR XML content.

Additional Options	
ImplementationDataType Reference:	<input type="text" value="Allowed"/>
SwCalibrationAccess DefaultValue:	<input type="text" value="ReadWrite"/>
Internal DataConstraints Export:	<input type="checkbox"/>
Identify Service Instance Using:	<input type="text" value="InstanceIdentifier"/>

You can:

- Optionally override the default behavior for generating AUTOSAR application data types in arxml code. To force generation of an application data type for each AUTOSAR data type, change the value of **ImplementationDataType Reference** from Allowed to NotAllowed. For more information, see “Control Application Data Type Generation” on page 4-326.
- Control the default value of the **SwCalibrationAccess** property of generated AUTOSAR measurement variables, calibration parameters, and signal and parameter data objects. Select one of the following values for **SwCalibrationAccess DefaultValue**:
 - **ReadOnly** — Read access only.
 - **ReadWrite** (default) — Read and write access.
 - **NotAccessible** — Not accessible with measurement and calibration tools.

For more information, see “Configure SwCalibrationAccess” on page 4-285.

- Optionally override the default behavior for generating internal data constraint information for AUTOSAR implementation data types in arxml code. To force export of internal data constraints for implementation data types, select the option **Internal DataConstraints Export**. For more information, see “Configure AUTOSAR Internal Data Constraints Export” on page 4-324.
- Specify the form in which to generate adaptive service instance information. Set **Identify Service Instance Using** to InstanceIdentifier or InstanceSpecifier. The form that you select is used to identify service instances in generated Proxy and Skeleton functions. For more information, see “Configure AUTOSAR Adaptive Service Instance Identification” on page 6-63.

Alternatively, you can programmatically configure the additional XML options by calling the AUTOSAR set function. Specify a property name and value. The valid property names are ImplementationTypeReference, SwCalibrationAccessDefault, InternalDataConstraintExport, and IdentifyServiceInstance. For example:

```
arProps = autosar.api.getAUTOSARProperties(hModel);
set(arProps, 'XmlOptions', 'ImplementationTypeReference', 'NotAllowed');
set(arProps, 'XmlOptions', 'SwCalibrationAccessDefault', 'ReadOnly');
set(arProps, 'XmlOptions', 'InternalDataConstraintExport', true);
set(arProps, 'XmlOptions', 'IdentifyServiceInstance', 'InstanceSpecifier')
```

See Also

Related Examples

- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

More About

- “AUTOSAR Component Configuration” on page 4-3

Map AUTOSAR Adaptive Elements for Code Generation

In Simulink, you can use the Code Mappings editor and the AUTOSAR Dictionary separately or together to graphically configure an AUTOSAR adaptive software component and map Simulink model elements to AUTOSAR component elements. For more information, see “AUTOSAR Component Configuration” on page 4-3.

Use the Code Mappings editor to map Simulink model elements to AUTOSAR component elements from a Simulink model perspective. The editor display consists of tabbed tables, including **Inports** and **Outports**. Use the tables to select Simulink elements and map them to corresponding AUTOSAR elements. The mappings that you configure are reflected in generated AUTOSAR-compliant C++ code and exported arxml descriptions.

In this section...

“Simulink to AUTOSAR Mapping Workflow” on page 6-43

“Map Inports and Outports to AUTOSAR Required and Provided Service Ports” on page 6-45

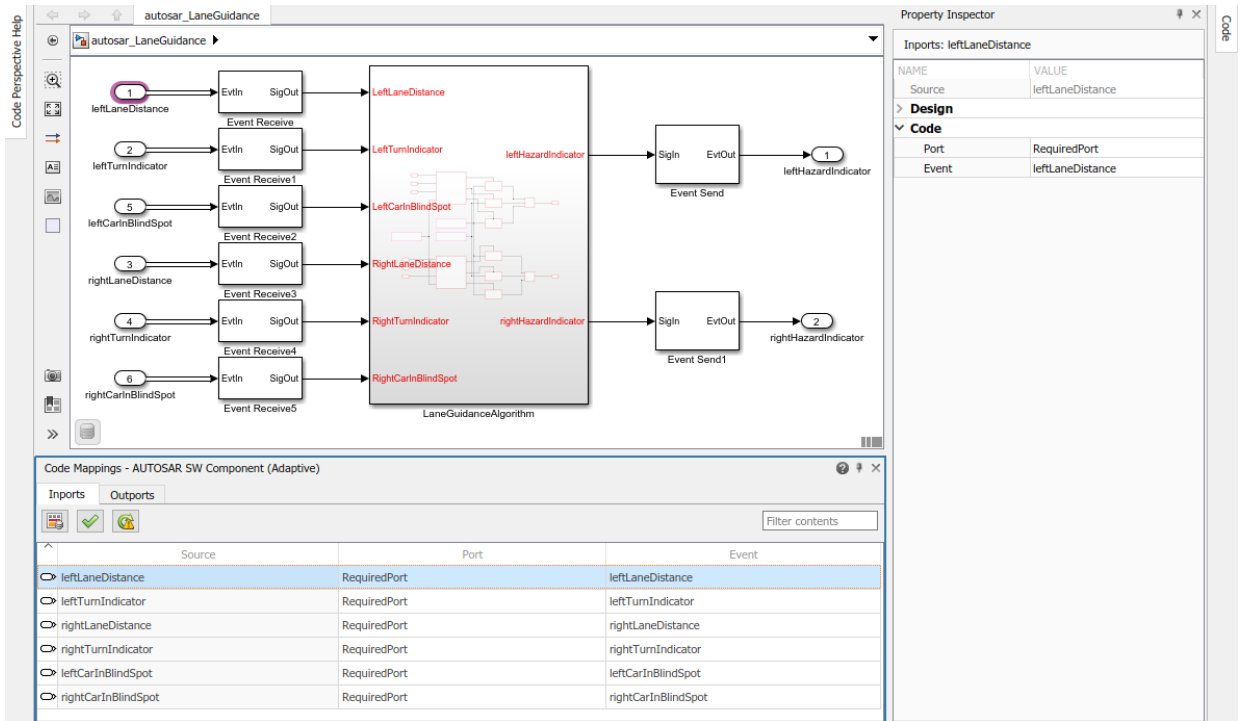
Simulink to AUTOSAR Mapping Workflow

To map Simulink model elements to AUTOSAR adaptive software component elements:

- 1 Open a model for which AUTOSAR system target file `autosar_adaptive.tlc` is selected.
- 2 Create or open a mapped view of the AUTOSAR model. In the model window, do one of the following:
 - From the **Apps** tab, open the AUTOSAR Component Designer app.
 - Click the perspective control in the lower-right corner and select **Code**.

If the model has not yet been mapped to an AUTOSAR software component, the AUTOSAR Component Quick Start opens. To configure the model for AUTOSAR component development, work through the quick-start procedure and click **Finish**. For more information, see “Create Mapped AUTOSAR Component with Quick Start” on page 3-2.


The model opens in the AUTOSAR code perspective. This perspective displays a help panel, a Property Inspector dialog box, and, directly under the model, the Code Mappings editor.



The Code Mappings editor provides in-canvas access to AUTOSAR mapping information, with batch editing, element filtering, easy navigation to model elements and AUTOSAR properties, and model element traceability.

- 3 Use the Code Mappings editor **Imports** and **Exports** tabs to map each Simulink import or output to an AUTOSAR required or provided port and a service interface event.

Use the **Filter contents** field (where available) to selectively display some elements, while omitting others, in the current view.

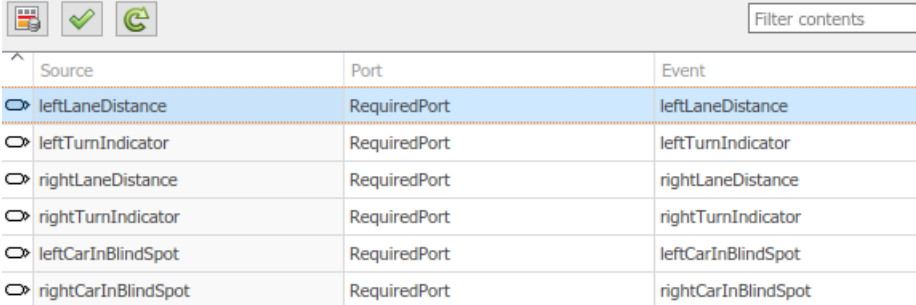
- 4 After mapping model elements, click the **Validate** button  to validate the AUTOSAR component configuration. If errors are reported, address them and then retry validation.

Map Inports and Outports to AUTOSAR Required and Provided Service Ports

The **Inports** and **Outports** tabs of the Code Mappings editor support modeling AUTOSAR service interface communication in Simulink. After using the AUTOSAR Dictionary to create AUTOSAR required and provided service ports, service interfaces, and service interface events in your model, open the Code Mappings editor. Use the **Inports** and **Outports** tabs to map Simulink root inports and outports to AUTOSAR required and provided service ports and AUTOSAR service interface events.

For more information, see “Model AUTOSAR Adaptive Service Communication” on page 6-57.

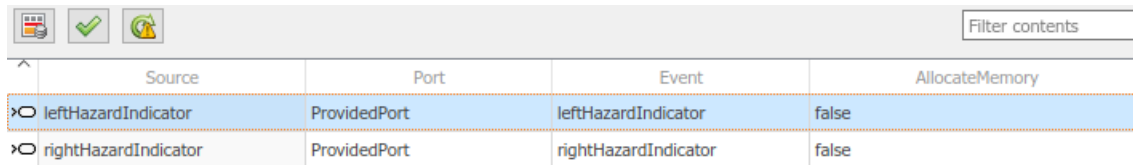
The **Inports** tab of the Code Mappings editor maps each Simulink root inport to an AUTOSAR required port and a service interface event. To map a Simulink inport, select the inport and then select menu values for an AUTOSAR port and an AUTOSAR event, among values listed for the component.



Source	Port	Event
leftLaneDistance	RequiredPort	leftLaneDistance
leftTurnIndicator	RequiredPort	leftTurnIndicator
rightLaneDistance	RequiredPort	rightLaneDistance
rightTurnIndicator	RequiredPort	rightTurnIndicator
leftCarInBlindSpot	RequiredPort	leftCarInBlindSpot
rightCarInBlindSpot	RequiredPort	rightCarInBlindSpot

The **Outports** tab of the Code Mappings editor maps each Simulink root outport to an AUTOSAR provided port and a service interface event. In the **Outports** tab, you can:

- Map a Simulink outport by selecting the outport and then selecting menu values for an AUTOSAR port and an AUTOSAR event, among values listed for the component.
- Use the code attribute `AllocateMemory` to configure memory allocation for AUTOSAR adaptive service data. Specify whether to send event data by reference (the default) or by `ara::com` allocated memory. To send event data by `ara::com` allocated memory, select the value `true`. To send event data by reference, select `false`. For more information, see “Configure Memory Allocation for AUTOSAR Adaptive Service Data” on page 6-61.



	Source	Port	Event	AllocateMemory
>O	leftHazardIndicator	ProvidedPort	leftHazardIndicator	false
>O	rightHazardIndicator	ProvidedPort	rightHazardIndicator	false

See Also

Related Examples

- “Configure Memory Allocation for AUTOSAR Adaptive Service Data” on page 6-61
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Configure and Map AUTOSAR Component Programmatically” on page 4-332

More About

- “AUTOSAR Component Configuration” on page 4-3

Configure AUTOSAR Adaptive Software Components

In Simulink, you can flexibly model the structure and behavior of software components for the AUTOSAR Adaptive Platform. The AUTOSAR Adaptive Platform defines a service-oriented architecture for automotive components that must flexibly adapt to external events and conditions.

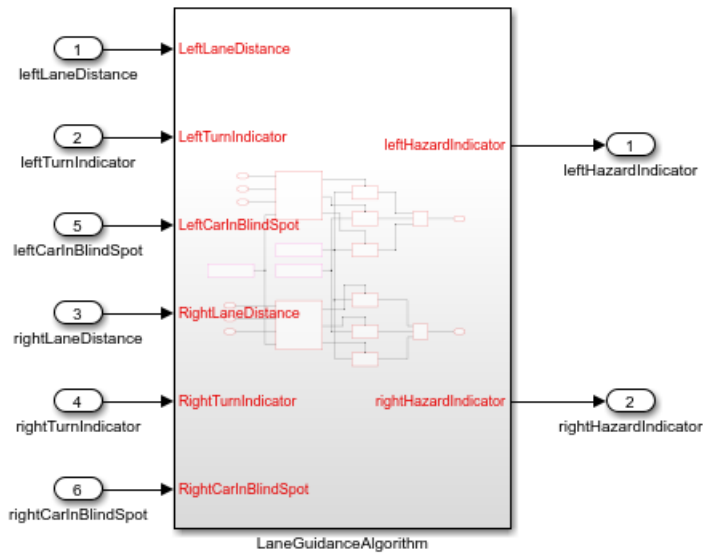
An AUTOSAR adaptive software component provides and consumes services. Each software component contains:

- An automotive algorithm, which performs tasks in response to received events.
- Required and provided ports, each associated with a service interface.
- Service interfaces, with associated events and associated namespaces.

For more information, see “Model AUTOSAR Adaptive Software Components” on page 6-2.

This example configures a Simulink representation of an automotive algorithm as an AUTOSAR adaptive software component. The configuration steps use example models `LaneGuidance` and `autosar_LaneGuidance`.

- 1 Open a Simulink model that either is empty or contains a functional algorithm. This example uses ERT algorithm model `LaneGuidance`.



- Using the Model Configuration Parameters dialog box, **Code Generation** pane, configure the model for adaptive AUTOSAR code generation. Set **System target file** to `autosar_adaptive.tlc`. Apply the change.

Target selection

System target file:

Language:

Description: AUTOSAR Adaptive

Build process

Generate code only

Package code and artifacts

Toolchain settings

Toolchain:

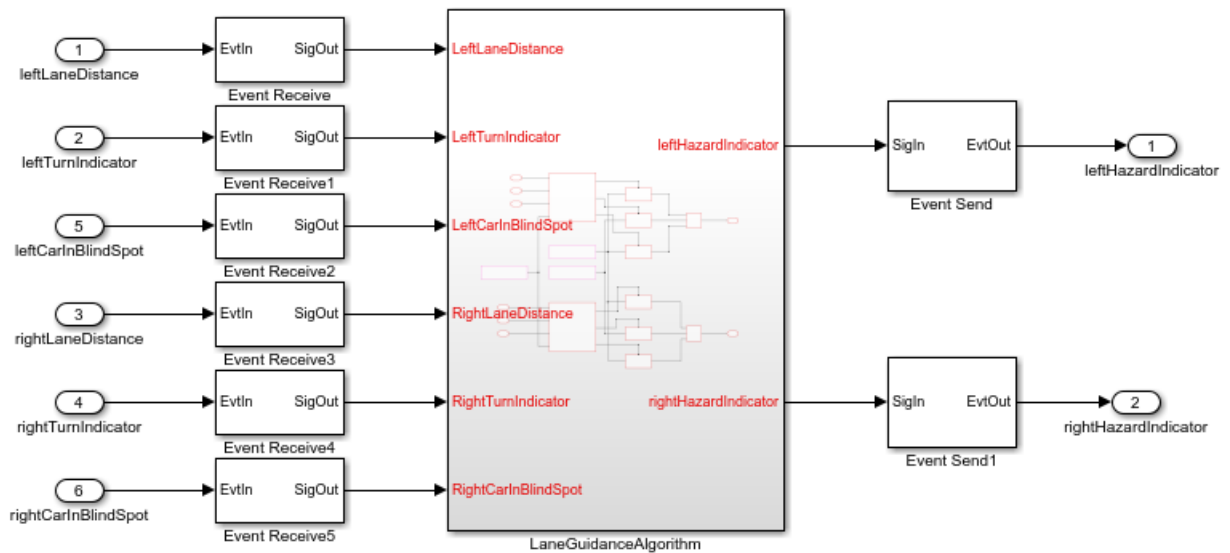
The new setting affects other model settings. For example, the target file selection:

- Sets **Language** to C++.

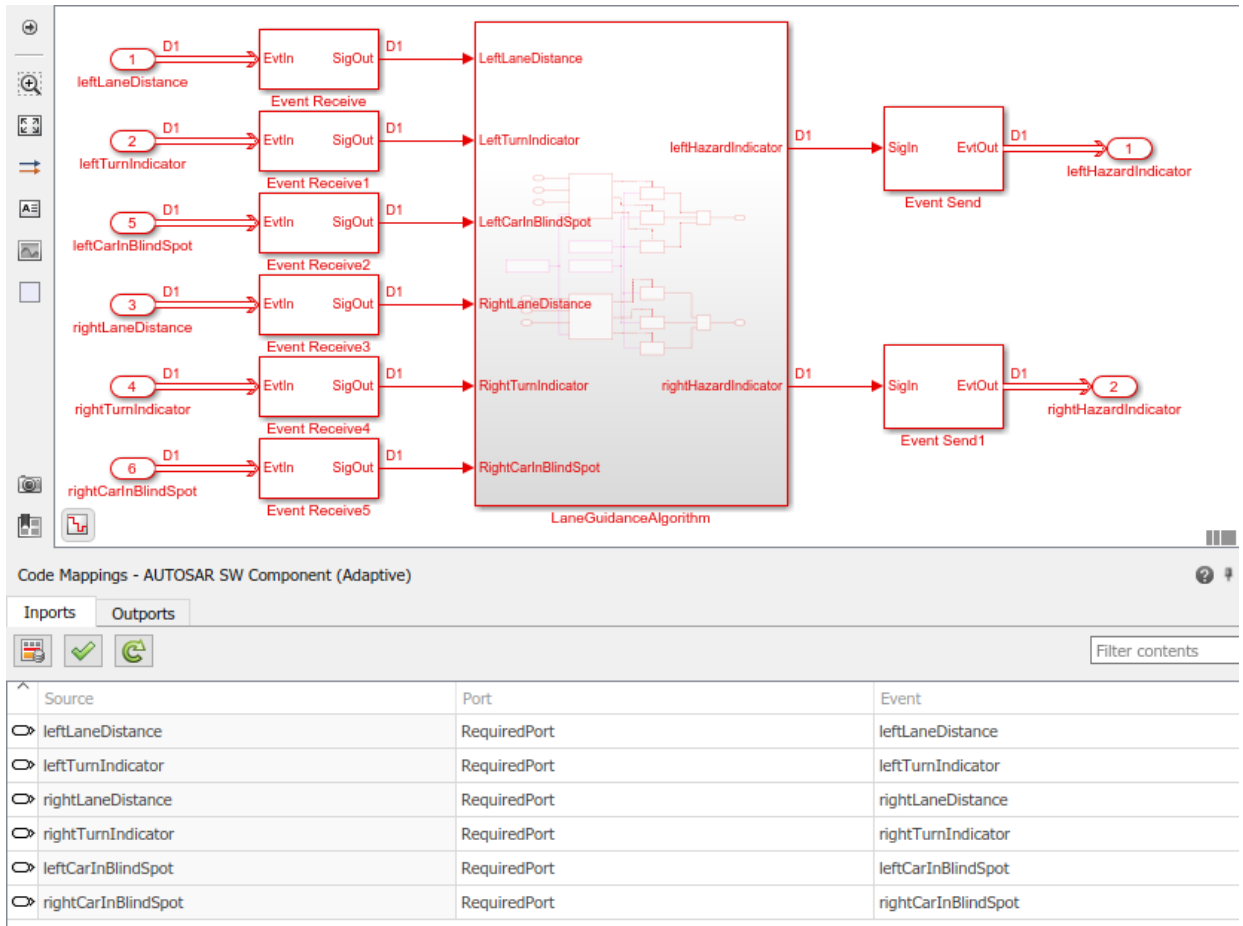
- Selects **Generate code only**.
 - Sets **Toolchain** to AUTOSAR Adaptive | CMake.
 - Sets **Interface > Code interface packaging** to C++ class.
- 3** Develop the model algorithmic content for use in an AUTOSAR adaptive software component. If the model is empty, construct or copy in an algorithm. Possible sources for algorithms include algorithmic elements in other Simulink models. Examples include subsystems, referenced models, MATLAB Function blocks, and C Caller blocks.
- 4** At the top level of the model, set up event-based communication, which the AUTOSAR Adaptive Platform requires for AUTOSAR required and provided ports. AUTOSAR Blockset provides Event Receive and Event Send blocks to make the necessary event/signal connections.
- After each root inport, add an Event Receive block, which converts an input event to a signal while preserving the signal values and data type.
 - Before each root outport, add an Event Send block, which converts an input signal to an event while preserving the signal values and data type.

Note Alternatively, you can skip this step. A later step provides a finished mapped model with event conversion blocks included.

Here is example model LaneGuidance with the event blocks added and connected.




- 5 Map the algorithm model to an AUTOSAR adaptive software component.
 - a To map the algorithm model, in the **Apps** tab, click **AUTOSAR Component Designer**. Because the model is unmapped, the AUTOSAR Component Quick Start opens. (Alternatively, click the perspective control in the lower-right corner and select **Code**, or call MATLAB function `autosar.api.create(modelName)`.)
 - b Work through the quick-start procedure. Click **Finish** to map the model.
 - c The model opens in the AUTOSAR code perspective. The perspective displays the mapping of Simulink elements to AUTOSAR adaptive software component elements and an AUTOSAR Dictionary, which contains AUTOSAR adaptive component elements with default properties.

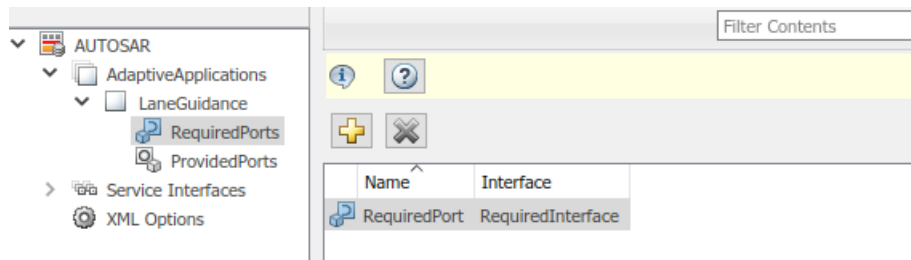


- 6 If you completed the adaptive configuration steps, save the AUTOSAR adaptive software component model with a unique name.

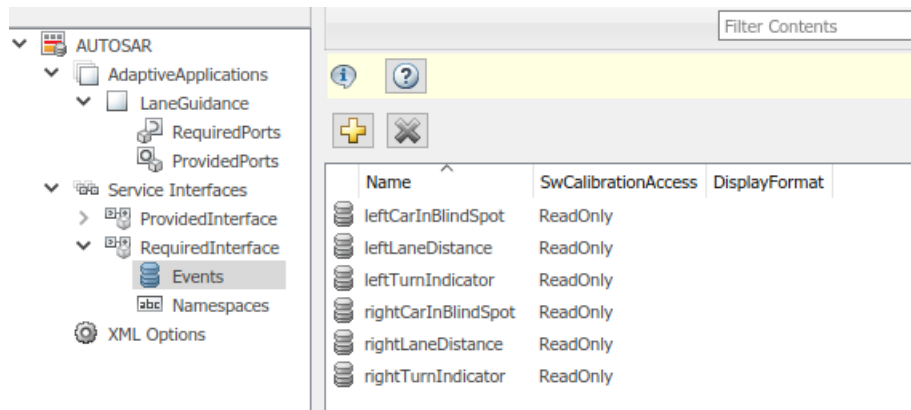
If you skipped any steps, open an example of a finished mapped AUTOSAR adaptive software component, example model `autosar_LaneGuidance`.

- 7 Using the AUTOSAR code perspective and the AUTOSAR Dictionary (or equivalent AUTOSAR map and property functions), further refine the AUTOSAR adaptive model configuration.

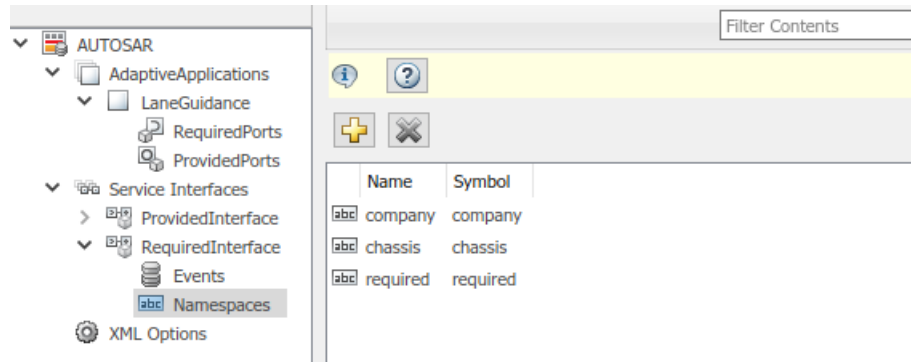
- In the model window, check model data to see if you need to make post-mapping adjustments to types or other attributes. For example, verify that event data is configured correctly for your design.
- In the AUTOSAR code perspective, examine the mapping of Simulink inports and outports to AUTOSAR required and provided ports and events.
- To open the AUTOSAR Dictionary, select an inport or outport and click the **AUTOSAR Dictionary** button . The dictionary opens in the view of the corresponding mapped AUTOSAR port.



- In the dictionary, you can expand service interface nodes to examine the AUTOSAR events created by the default component mapping.



- In the dictionary, you can define a unique namespace for each service interface. Example model `autosar_LaneGuidance` defines namespaces `company::chassis::provided` and `company::chassis::required` for the respective service interfaces. When you build the model, generated C++ code uses the service interface namespaces.



- In the dictionary, in the XML options view, you can configure characteristics of exported AUTOSAR XML. To generate compact code, example model `autosar_LaneGuidance` sets XML option **Exported XML file packaging** to `Single file`. In the Model Configuration Parameters dialog box, the example model sets **Code Placement > File packaging format** to `Compact`.
- 8** Build the AUTOSAR adaptive software component model. For example, in the model window, enter **Ctrl+B**. Building the model generates:

- C++ files that implement the model algorithms for the AUTOSAR Adaptive Platform and provide shared data type definitions.

[-] **Model files**

[autosar_LaneGuidance.cpp](#)

[autosar_LaneGuidance.h](#)

[-] **Shared files**

[rtwtypes.h](#)

- AUTOSAR XML descriptions of the AUTOSAR adaptive software component and a model class header file.

[-] **Interface files**

[autosar_LaneGuidance.arxml](#)

[rtmodel.h](#)

- C++ files that implement a main program module.

[\[-\] Other files](#)

[MainUtils.hpp](#)

[main.cpp](#)

- CMakeLists.txt file that supports CMake generation of executables.

The generated C++ model files include model class definitions and AUTOSAR Runtime for Adaptive Applications (ARA) calls to implement the adaptive software component services. For example, model file `autosar_LaneGuidance.cpp` contains initialization code for each service interface and event. The code reflects the service interface namespaces and event names configured in the AUTOSAR Dictionary.

```
// Model initialize function
void mObjectDetectionModelClass::initialize()
{
    {
        ara::com::ServiceHandleContainer< company::chassis::required::proxy::
            RequiredInterfaceProxy::HandleType > handles;
        ...
        handles = company::chassis::required::proxy::RequiredInterfaceProxy::
            FindService();
        if (handles.size() > 0U) {
            RequiredPort = std::make_shared<company::chassis::required::proxy::
                RequiredInterfaceProxy>(*handles.begin());
        }

        // Subscribe event
        RequiredPort->rightCarInBlindSpot.Subscribe(ara::com::EventCacheUpdatePolicy::
            kNewestN, 1U);
        ...
    }
}
```

Model file `autosar_LaneGuidance.cpp` also contains step code for each service interface event. For example, the step code for `RequiredInterface`, event `rightCarInBlindSpot`, calls a message pop function to fetch and handle new `rightCarInBlindSpot` event data received by ARA middleware.

```
// Model step function
void mObjectDetectionModelClass::step()
{
    ...
    // Chart: '<S6>/Event Receive'
    autosar_LaneGuidance_DW.EvtIn_isValid = false;
    if (autosar_LaneGuidance_sf_msg_pop_EvtIn_n()) {
        autosar_LaneGuidance_B.SigOut = *(real_T *)
            autosar_LaneGuidance_DW.EvtIn_msgDataPtr;
    }

    autosar_LaneGuidance_sf_msg_discard_EvtIn_kl();
}
```



```

    // End of Chart: '<S6>/Event Receive'
    ...
}

```

The exported AUTOSAR XML code includes descriptions of AUTOSAR elements that you configured by using the AUTOSAR Dictionary. For example, component file `autosar_LaneGuidance.arxml` describes the namespaces and events specified for required and provided interfaces.

```

<SERVICE-INTERFACE UUID="...">
  <SHORT-NAME>RequiredInterface</SHORT-NAME>
  <NAMESPACES>
    <SYMBOL-PROPS>
      <SHORT-NAME>company</SHORT-NAME>
      <SYMBOL>company</SYMBOL>
    </SYMBOL-PROPS>
    <SYMBOL-PROPS>
      <SHORT-NAME>chassis</SHORT-NAME>
      <SYMBOL>chassis</SYMBOL>
    </SYMBOL-PROPS>
    <SYMBOL-PROPS>
      <SHORT-NAME>required</SHORT-NAME>
      <SYMBOL>required</SYMBOL>
    </SYMBOL-PROPS>
  </NAMESPACES>
  <EVENTS>
    ...
    <VARIABLE-DATA-PROTOTYPE UUID="...">
      <SHORT-NAME>rightCarInBlindSpot</SHORT-NAME>
      <CATEGORY>VALUE</CATEGORY>
      <SW-DATA-DEF-PROPS>
        <SW-DATA-DEF-PROPS-VARIANTS>
          <SW-DATA-DEF-PROPS-CONDITIONAL>
            <SW-CALIBRATION-ACCESS>READ-ONLY</SW-CALIBRATION-ACCESS>
            <SW-IMPL-POLICY>QUEUED</SW-IMPL-POLICY>
          </SW-DATA-DEF-PROPS-CONDITIONAL>
        </SW-DATA-DEF-PROPS-VARIANTS>
      </SW-DATA-DEF-PROPS>
      <TYPE-TREF DEST="IMPLEMENTATION-DATA-TYPE">
        /LaneGuidance_pkg/LaneGuidance_dt/Double</TYPE-TREF>
    </VARIABLE-DATA-PROTOTYPE>
  </EVENTS>
</SERVICE-INTERFACE>

```

The generated C++ main program file provides a framework for running adaptive software component service code. For the `autosar_LaneGuidance` model, the `main.cpp` file:

- Instantiates the adaptive software component model object.
- Reports the adaptive application state to ARA.

- Calls the model initialize and terminate functions.
- Sets up asynchronous function call objects for each task.
- Runs asynchronous function calls in response to base-rate tick semaphore posts.

See Also

Event Receive | Event Send

Related Examples

- “Model AUTOSAR Adaptive Software Components” on page 6-2
- “Create and Configure AUTOSAR Adaptive Software Component” on page 6-7
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Model AUTOSAR Adaptive Service Communication” on page 6-57
- “Configure AUTOSAR Adaptive Code Generation” on page 6-70

More About

- “Comparison of AUTOSAR Classic and Adaptive Platforms” on page 1-4

Model AUTOSAR Adaptive Service Communication

The AUTOSAR Adaptive Platform defines service-oriented, event-based communication between adaptive software components. Each adaptive software component provides and consumes services, and interconnected components send and receive service events. A component contains:


- An algorithm that performs tasks in response to received events.
- Required and provided ports, through which events are received and sent.
- Service interfaces, which provide the framework for event-based communication.

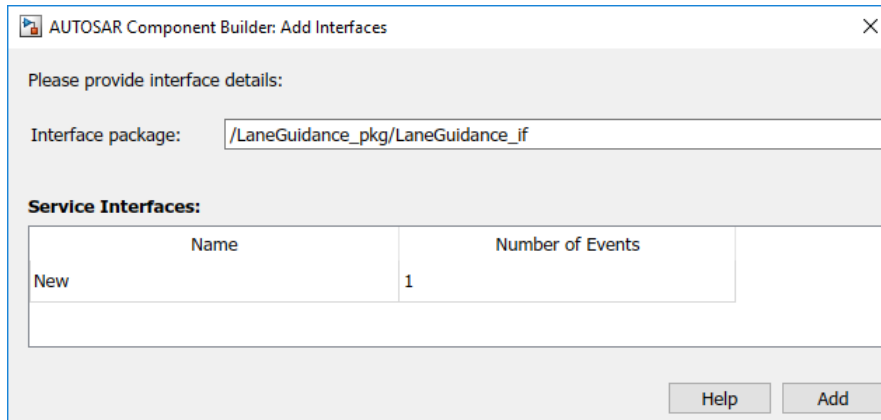
To model adaptive service communication in Simulink, you can:

- Create AUTOSAR required and provided ports, service interfaces, service interface events, and C++ namespaces.
- Create root-level inports and outports and map them to AUTOSAR required and provided ports and service interface events.

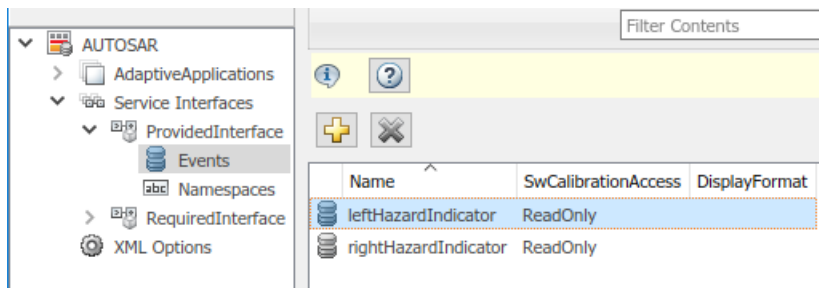
If you have Simulink Coder and Embedded Coder software, you can generate C++ code and `arxml` descriptions for AUTOSAR service communication.

To implement adaptive service communication in Simulink:

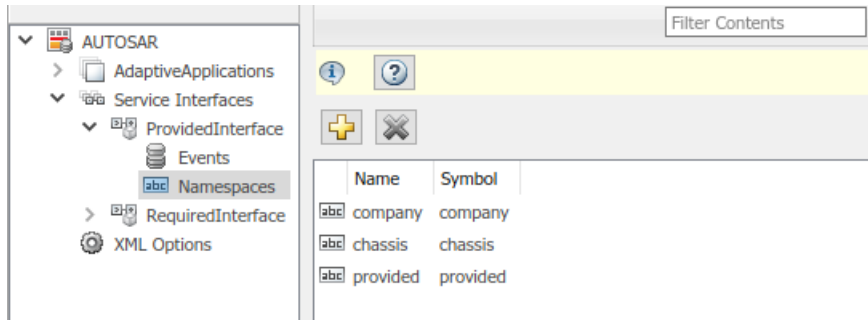
- 1 Open a model configured for the AUTOSAR Adaptive Platform. Displays in this example use model `autosar_LaneGuidance`.
- 2 Open the AUTOSAR Dictionary and select **Service Interfaces**. To create an AUTOSAR service interface, click the **Add** button . In the Add Interfaces dialog box, specify the interface name and the number of associated events.



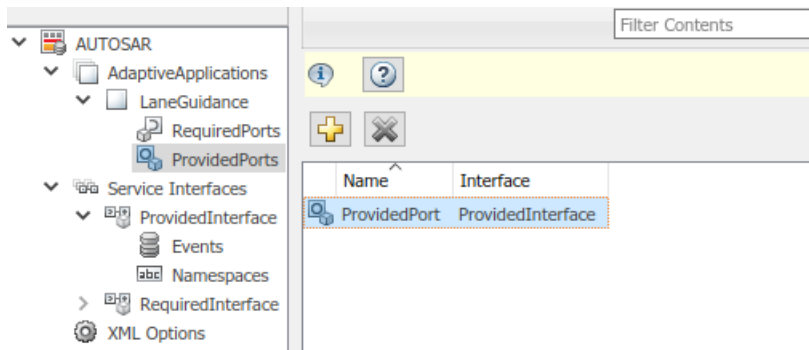
- Expand the **Service Interfaces** node. Expand the new service interface and select **Events**. In the events view, select each service event and configure its attributes.



- Select **Namespaces**. The namespaces view allows you to define a unique namespace for each service interface. The code generator uses the defined namespace when producing C++ code for the interface. To modify or construct a namespace specification, select a namespace element and edit the name value. For example, this namespaces view defines namespace `company::chassis::provided` for service interface `ProvidedInterface`.



- At the top level of the AUTOSAR Dictionary, expand **AdaptiveApplications** and expand the adaptive software component. Use the **RequiredPorts** and **ProvidedPorts** views to add AUTOSAR required and provided ports that you want to associate with the new service interface. For each new service port, select the service interface you created.



- In the model widow, to model AUTOSAR adaptive service ports, create root-level inports and outports.
- Open the Code Mappings editor. Use the **Inports** and **Outports** tabs to map Simulink inports and outports to AUTOSAR required and provided ports. For each inport or outport, select an AUTOSAR required or provided port and a service interface event.

Source	Port	Event
leftHazardIndicator	ProvidedPort	leftHazardIndicator
rightHazardIndicator	ProvidedPort	rightHazardIndicator

After validating the adaptive component model configuration, you can simulate or generate code for AUTOSAR service communication.

To programmatically configure AUTOSAR adaptive service communication, use the AUTOSAR property and mapping functions. For example, the following MATLAB code adds an AUTOSAR service interface, event, and required port to an open model. It then maps a Simulink inport to the AUTOSAR required port.

```
hModel = 'autosar_LaneGuidance';
open_system(hModel);

% Add AUTOSAR service interface mySvcInterface with event mySvcEvent
arProps = autosar.api.getAUTOSARProperties(hModel);
addPackageableElement(arProps, 'ServiceInterface', ...
    '/LaneGuidance_pkg/LaneGuidance_if', 'mySvcInterface');
add(arProps, 'mySvcInterface', 'Events', 'mySvcEvent');

% Add AUTOSAR required port myRPort, associated with mySvcInterface
add(arProps, 'LaneGuidance', 'RequiredPorts', 'myRPort', ...
    'Interface', 'mySvcInterface');

% Map Simulink inport to AUTOSAR port/event pair myRPort and mySvcEvent
slMap = autosar.api.getSimulinkMapping(hModel);
mapInport(slMap, 'rightCarInBlindSpot', 'myRPort', 'mySvcEvent');
```

See Also

Related Examples

- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43

More About

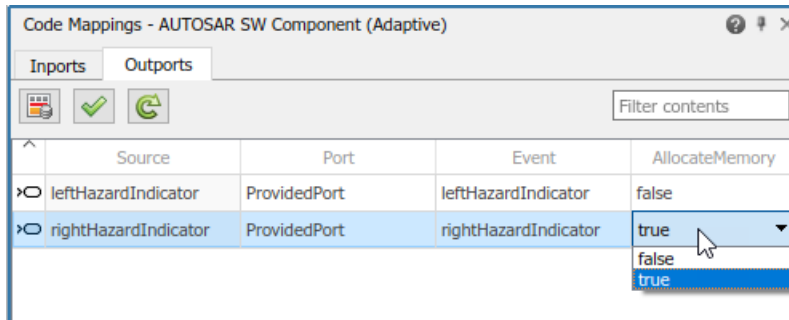
- “Model AUTOSAR Communication” on page 2-28
- “AUTOSAR Component Configuration” on page 4-3

Configure Memory Allocation for AUTOSAR Adaptive Service Data

To send service event data, the AUTOSAR Adaptive Platform supports these methods:

- By reference — The send function uses memory in the application address space. After the send returns, the application can modify the event data.
- By `ara::com` allocated memory — The application requests `ara::com` middleware to allocate memory for the data. This method avoids data copies by `ara::com` middleware and can be more efficient for frequent sends or large amounts of data. But the application loses access to the memory after the send returns.

To configure memory allocation for event sends, open the Code Mappings editor. Select the **Outports** tab and examine each outport. When you select an outport, the editor displays the code attribute `AllocateMemory`. To send event data by `ara::com` allocated memory, select the value `true`. To send event data by reference, select `false`.



If you set `AllocateMemory` to `true`, in the generated C++ model code, the corresponding event send uses an `ara::com` allocated buffer.

```
void autosar_LaneGuidanceModelClass::autosar_LaneGuidance_sf_msg_send_EvtOut_g(void)
{
    ara::com::SampleAllocateePtr<company::chassis::provided::skeleton::events::
        rightHazardIndicator::SampleType> rightHazardIndicatorAllocatedPtr;
    rightHazardIndicatorAllocatedPtr = ProvidedPort->rightHazardIndicator.Allocate();
    *rightHazardIndicatorAllocatedPtr.get() =
        autosar_LaneGuidance_DW.EvtOut_msgData;

    // Send event
    ProvidedPort->rightHazardIndicator.Send(std::move
        (rightHazardIndicatorAllocatedPtr));
}
```

See Also

Related Examples

- “Model AUTOSAR Adaptive Service Communication” on page 6-57
- “Map AUTOSAR Adaptive Elements for Code Generation” on page 6-43

More About

- “AUTOSAR Component Configuration” on page 4-3

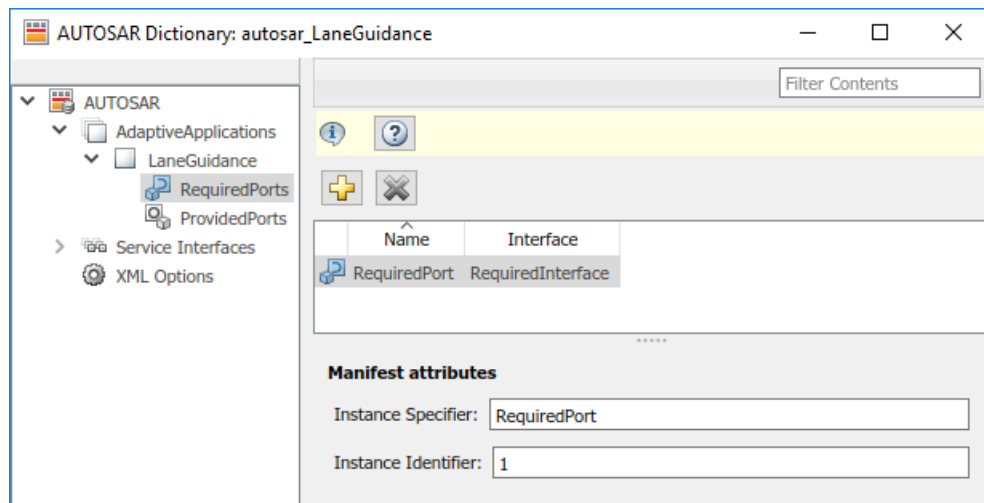
Configure AUTOSAR Adaptive Service Instance Identification

You can configure service instance identification for required and provided ports in an AUTOSAR adaptive component. When you build an adaptive software component model:

- Exported arxml files include a service instance manifest file, which describes port-to-service instance mapping.
- Generated C++ code uses the configured service instance information in `ara::com` function calls.

To configure service instance identification:

- 1 Open the AUTOSAR Dictionary and select **XML Options**. Set XML option **Identify Service Instance Using** to indicate the form in which to generate service instance information. Select **InstanceIdentifier** or **InstanceSpecifier**. The form that you select is used to identify service instances in generated Proxy and Skeleton functions.
- 2 Go to the required ports and provided ports views in the dictionary. Select each listed port to display its **Manifest attributes**. For each port, based on the service instance form you selected in XML options, examine the value for **Instance Specifier** or **Instance Identifier**. You can enter a value or accept an existing value.



Building the model generates the service instance manifest file *model_ServiceInstanceManifest.arxml*. The manifest file describes service interface deployments, service instance to port mapping, and service interfaces for the adaptive component.

In the generated C++ code, `ara::com` function calls use the configured service instance information. For example, if you selected the `InstanceIdentifier` form, and set **Instance Identifier** to 1 for a required port, the generated function calls use that configuration.

```
// Model initialize function
void autosar_LaneGuidanceModelClass::initialize()
{
    {
        ara::com::ServiceHandleContainer<proxy::RequiredInterfaceProxy::HandleType > handles;
        ...
        handles = proxy::RequiredInterfaceProxy::FindService(ara::com::InstanceIdentifier("1"));
        ...
    }
}
```

See Also

Related Examples

- “Model AUTOSAR Adaptive Service Communication” on page 6-57
- “Configure AUTOSAR Adaptive Elements and Properties” on page 6-27

More About

- “AUTOSAR Component Configuration” on page 4-3

Generate AUTOSAR Adaptive C++ Code and XML Descriptions

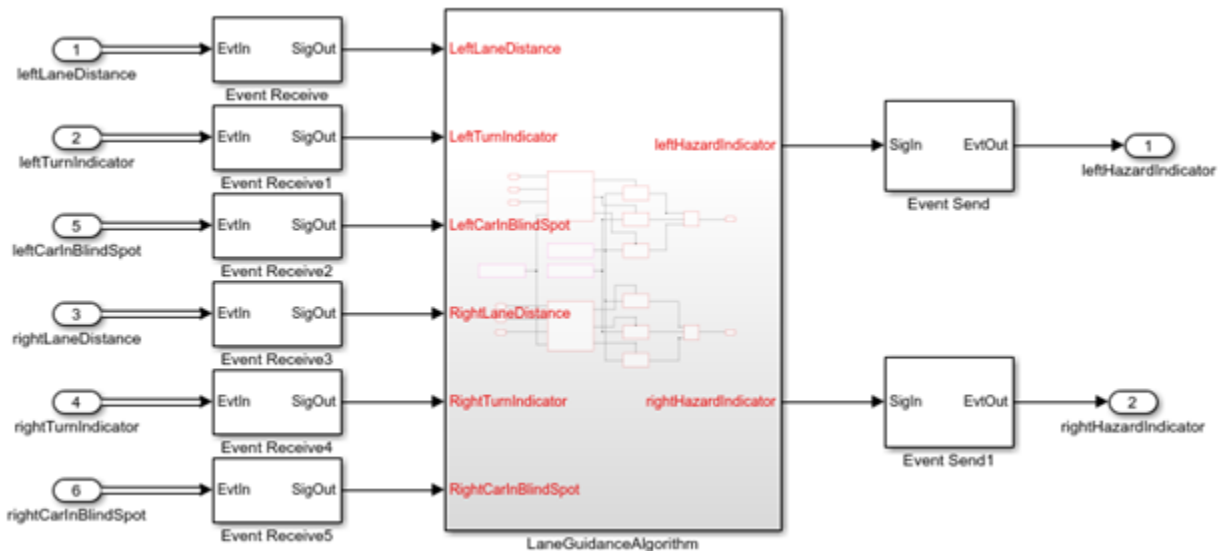
Generate AUTOSAR-compliant C++ code and export AUTOSAR XML (arxml) descriptions from AUTOSAR adaptive component model

If you have Simulink Coder and Embedded Coder software, you can build AUTOSAR component models. Building an adaptive component model generates algorithmic C++ code and exports arxml descriptions that comply with AUTOSAR Adaptive Platform specifications. Use the generated C++ code and arxml descriptions for testing in Simulink or integration into an AUTOSAR adaptive run-time environment.

Prepare AUTOSAR Adaptive Component Model for Code Generation

Open an adaptive component model from which you want to generate AUTOSAR C++ code and arxml descriptions. This example uses AUTOSAR example model `autosar_LaneGuidance`.

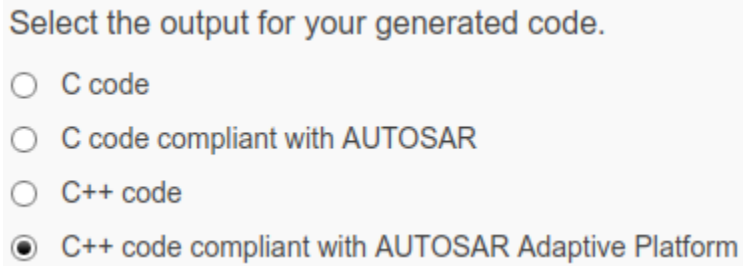
```
open_system('autosar_LaneGuidance');
```



Optionally, to refine model configuration settings for code generation, you can use the Embedded Coder Quick Start (recommended). This example uses the Embedded Coder

Quick Start. From the **Apps** tab, open the AUTOSAR Component Designer app. On the **AUTOSAR** tab, click **Quick Start**.

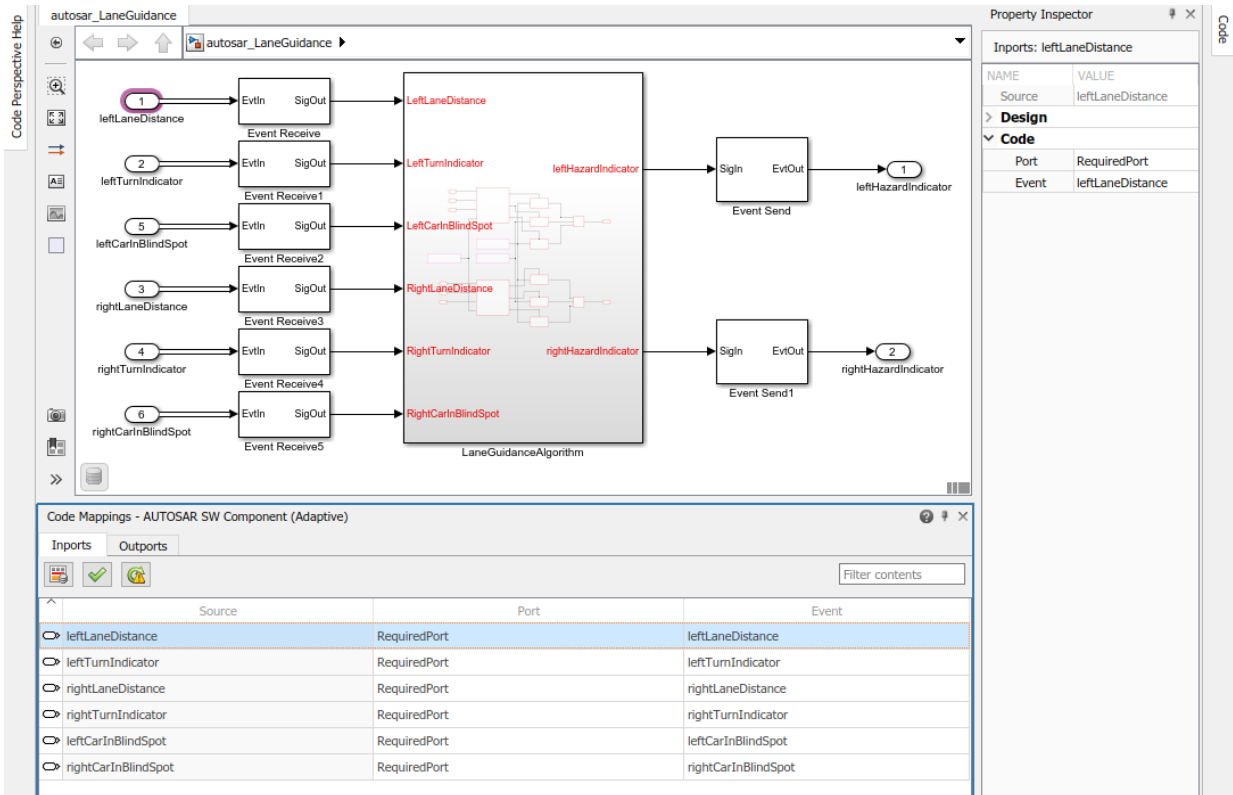
Work through the quick-start procedure. In the Output window, select output option **C++ code compliant with AUTOSAR Adaptive Platform**.



The quick-start software takes the following steps to configure an AUTOSAR adaptive software component model:

- 1 Configures code generation settings for the model. If the AUTOSAR target is not selected, the software sets model configuration parameter **System target file** to `autosar_adaptive.tlc`.
- 2 If no AUTOSAR mapping exists, the software creates a mapped AUTOSAR adaptive software component for the model.
- 3 Performs a model build.

In the last window, when you click **Finish**, your model opens in the AUTOSAR code perspective.



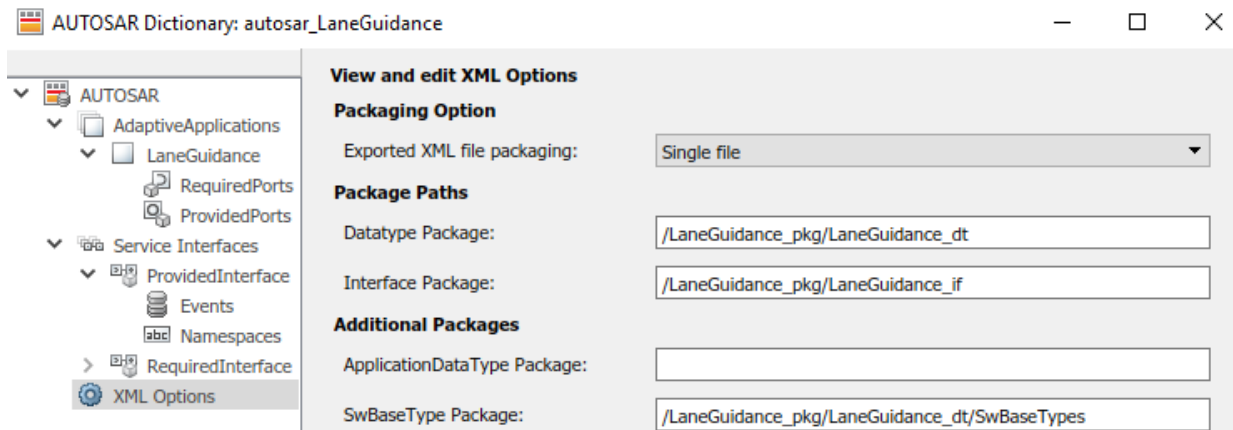
Inspect XML Options in AUTOSAR Dictionary

Before generating code, open the AUTOSAR Dictionary and examine the settings of AUTOSAR XML export parameters. In the **AUTOSAR** tab, click **Settings > AUTOSAR Dictionary**. In the AUTOSAR Dictionary, select **XML Options**.

The XML options view in the AUTOSAR Dictionary displays XML export parameters and their values. You can configure:

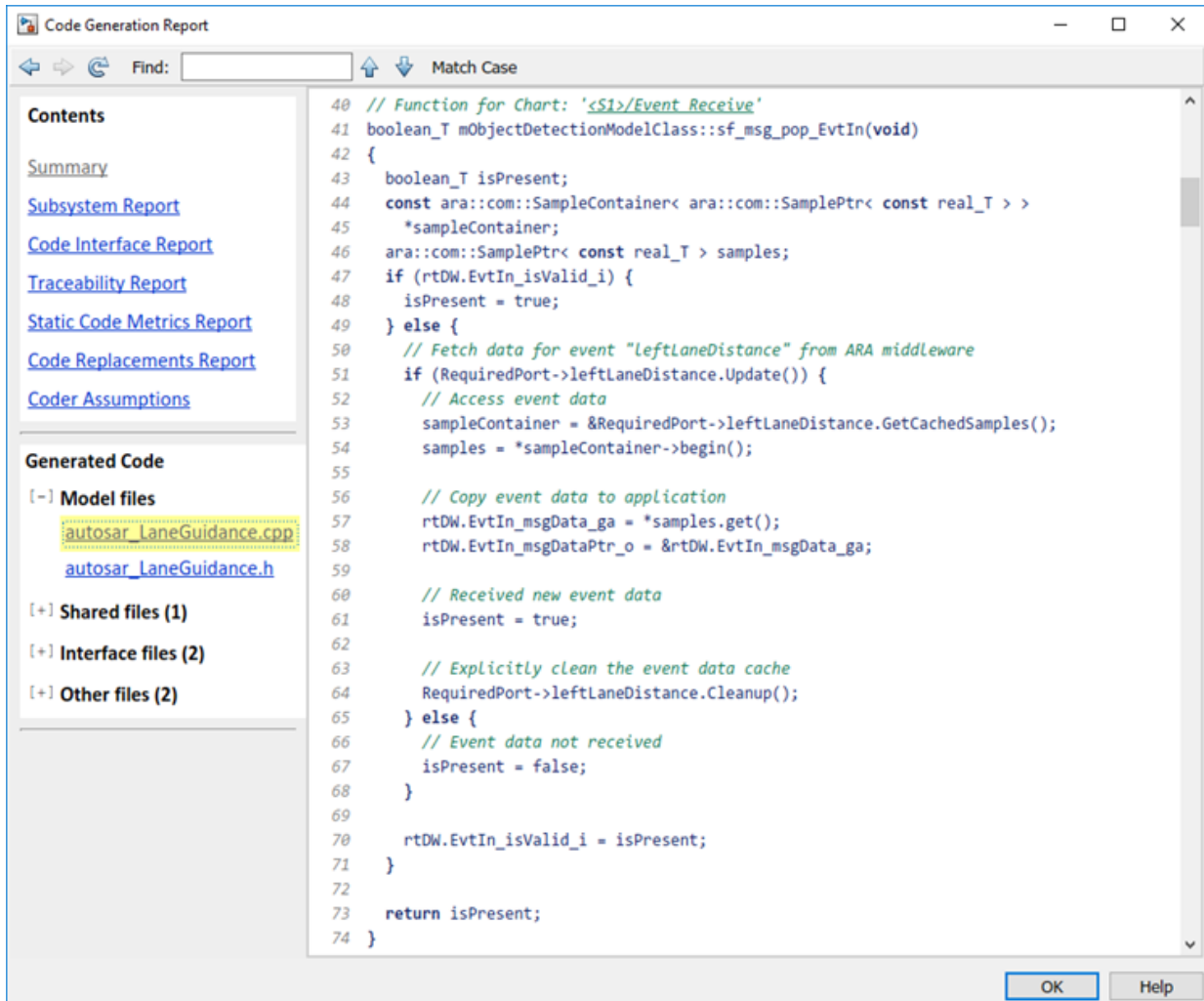
- XML file packaging for AUTOSAR elements created in Simulink
- AUTOSAR package paths
- Aspects of exported AUTOSAR XML content

This example sets **Exported XML file packaging** to **Single file**, so that arxml is exported into a single file, *modelName.arxml*.



Generate AUTOSAR C++ Code and XML Descriptions

To generate AUTOSAR C++ code and XML software descriptions that comply with Adaptive Platform specifications, build the model. In the model window, press **Ctrl+B**. The build process generates C++ code and arxml descriptions to the model build folder, `autosar_LaneGuidance_autosar_adaptive`. When the build completes, a code generation report opens.



Related Links

- "Code Generation"
- "AUTOSAR Component Configuration" on page 4-3
- "AUTOSAR Blockset"

Configure AUTOSAR Adaptive Code Generation

To generate AUTOSAR-compliant C++ code and arxml component descriptions from a model configured for the AUTOSAR Adaptive platform:

- 1 Examine AUTOSAR XML export options using the AUTOSAR Dictionary or AUTOSAR property functions.
- 2 Build the model.

In this section...

“Inspect AUTOSAR Adaptive XML Options” on page 6-70

“Generate AUTOSAR Adaptive C++ and XML Files” on page 6-70
--

Inspect AUTOSAR Adaptive XML Options

Examine the XML options that you configured using the AUTOSAR Dictionary. If you have not yet configured them, see “Configure AUTOSAR Adaptive XML Options” on page 6-38.

Generate AUTOSAR Adaptive C++ and XML Files

After configuring AUTOSAR code generation and XML options, generate code. To generate C++ code and export XML descriptions, build the adaptive component model (**Ctrl+B**).

The build process generates AUTOSAR-compliant C++ code and AUTOSAR XML descriptions to the model build folder. The exported XML files include:

- One or more *modelname*.arxml* files, based on whether you set **Exported XML file packaging** to Single file or Modular.
- Manifests for AUTOSAR executables and service instances.
- If you imported arxml files into Simulink, updated versions of the same files.

The following table shows which *modelname*.arxml* files are generated, based on the value of the **Exported XML file packaging** option configured in the AUTOSAR Dictionary.

Exported XML File Packaging Value	Exported File Name	By Default Contains...
Single file	<i>modelname</i> .arxml	All AUTOSAR elements.
	<i>modelname_ExecutionManifest</i> .arxml	Specifies deployment-related information for applications.
	<i>modelname_ServiceInstanceManifest</i> .arxml	Specifies configuration of service-oriented communication.
Modular	<i>modelname_component</i> .arxml	Software components. This is the main arxml file exported for the Simulink model. In addition to AUTOSAR software components, the file includes elements for which AUTOSAR packages (AR-PACKAGES) are not configured, and AR-PACKAGES that do not align with the package paths in the other exported arxml files. For more information on AR-PACKAGES and their location in modular exported arxml files, see “AR-PACKAGE Location in Exported ARXML Files” on page 4-119.
	<i>modelname_datatype</i> .arxml	Data types and related elements.
	<i>modelname_interface</i> .arxml	Interfaces, including adaptive service interfaces.
	<i>modelname_ExecutionManifest</i> .arxml	Specifies deployment-related information for applications.
	<i>modelname_ServiceInstanceManifest</i> .arxml	Specifies configuration of service-oriented communication.

You can merge the AUTOSAR adaptive XML component descriptions into an AUTOSAR authoring tool. The AUTOSAR component information is partitioned into separate files to facilitate merging. The partitioning attempts to minimize the number of merges that you must do. You do not need to merge the data type file into the authoring tool because data types are usually defined early in the design process. You must, however, merge the internal behavior file because this information is part of the model implementation.

To help support the round trip of AUTOSAR elements between an AAT and the Simulink model-based design environment, the code generator preserves AUTOSAR elements and their UUIDs across a xml import and export. For more information, see “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38.

For an example of how to generate AUTOSAR-compliant C++ code and export AUTOSAR XML component descriptions from a Simulink model, see “Generate AUTOSAR Adaptive C++ Code and XML Descriptions” on page 6-65.

See Also

Related Examples

- “Configure AUTOSAR Adaptive XML Options” on page 6-38
- “Generate AUTOSAR Adaptive C++ Code and XML Descriptions” on page 6-65

More About

- “Round-Trip Preservation of AUTOSAR XML File Structure and Element Information” on page 3-38

AUTOSAR Composition and ECU Software Simulation

- “Import AUTOSAR Composition to Simulink” on page 7-2
- “Combine and Simulate AUTOSAR Software Components” on page 7-7
- “Model AUTOSAR Basic Software Service Calls” on page 7-13
- “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15
- “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22
- “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29
- “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34

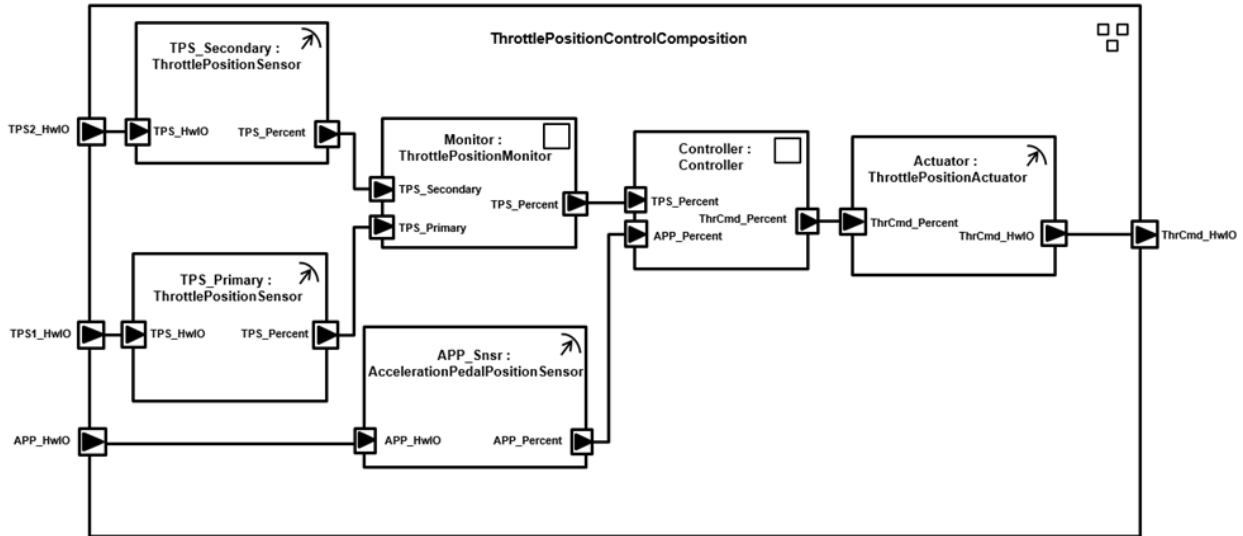
Import AUTOSAR Composition to Simulink

Create Simulink® model from XML description of AUTOSAR software composition.

Import AUTOSAR Composition from arxml File to Simulink

Here is an AUTOSAR software composition that implements a throttle position control system. The composition contains six interconnected AUTOSAR software component prototypes -- four sensor/actuator components and two application components.

The composition was created in an AUTOSAR authoring tool and exported to the file `ThrottlePositionControlComposition.arxml`.



Use the MATLAB function `createCompositionAsModel` to import the `arxml` description and create an initial Simulink representation of the AUTOSAR composition.

```
ar = arxml.importer('ThrottlePositionControlComposition.arxml');
createCompositionAsModel(ar, '/Company/Components/ThrottlePositionControlComposition');
```

```
Creating model 'ThrottlePositionSensor' for component 1 of 5:
```

```
/Company/Components/ThrottlePositionSensor
```

```
Creating model 'ThrottlePositionMonitor' for component 2 of 5:
```

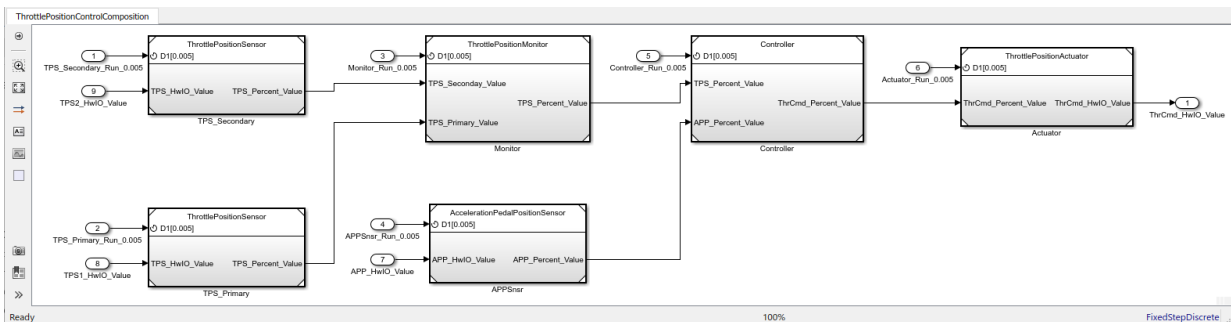
```
/Company/Components/ThrottlePositionMonitor
```

```
Creating model 'Controller' for component 3 of 5: /Company/Components/Controller
```

```

Creating model 'AccelerationPedalPositionSensor' for component 4 of 5:
/Company/Components/AccelerationPedalPositionSensor
Creating model 'ThrottlePositionActuator' for component 5 of 5:
/Company/Components/ThrottlePositionActuator
Creating model 'ThrottlePositionControlComposition' for composition 1 of 1:
/Company/Components/ThrottlePositionControlComposition
    
```

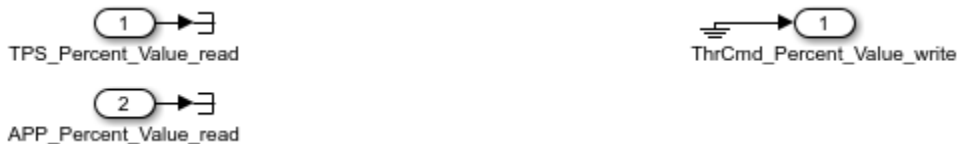
The function call creates a composition model that contains six component models, one for each atomic software component in the composition. Simulink inports and outports represent AUTOSAR ports and signal lines represent AUTOSAR component connectors.



Develop AUTOSAR Component Algorithms, Simulate, and Generate Code

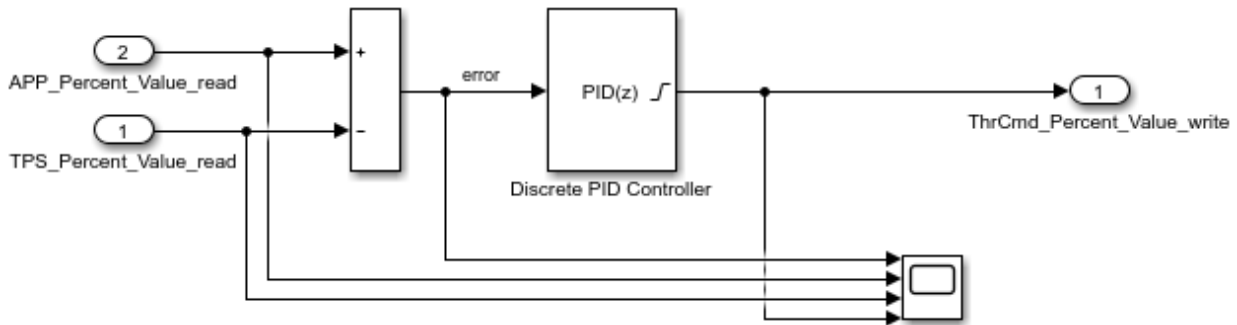
After creating an initial Simulink representation of the AUTOSAR composition, you develop each component in the composition. For each component, you refine the AUTOSAR configuration and create algorithmic model content.

For example, the Controller component model in the ThrottlePositionControlComposition composition model contains an atomic subsystem Runnable_Step_sys, which represents an AUTOSAR periodic runnable. The Runnable_Step_sys subsystem contains the initial stub implementation of the controller behavior.



Here is a possible implementation of the throttle position controller behavior. The controller component takes input values from an accelerator pedal position (APP) sensor

and a throttle position sensor (TPS). The controller translates the values into input values for a throttle actuator. (To explore this implementation, open model `Controller.slx`.)



As you develop AUTOSAR components, you can:

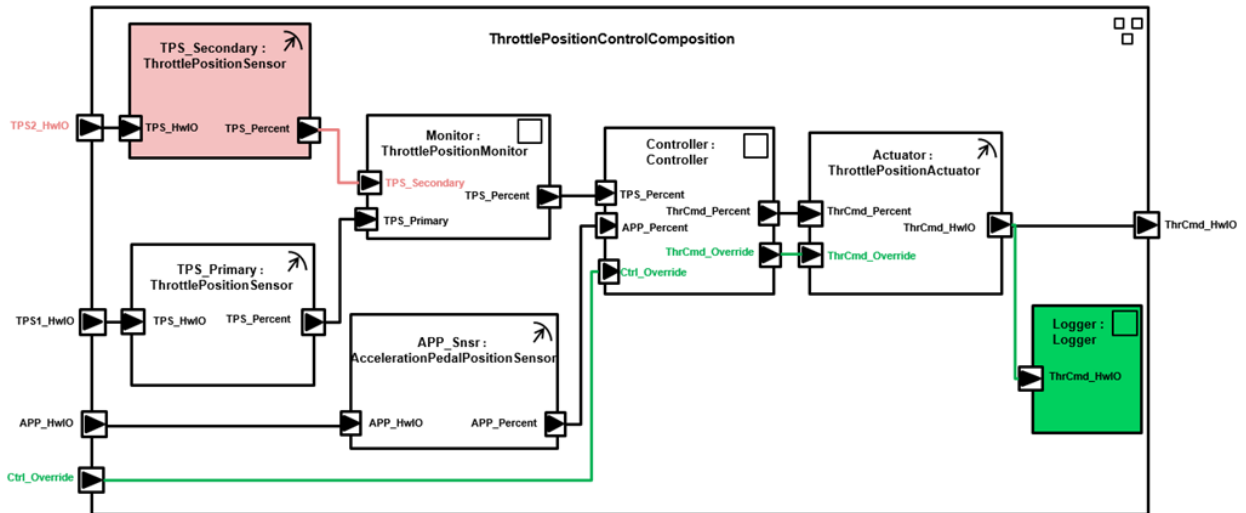
- Simulate component models individually or together in a containing composition.
- Generate arxml component description files and algorithmic C code for testing in Simulink or integration into an AUTOSAR run-time environment. (AUTOSAR code generation requires Simulink Coder and Embedded Coder.)

For more information on developing, simulating, and building AUTOSAR components, see example “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103.

Update AUTOSAR Composition Model with Architectural Changes from Authoring Tool

Suppose that, after you imported the AUTOSAR software composition into Simulink and began developing algorithms, architectural changes were made to the composition in the AUTOSAR authoring tool.

Here is the revised composition. The changes delete a sensor component, add a logger component, and add ports and connections at the composition and component levels. In the AUTOSAR authoring tool, the revised composition is exported to the file `ThrottlePositionControlComposition_updated.arxml`.



Use the MATLAB function `updateModel` to import the architectural revisions from the `arxml` file. The function updates the AUTOSAR composition model with the changes and reports the results.

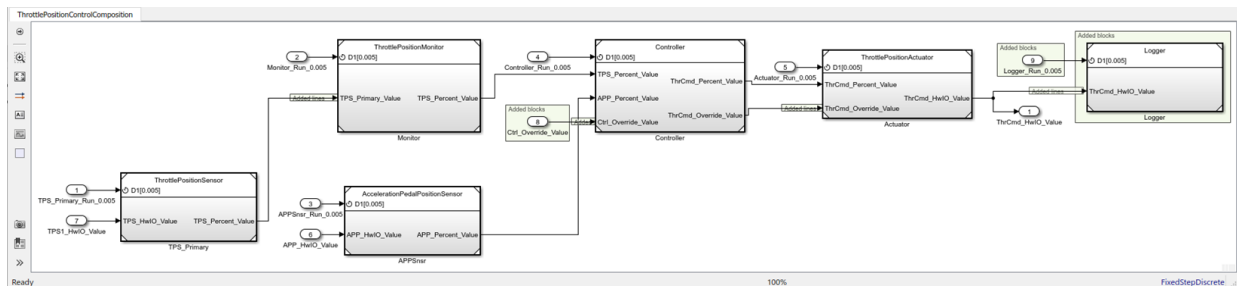
```
ar2 = arxml.importer('ThrottlePositionControlComposition_updated.arxml');
updateModel(ar2, 'ThrottlePositionControlComposition');
```

```
Updating model 'ThrottlePositionSensor' for component 1 of 6:
/Company/Components/ThrottlePositionSensor
### Updating model ThrottlePositionSensor
### Saving original model as ThrottlePositionSensor_backup.slx
### Creating HTML report ThrottlePositionSensor_update_report.html
Updating model 'ThrottlePositionMonitor' for component 2 of 6:
/Company/Components/ThrottlePositionMonitor
### Updating model ThrottlePositionMonitor
### Saving original model as ThrottlePositionMonitor_backup.slx
### Creating HTML report ThrottlePositionMonitor_update_report.html
Creating model 'Logger' for component 3 of 6: /Company/Components/Logger
Updating model 'Controller' for component 4 of 6: /Company/Components/Controller
### Updating model Controller
### Saving original model as Controller_backup.slx
### Creating HTML report Controller_update_report.html
Updating model 'AccelerationPedalPositionSensor' for component 5 of 6:
/Company/Components/AccelerationPedalPositionSensor
### Updating model AccelerationPedalPositionSensor
### Saving original model as AccelerationPedalPositionSensor_backup.slx
```

```

### Creating HTML report AccelerationPedalPositionSensor_update_report.html
Updating model 'ThrottlePositionActuator' for component 6 of 6:
/Company/Components/ThrottlePositionActuator
### Updating model ThrottlePositionActuator
### Saving original model as ThrottlePositionActuator_backup.slx
### Creating HTML report ThrottlePositionActuator_update_report.html
Updating model 'ThrottlePositionControlComposition' for composition 1 of 1:
/Company/Components/ThrottlePositionControlComposition
### Updating model ThrottlePositionControlComposition
### Saving original model as ThrottlePositionControlComposition_backup.slx
### Creating HTML report ThrottlePositionControlComposition_update_report.html
    
```

After the update, in the composition model, highlighting indicates where changes occurred.



The function also generates and displays an HTML AUTOSAR update report. The report lists changes that the update made to Simulink and AUTOSAR elements in the composition model. In the report, you can click hyperlinks to navigate from change descriptions to model changes, and to navigate from the main report to individual component reports.

Related Links

- [createCompositionAsModel](#)
- [updateModel](#)
- “Component Creation”
- “Import AUTOSAR Software Component Updates” on page 3-31
- “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103

Combine and Simulate AUTOSAR Software Components

When you develop multiple AUTOSAR software component models that are interconnected and work together, you can combine them in an AUTOSAR composition model for simulation. A composition is an AUTOSAR software component that aggregates related groups of software components.

To create a Simulink representation of an AUTOSAR composition, take one of these actions:

- Import an AUTOSAR XML (`arxml`) description of a composition (Classic Platform).
- Create a model and use Model blocks to reference and connect AUTOSAR component models.

When you simulate a composition model, you simulate the combined behavior of the aggregated AUTOSAR components.

After you develop AUTOSAR components and compositions, you can test groups of components that belong together in a system-level simulation. For example, you can create a system-level model containing compositions, components, a scheduler, a plant model, and potentially Basic Software service components and callers. You can configure system-level models to perform closed-loop or open-loop system simulations.

In this section...

“Import AUTOSAR Composition as Model (Classic Platform)” on page 7-7

“Create Composition Model for Simulating AUTOSAR Components” on page 7-8

“Alternatives for AUTOSAR System-Level Simulation” on page 7-10

Import AUTOSAR Composition as Model (Classic Platform)

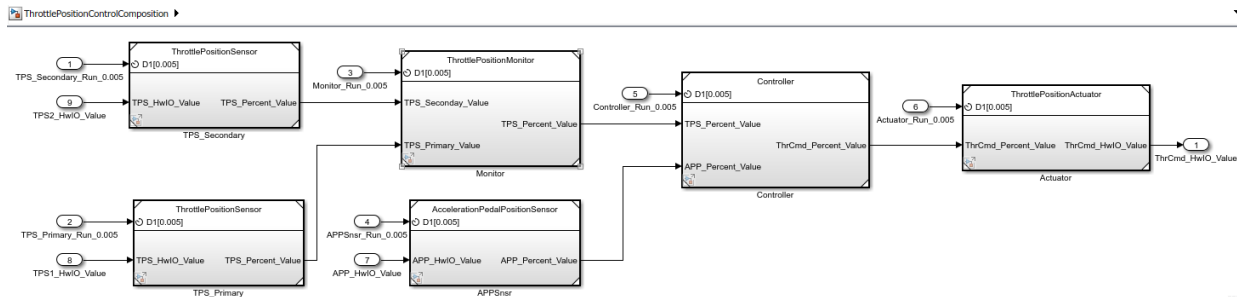
A composition is an AUTOSAR software component that aggregates related groups of software components. Compositions support component scaling and help to manage complexity in a design.

If you are developing software components for the AUTOSAR Classic Platform, you can create an AUTOSAR composition model by importing a composition description from `arxml` files. Use AUTOSAR importer function `createCompositionAsModel`. This function call creates composition model `ThrottlePositionControlComposition`.

```

addpath(fullfile(matlabroot, 'examples', 'autosarblockset'));
ar = arxml.importer('ThrottlePositionControlComposition.arxml');
createCompositionAsModel(ar, '/Company/Components/ThrottlePositionControlComposition');

```



To simulate the combined behavior of the aggregated AUTOSAR components, simulate the composition model. Click the **Run** button in the model window or enter this MATLAB command.

```
simOutComposition = sim('ThrottlePositionControlComposition');
```

For more information, see “Import AUTOSAR Composition to Simulink” on page 7-2.

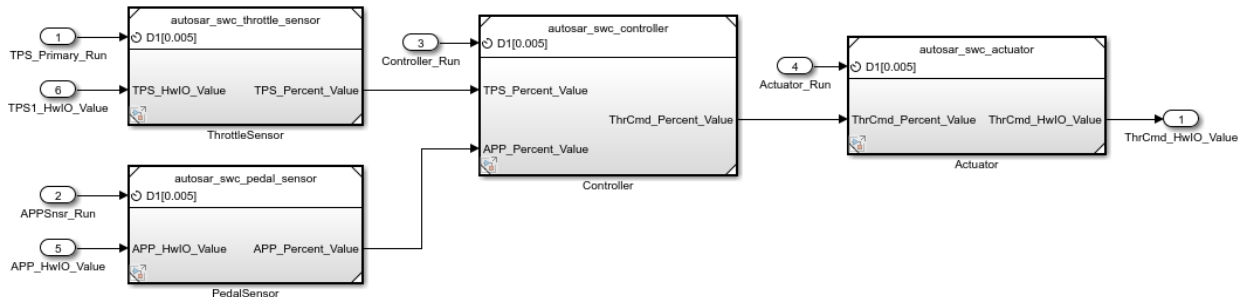
Create Composition Model for Simulating AUTOSAR Components

To combine related AUTOSAR software components in a composition model for simulation, create a Simulink model and use Model blocks to reference and connect AUTOSAR component models.

This example creates an AUTOSAR composition model. The created model is a simplified version of AUTOSAR example model `autosar_composition`. To expedite configuration and resolve issues, you can compare the new model against example model `autosar_composition`. If needed, you can copy elements such as inports and outports between the models. For a diagram of the finished composition model, see step 4.

- 1 Move AUTOSAR software component models that you want to simulate together into a working folder and `cd` to that folder. This example uses component models copied from `matlabroot/examples/autosarblockset` (open).
 - `autosar_swc_actuator`
 - `autosar_swc_controller`

- `autosar_swc_pedal_sensor`
 - `autosar_swc_throttle_sensor`
- 2 Create a Simulink model. Save the model to the working folder with the name `composition`.
 - 3 For each AUTOSAR component model:
 - a Open the component model separately and verify that it simulates.
 - b In the `composition` model, add a Model block and configure the block to reference the component. In the Model block parameters, select option **Schedule rates**. This option allows rate-based runnable tasks to be scheduled on the same basis as exported functions.
 - c Add ports that the component requires.
 - d Component model `autosar_swc_throttle_sensor` requires a special adjustment, because parent model `composition` (unlike example model `autosar_composition`) references the component only once. Open Model Explorer, select the model workspace for `autosar_swc_throttle_sensor`, select data object `TPSPercent_LkupTbl`, and clear the **Argument** option.
 - 4 When you have created Model blocks for each AUTOSAR component, connect the components as shown here.



To simulate the combined behavior of the aggregated AUTOSAR components, simulate the composition model. Click the **Run** button in the model window or enter this MATLAB command.

```
simOutComposition = sim('composition');
```

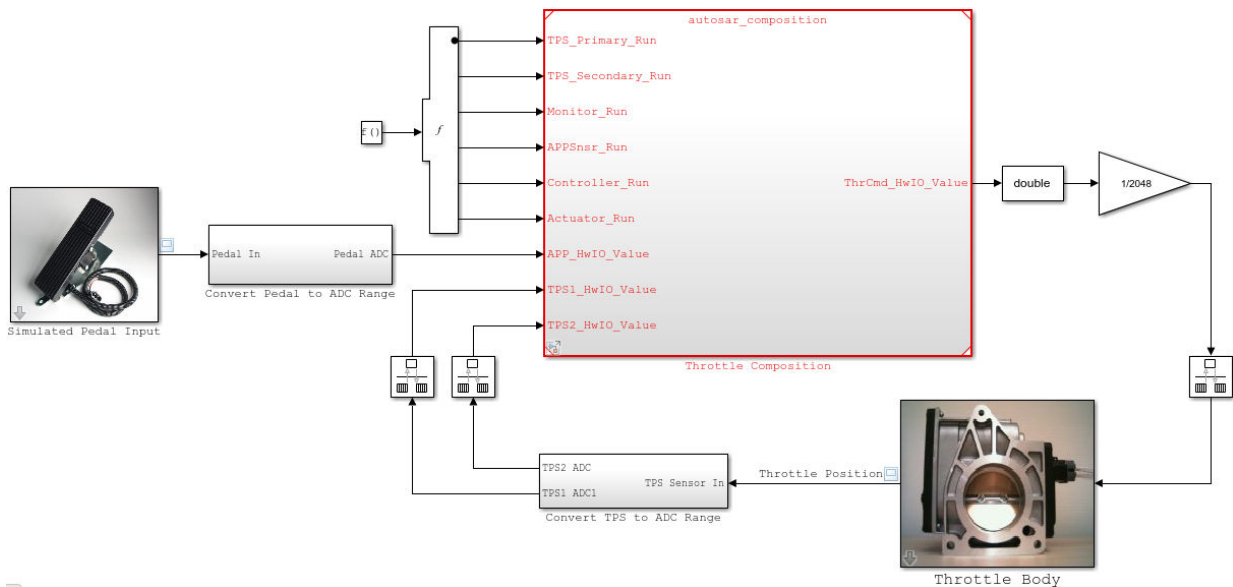
For more information, see “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103.

Alternatives for AUTOSAR System-Level Simulation

After you develop AUTOSAR components and compositions, you can test groups of components that belong together in a system-level simulation. For example, you can create a system-level model containing compositions, components, a scheduler, a plant model, and potentially Basic Software service components and callers. You can configure system-level models to perform closed-loop or open-loop system simulations. For a system-level model, use a Simulink model or a Simulink Test™ test harness model.

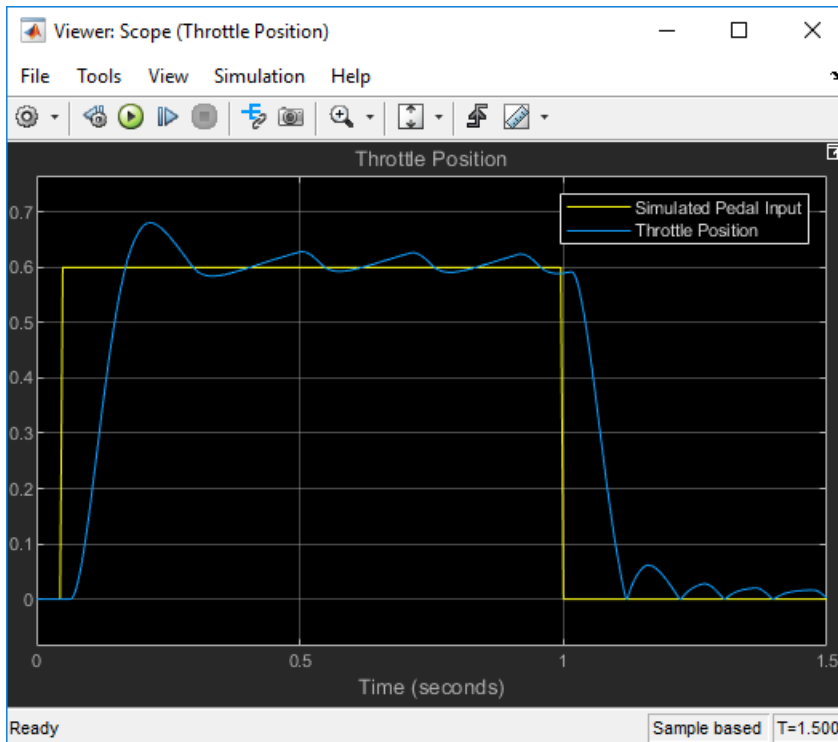
For an example of a closed-loop simulation, open example model `autosar_system`. This model provides a system-level test harness for the AUTOSAR composition model `autosar_composition`.

```
open_system('autosar_system');
```



A throttle position scope opens with the model. If you simulate system-level model `autosar_system`, the scope indicates how well the throttle-position control algorithms in composition model `autosar_composition` are tracking the pedal input. To improve the behavior, you can modify component algorithms in the composition or change a sensor source.

```
simOutSystem = sim('autosar_system');
```



For more information, see “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103.

For an example of open-loop simulation using Simulink Test, see “Testing AUTOSAR Compositions” (Simulink Test). This example performs back-to-back testing for an AUTOSAR composition model.

For an example of simulating AUTOSAR Basic Software services, see “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

See Also

`createCompositionAsModel`

Related Examples

- “Import AUTOSAR Composition to Simulink” on page 7-2
- “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103
- “Testing AUTOSAR Compositions” (Simulink Test)
- “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34

More About

- “AUTOSAR Software Components and Compositions” on page 1-11


Model AUTOSAR Basic Software Service Calls

The AUTOSAR standard defines important services as part of Basic Software (BSW) that runs in the AUTOSAR Runtime Environment (RTE). Examples include the NVRAM Manager (NvM) and the Diagnostic Event Manager (Dem). In the AUTOSAR RTE, AUTOSAR software components typically access BSW services using client-server or sender-receiver communication.

To support system-level modeling of AUTOSAR components and services, AUTOSAR Blockset provides an AUTOSAR Basic Software block library. The library contains preconfigured Function Caller blocks for modeling component calls to AUTOSAR BSW services.

- Diagnostic Event Manager (Dem) blocks — Calls to Dem service interfaces, including DiagnosticInfoCaller and DiagnosticMonitorCaller.
- NVRAM Manager (NvM) blocks — Calls to NvM service interfaces, including NvMAdminCaller and NvMServiceCaller.

To implement client calls to AUTOSAR BSW service interfaces in your AUTOSAR software component, you drag and drop Basic Software blocks into an AUTOSAR model. Each block has prepopulated parameters, such as **Client port name** and **Operation**. If you modify the operation selection, the software updates the block inputs and outputs to correspond.

To configure the added blocks in the AUTOSAR software component, click the **Update** button  in the Code Mappings editor view of the model. The software creates AUTOSAR client-service interfaces, operations, and ports, and maps each Simulink function caller to an AUTOSAR client port and operation.

For more information, see “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15 and “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22.

To simulate an AUTOSAR component model that calls BSW services, create a containing composition, system, or harness model. In that containing model, provide reference implementations of the NvM and Dem service operations called by the component.

The AUTOSAR Basic Software block library includes an NVRAM Service Component block and a Diagnostic Service Component block. The blocks provide reference implementations of NvM and Dem service operations. To support simulation of component

calls to the NvM and Dem services, include the blocks in the containing model. You can insert the blocks in either of two ways:

- Automatically insert the blocks by creating a Simulink Test harness model.
- Manually insert the blocks into a containing composition, system, or harness model

For more information, see “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29 and “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

See Also

Diagnostic Service Component | DiagnosticInfoCaller | DiagnosticMonitorCaller | NVRAM Service Component | NvMAdminCaller | NvMServiceCaller

Related Examples

- “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15
- “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22
- “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29
- “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34

More About

- “Model AUTOSAR Communication” on page 2-28

Configure Calls to AUTOSAR Diagnostic Event Manager Service

The AUTOSAR standard defines important services as part of Basic Software (BSW) that runs in the AUTOSAR Runtime Environment (RTE). Examples include the NVRAM Manager (NvM) and the Diagnostic Event Manager (Dem). In the AUTOSAR RTE, AUTOSAR software components typically access BSW services using client-server or sender-receiver communication.

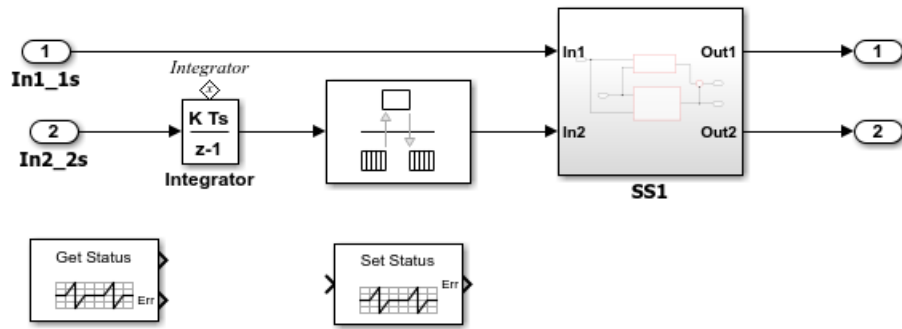
To support system-level modeling of AUTOSAR components and services, AUTOSAR Blockset provides an AUTOSAR Basic Software block library. The library contains preconfigured blocks for modeling component calls to AUTOSAR BSW services and reference implementations of the BSW services. For information about using the blocks to model client calls to AUTOSAR BSW service interfaces, see “Model AUTOSAR Basic Software Service Calls” on page 7-13.

For a live-script example of simulating AUTOSAR BSW services, see example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

Here is an example of configuring client calls to Dem service interfaces in your AUTOSAR software component.

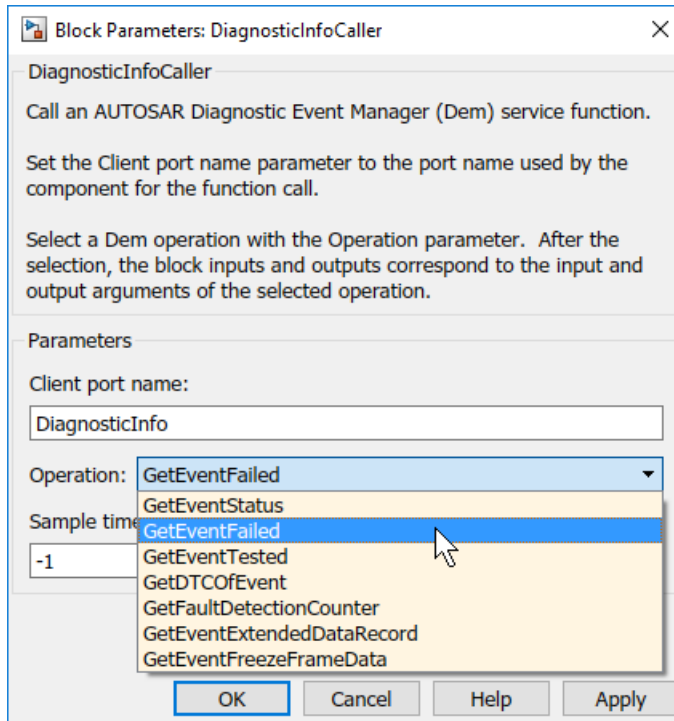
- 1 Open a model that is configured for AUTOSAR code generation. Using the Library Browser or by typing block names in the model window, add Dem blocks to the model. This example adds the blocks DiagnosticInfoCaller and DiagnosticMonitorCaller to a writable copy of the example model `autosar_sw`.

As you insert each block, you are prompted for a client port name, which is the name of the AUTOSAR client port used by this component to call the BSW interface. For the purposes of this example, accept the default names, `DiagnosticInfo` and `DiagnosticMonitor`.

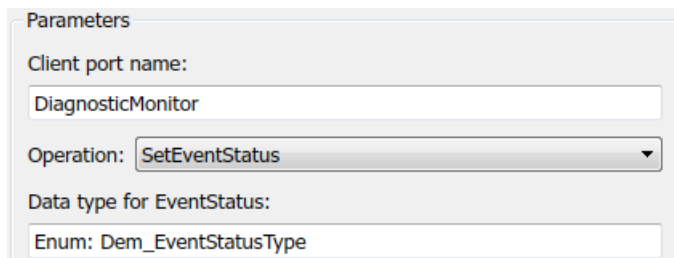



- 2 Open each block and examine the parameters, especially **Operation**. If you select a different operation and click **Apply**, the software updates the block inputs and outputs to match the arguments of the selected operation.

This example changes the **Operation** for the DiagnosticInfoCaller block from `GetEventStatus` to `GetEventFailed`. (For an example of using `GetEventFailed` in a throttle position monitor implementation, see example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.)



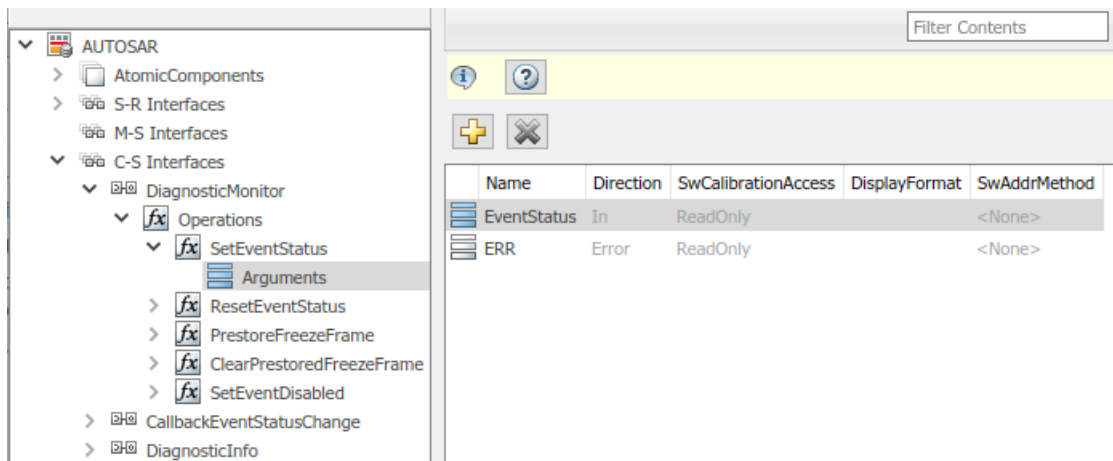
For some Dem operations, such as `GetDTCOfEvent` and `SetEventStatus`, the block parameters dialog box displays a data type parameter. The parameter specifies an enumerated data type for a function input that represents a Dem format type or event status. Default data types are provided, such as `Dem_DTCFormatType` or `Dem_EventStatusType`. For more information about format type or event status values, see the AUTOSAR standard *Specification of Diagnostic Event Manager*.



- Open the Code Mappings editor. To update the Simulink to AUTOSAR mapping of the model with changes to Simulink function callers, click the **Update** button . The software creates AUTOSAR client-service interfaces, operations, and ports, and maps each Simulink function caller to an AUTOSAR client port and operation.

For example, for the DiagnosticMonitorCaller block in this example, for which the SetEventStatus operation is selected:

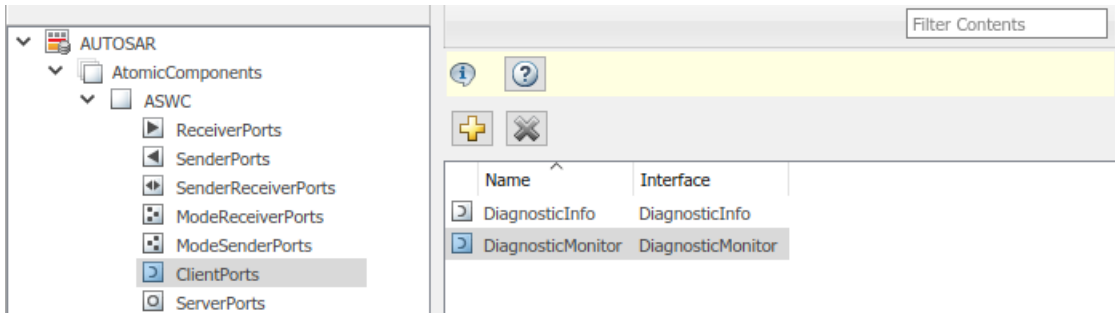
- The software creates C-S interface DiagnosticMonitor, and under DiagnosticMonitor, its supported operations. For each operation, arguments are provided with read-only properties. Here are the arguments for the DiagnosticMonitor operation SetEventStatus displayed in the AUTOSAR Dictionary.



The screenshot shows the AUTOSAR Dictionary interface. On the left, a tree view shows the hierarchy: AUTOSAR > C-S Interfaces > DiagnosticMonitor > Operations > SetEventStatus > Arguments. The right pane displays a table of arguments for the SetEventStatus operation.

Name	Direction	SwCalibrationAccess	DisplayFormat	SwAddrMethod
EventStatus	In	ReadOnly	<None>	<None>
ERR	Error	ReadOnly	<None>	<None>

- The software creates a client port with the default name DiagnosticMonitor. Unlike the C-S-interface, operation, and argument names, the client port name can be customized. The client port is mapped to the DiagnosticMonitor interface.



- The Code Mappings editor maps the DiagnosticMonitor function caller block to AUTOSAR client port DiagnosticMonitor and AUTOSAR operation SetEventStatus.

The screenshot shows the Code Mappings editor. It displays a table with the following data:

Source	ClientPort	Operation
DiagnosticInfo_GetEventFailed	DiagnosticInfo	GetEventFailed
DiagnosticMonitor_SetEventStatus	DiagnosticMonitor	SetEventStatus

- 4 Optionally, build your component model and examine the generated C and arxml code. The C code includes the client calls to the BSW services, for example:

```

/* FunctionCaller: '<Root>/DiagnosticInfoCaller' */
Rte_Call_DiagnosticInfo_GetEventFailed(&rtb_DiagnosticInfoCaller_o1);

/* FunctionCaller: '<Root>/DiagnosticMonitorCaller' */
Rte_Call_DiagnosticMonitor_SetEventStatus(DEM_EVENT_STATUS_PASSED);
    
```

Generated RTE include files define the server operation call points, such as Rte_Call_DiagnosticMonitor_SetEventStatus, and argument data types, such as enumeration type Dem_EventStatusType.

The arxml code defines the BSW service operations called by the component as server call points, for example:

```

<SERVER-CALL-POINTS>
...
  <SYNCHRONOUS-SERVER-CALL-POINT UUID="...">
    <SHORT-NAME>SC_DiagnosticMo_334e61e63627b44b</SHORT-NAME>
    <OPERATION-IREF>
      <CONTEXT-R-PORT-REF DEST="R-PORT-PROTOTYPE">
        /Company/Powertrain/Components/ASWC/DiagnosticMonitor
      </CONTEXT-R-PORT-REF>
      <TARGET-REQUIRED-OPERATION-REF DEST="CLIENT-SERVER-OPERATION">
        /AUTOSAR/Services/Dem/DiagnosticMonitor/SetEventStatus
      </TARGET-REQUIRED-OPERATION-REF>
    </OPERATION-IREF>
  </SYNCHRONOUS-SERVER-CALL-POINT>
    
```

```

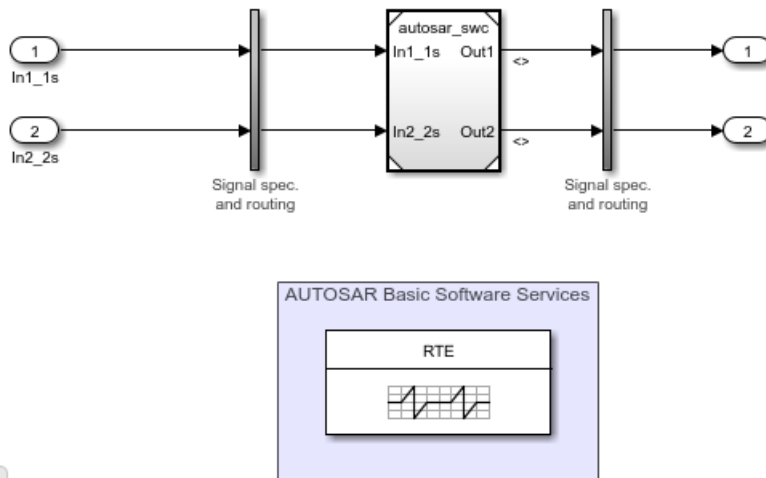
        </TARGET-REQUIRED-OPERATION-REF>
        </OPERATION-IREF>
        <TIMEOUT>1.0E-06</TIMEOUT>
        </SYNCHRONOUS-SERVER-CALL-POINT>
    </SERVER-CALL-POINTS>

```

- To simulate the component model, create a containing composition, system, or test harness model. In that containing model, insert reference implementations of the Dem GetEventFailed and GetEventStatus service operations.

The AUTOSAR Basic Software block library provides a Diagnostic Service Component block, which provides reference implementations of Dem service operations. You can manually insert the block into a containing composition, system, or harness model, or automatically insert the block by creating a Simulink Test harness model.

For example, on the **Apps** tab, click **Simulink Test**. Then, on the **Tests** tab, click **Simulink Test Manager**. Click **Add Test Harness**. In the Create Test Harness dialog box, click **OK**. The software compiles the model, adds a Diagnostic Service Component block, and creates ports and other elements required for simulation.



For more information, see “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29 and “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

See Also

Diagnostic Service Component | DiagnosticInfoCaller | DiagnosticMonitorCaller

Related Examples

- “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29
- “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34
- “Configure AUTOSAR Client-Server Communication” on page 4-171

More About

- “Model AUTOSAR Basic Software Service Calls” on page 7-13
- “Model AUTOSAR Communication” on page 2-28

Configure Calls to AUTOSAR NVRAM Manager Service

The AUTOSAR standard defines important services as part of Basic Software (BSW) that runs in the AUTOSAR Runtime Environment (RTE). Examples include the NVRAM Manager (NvM) and the Diagnostic Event Manager (Dem). In the AUTOSAR RTE, AUTOSAR software components typically access BSW services using client-server or sender-receiver communication.

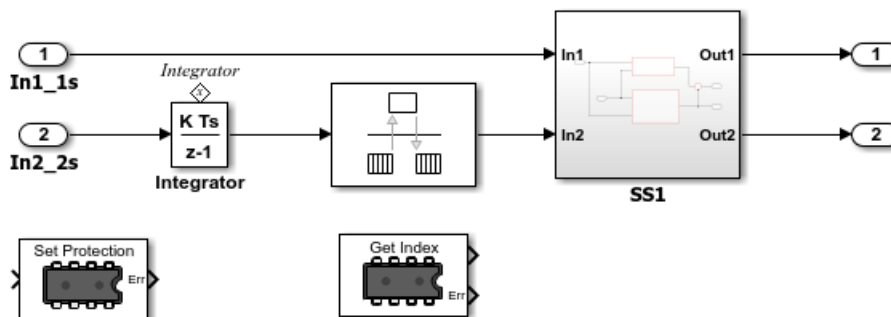
To support system-level modeling of AUTOSAR components and services, AUTOSAR Blockset provides an AUTOSAR Basic Software block library. The library contains preconfigured blocks for modeling component calls to AUTOSAR BSW services and reference implementations of the BSW services. For information about using the blocks to model client calls to AUTOSAR BSW service interfaces, see “Model AUTOSAR Basic Software Service Calls” on page 7-13.

For a live-script example of simulating AUTOSAR BSW services, see example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

Here is an example of configuring client calls to NvM service interfaces in your AUTOSAR software component.

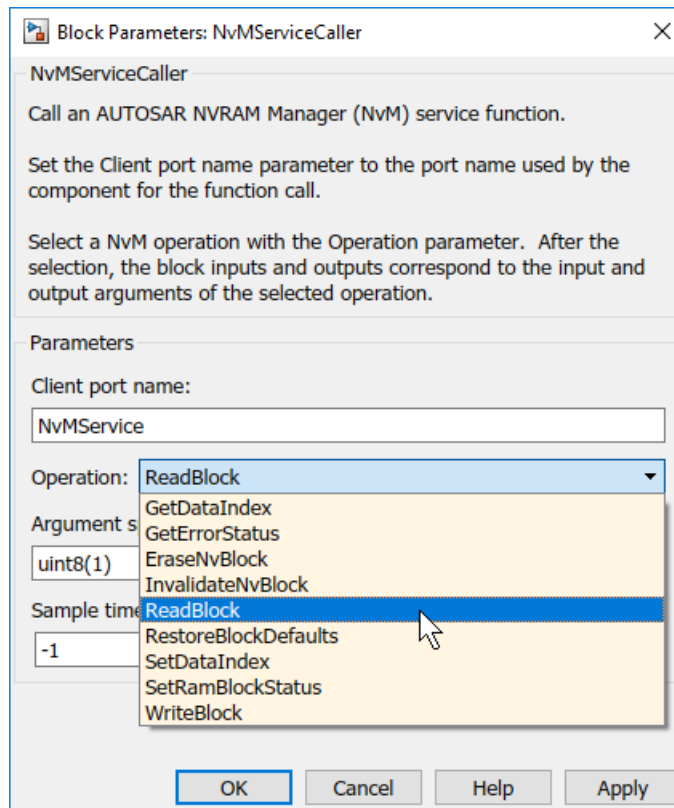
- 1 Open a model that is configured for AUTOSAR code generation. Using the Library Browser or by typing block names in the model window, add NvM blocks to the model. This example adds the blocks NvMAdminCaller and NvMServiceCaller to a writable copy of the example model `autosar_sw.c`.

As you insert each block, you are prompted for a client port name, which is the name of the AUTOSAR client port used by this component to call the BSW interface. For the purposes of this example, accept the default names, NvMAdmin and NvMService.



- 2 Open each block and examine the parameters, especially **Operation**. If you select a different operation and click **Apply**, the software updates the block inputs and outputs to match the arguments of the selected operation.

This example changes the **Operation** for the NvMServiceCaller block from `GetDataIndex` to `ReadBlock`. (For an example of using `readBlock` in a throttle position sensor implementation, see example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.)



For some NvM operations, such as `ReadBlock` and `WriteBlock`, the block parameters dialog box displays an argument specification parameter. The parameter specifies data type and dimension information for data to be read or written by the operation, set to `uint8(1)` by default. You can specify array and bus data types.

Parameters

Client port name:

Operation: **ReadBlock**

Argument specification (e.g. uint8(1)):

- Open the Code Mappings editor. To update the Simulink to AUTOSAR mapping of the model with changes to Simulink function callers, click the **Update** button . The software creates AUTOSAR client-service interfaces, operations, and ports, and maps each Simulink function caller to an AUTOSAR client port and operation.

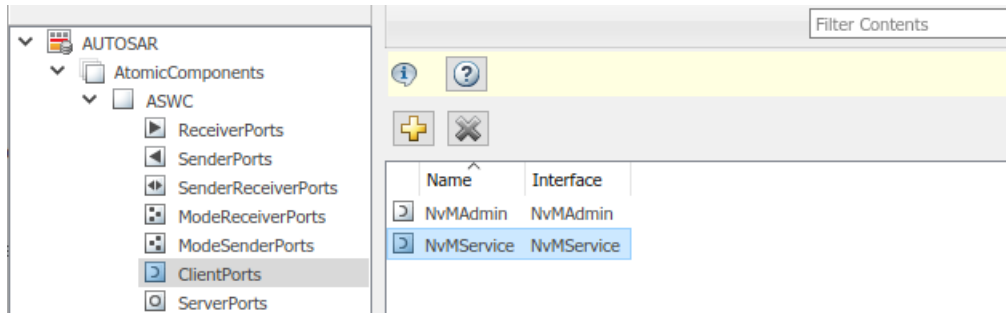
For example, for the NvMServiceCaller block in this example, for which the ReadBlock operation is selected:

- The software creates C-S interface NvMService, and under NvMService, its supported operations. For each operation, arguments are provided with read-only properties. Here are the arguments for the NvMService operation ReadBlock displayed in the AUTOSAR Dictionary.

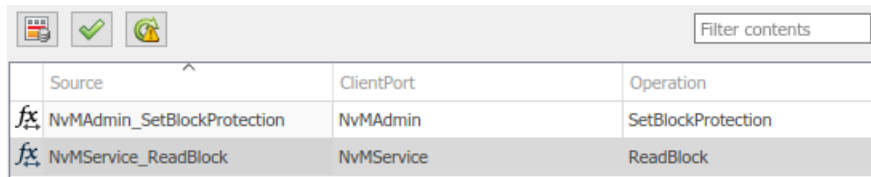
The screenshot shows the AUTOSAR Dictionary interface. On the left, a tree view shows the hierarchy: AUTOSAR > C-S Interfaces > NvMService > Operations > ReadBlock > Arguments. The right pane displays a table of arguments for the ReadBlock operation.

Name	Direction	SwCalibrationAccess	DisplayFormat	SwAddrMethod
DstPtr	Out	ReadOnly		<None>
ERR	Error	ReadOnly		<None>

- The software creates a client port with the default name `NvMService`. Unlike the C-S-interface, operation, and argument names, the client port name can be customized. The client port is mapped to the `NvMService` interface.

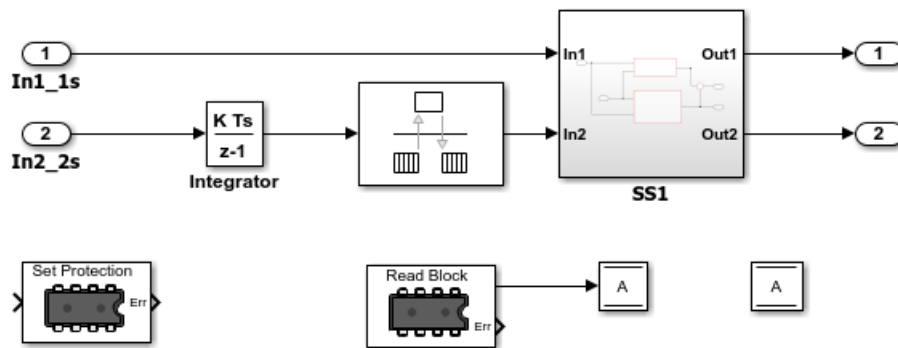


- The Code Mappings editor maps the `NvMService` function caller block to AUTOSAR client port `NvMService` and AUTOSAR operation `ReadBlock`.



- 4 Optionally, build your model and examine the generated C and arxml code.

In the block dialog step, if you selected operation `ReadBlock` for the `NvMServiceCaller` block, code generation requires adding data store blocks to the model. Connect the block first output to a Data Store Write block, and add a Data Store Memory block. For both blocks, specify data store name `A`. For example:



The C code includes the client calls to the BSW services, for example:

```
/* FunctionCaller: '<Root>/NvMServiceCaller' */
Rte_Call_NvMService_ReadBlock(&rtDW.A);
...
/* FunctionCaller: '<Root>/NvMAdminCaller' */
Rte_Call_NvMAdmin_SetBlockProtection(false);
```

Generated RTE include files define the server operation call points, such as `Rte_Call_NvMService_ReadBlock`.

The `arxml` code defines the BSW service operations called by the component as server call points, for example:

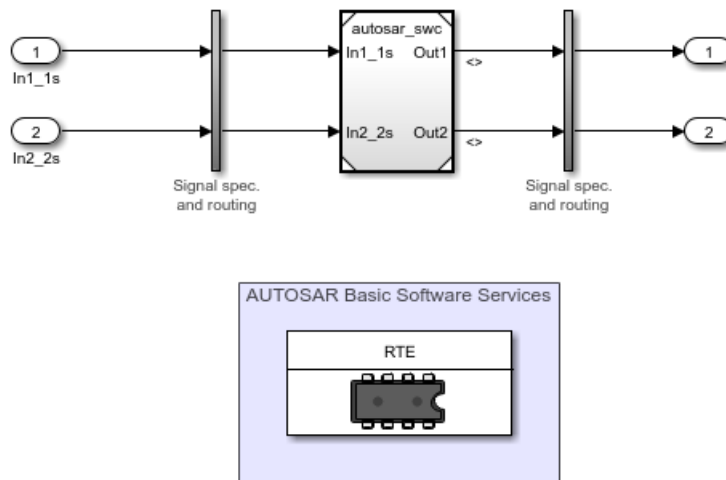
```
<SERVER-CALL-POINTS>
...
  <ASYNCHRONOUS-SERVER-CALL-POINT UUID="...">
    <SHORT-NAME>SC_NvMService_ReadBlock</SHORT-NAME>
    <OPERATION-IREF>
      <CONTEXT-R-PORT-REF DEST="R-PORT-PROTOTYPE">
        /Company/Powertrain/Components/ASWC/NvMService
      </CONTEXT-R-PORT-REF>
      <TARGET-REQUIRED-OPERATION-REF DEST="CLIENT-SERVER-OPERATION">
        /AUTOSAR/Services/NvM/NvMService/ReadBlock
      </TARGET-REQUIRED-OPERATION-REF>
    </OPERATION-IREF>
    <TIMEOUT>1</TIMEOUT>
  </ASYNCHRONOUS-SERVER-CALL-POINT>
</SERVER-CALL-POINTS>
```

- 5 To simulate the component model, create a containing composition, system, or test harness model. In that containing model, insert reference implementations of the NvM `ReadBlock` and `SetBlockProtection` service operations.

The AUTOSAR Basic Software block library provides an NVRAM Service Component block, which provides reference implementations of NvM service operations. You can

manually insert the block into a containing composition, system, or harness model, or automatically insert the block by creating a Simulink Test harness model.

For example, on the **Apps** tab, click **Simulink Test**. Then, on the **Tests** tab, click **Simulink Test Manager**. Click **Add Test Harness**. In the Create Test Harness dialog box, click **OK**. The software compiles the model, adds an NVRAM Service Component block, and creates ports and other elements required for simulation.



For more information, see “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29 and “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

See Also

NVRAM Service Component | NvMAdminCaller | NvMServiceCaller

Related Examples

- “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29
- “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34
- “Configure AUTOSAR Client-Server Communication” on page 4-171

More About

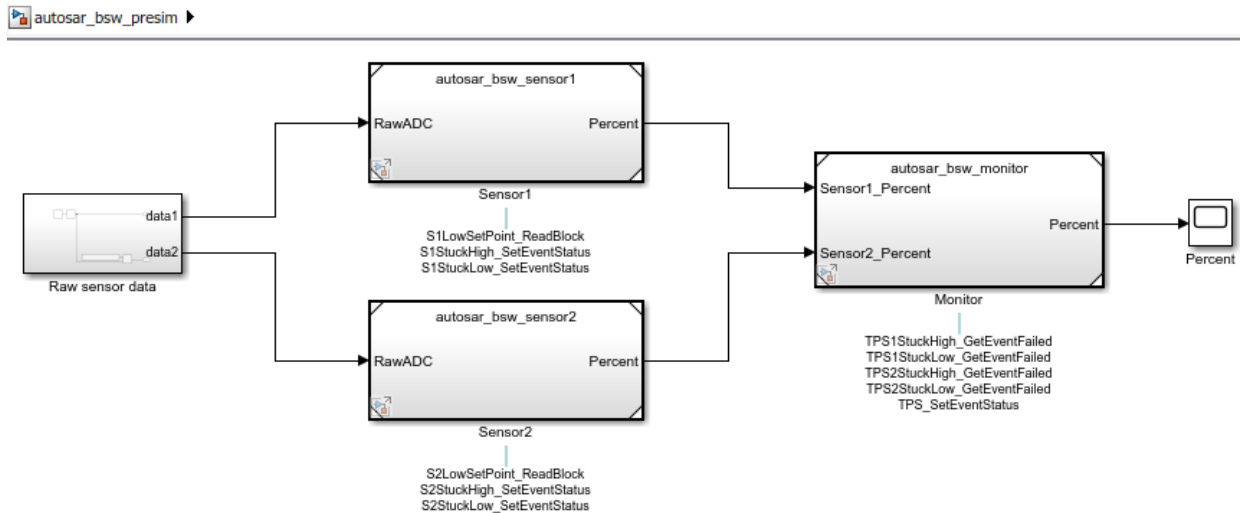
- “Model AUTOSAR Basic Software Service Calls” on page 7-13
- “Model AUTOSAR Communication” on page 2-28

Configure AUTOSAR Basic Software Service Implementations for Simulation

AUTOSAR Blockset provides reference implementations of NVRAM Manager (NvM) and Diagnostic Event Manager (Dem) services supported by AUTOSAR Basic Software (BSW) caller blocks. When coupled with the BSW caller blocks, the reference implementations allow you to configure and run system- or composition-level simulations of AUTOSAR BSW service calls. The ability to simulate calls into BSW services can help identify modeling problems before the AUTOSAR generated code reaches the AUTOSAR Runtime Environment (RTE).

To configure BSW caller blocks and BSW service reference implementations for simulation:

- 1** In one or more AUTOSAR component models, configure calls to the AUTOSAR NvM service or AUTOSAR Dem service. Follow the procedure described in “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22 or “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15.
- 2** For simulation purposes, create a composition, system, or harness model that contains instances of the AUTOSAR component models. This procedure uses AUTOSAR example model `autosar_bsw_presim`, which is used in example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34. The referenced component models call NvM service operation `ReadBlock` and Dem service operations `SetEventStatus` and `GetEventFailed`.

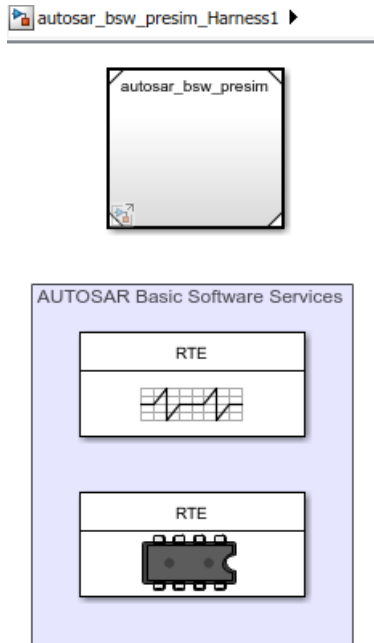


Alternatively, as shown in the next step, you can use Simulink Test to create a harness model.

- 3 In the containing model, provide reference implementations of the NvM or Dem service operations that your AUTOSAR component models call. For NvM and Dem service operations, the AUTOSAR Basic Software block library provides NVRAM Service Component and Diagnostic Service Component blocks.

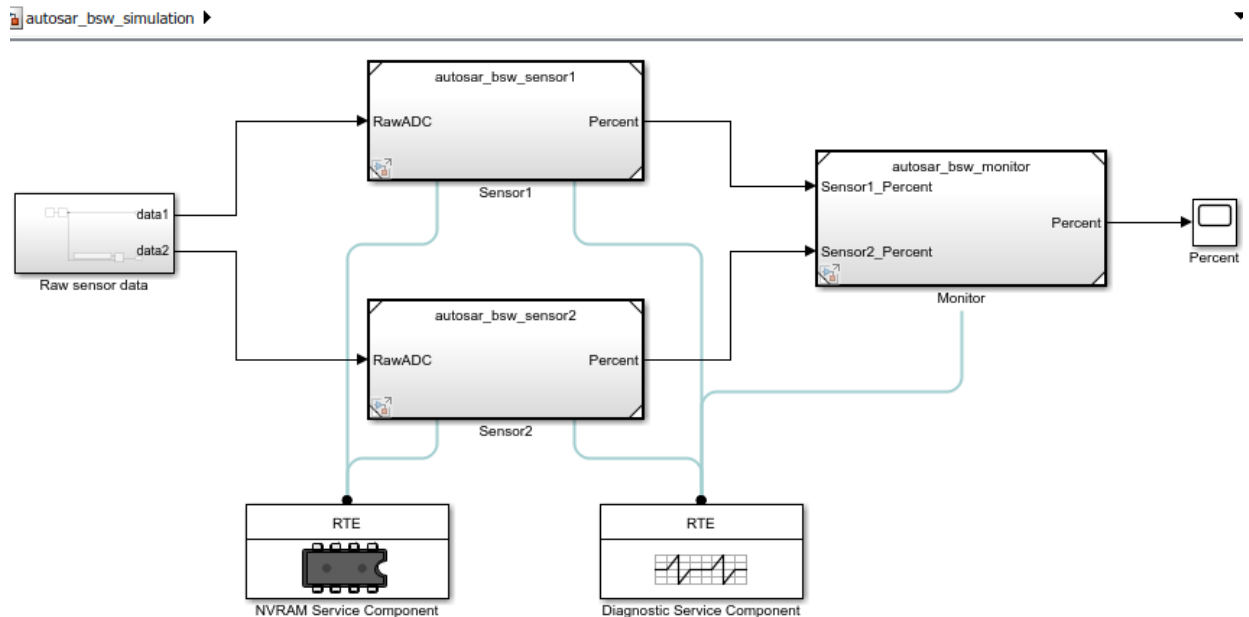
You can insert a Service Component block in either of two ways:

- Automatically insert the block by creating a Simulink Test harness model. In an AUTOSAR component model or a containing model, on the **Apps** tab, click **Simulink Test**. Then, on the **Tests** tab, click **Simulink Test Manager**. Click **Add Test Harness**. In the Create Test Harness dialog box, click **OK**. The software compiles the model, adds an NVRAM or Diagnostic Service Component block, and creates ports and other elements required for simulation. For example, here is a test harness created for the integration model in example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.



- Manually insert the block into a containing composition, system, or harness model. Using the Library Browser or `add_block` command, or by typing block names in the model window, add a service component block to the containing model. Example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34 uses these `add_block` commands to add NVRAM Service Component and Diagnostic Service Component blocks to a containing model.

```
add_block('autosarlibnvm/NVRAM Service Component',...
  'autosar_bsw_presim/NVRAM Service Component');
add_block('autosarlibdem/Diagnostic Service Component',...
  'autosar_bsw_presim/Diagnostic Service Component');
```



- 4 Each service component block has prepopulated parameters. Examine the parameter settings and consider if modifications are required, based on how you are using the NvM or Dem service operations. For more information, see NVRAM Service Component and Diagnostic Service Component.
- 5 Simulate the containing model. The simulation exercises the AUTOSAR NvM and Dem service calls in the component models. For a sample simulation, see example “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

See Also

Diagnostic Service Component | NVRAM Service Component

Related Examples

- “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34
- “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15

- “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22

More About

- “Model AUTOSAR Basic Software Service Calls” on page 7-13
- “Model AUTOSAR Communication” on page 2-28

Simulate AUTOSAR Basic Software Services and Run-Time Environment

Simulate AUTOSAR component calls to Basic Software memory and diagnostic services using reference implementations.

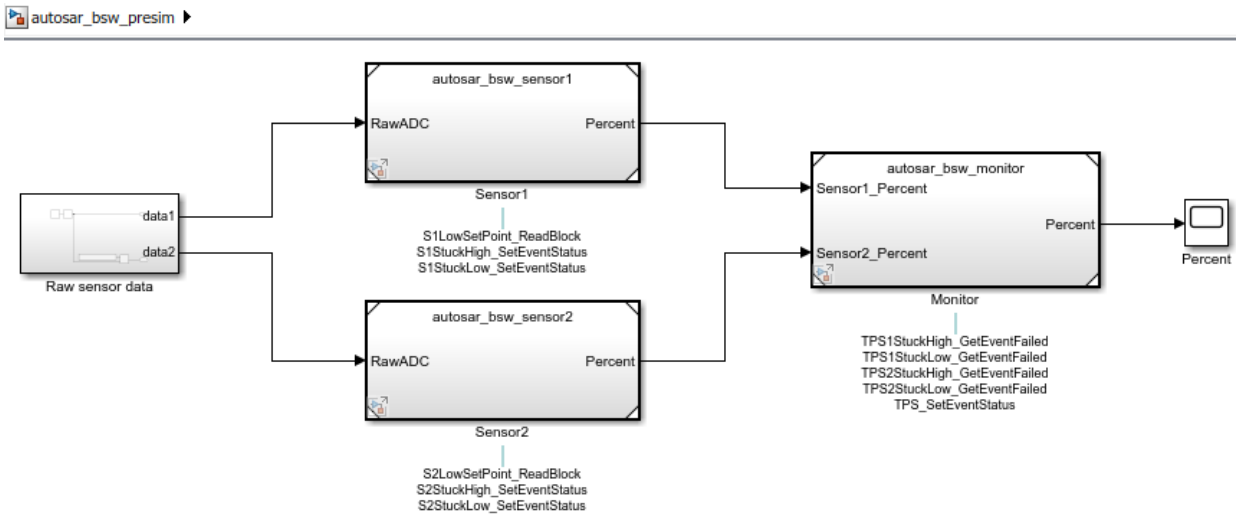
Configure Calls to AUTOSAR Basic Software Services

The AUTOSAR standard defines Basic Software (BSW) services that run in the AUTOSAR run-time environment. The services include NVRAM Manager (NvM) and Diagnostic Event Manager (Dem) services. In the AUTOSAR run-time environment, AUTOSAR software components typically access BSW services using client-server or sender-receiver communication.

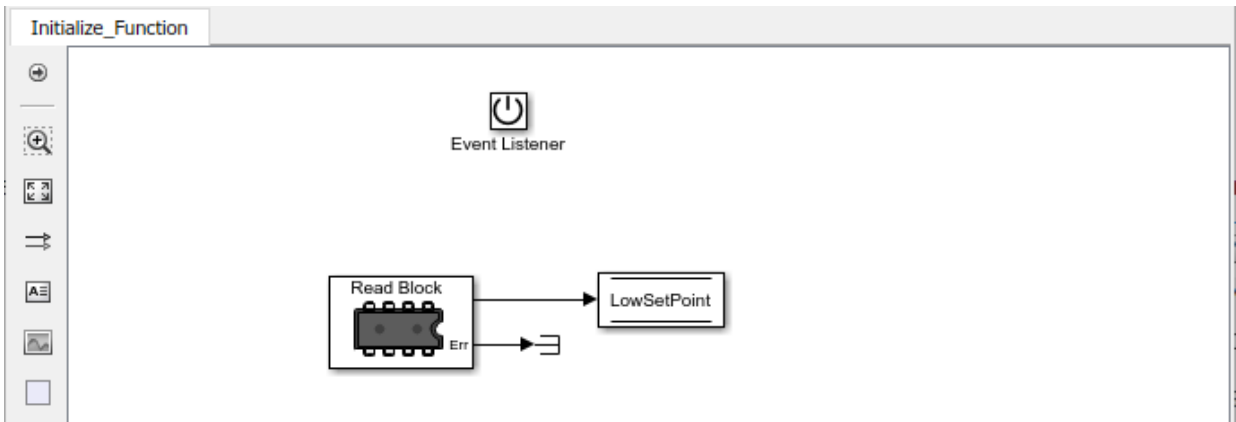
In your AUTOSAR software component model, to implement client calls to NvM and Dem service interfaces, you drag and drop preconfigured NvM and Dem caller blocks. Each block has prepopulated parameters, such as **Client port name** and **Operation**. You configure the block parameters, for example, to select an NvM or Dem service operation to call. To configure the added caller blocks in the AUTOSAR software component, you synchronize the model. The software creates AUTOSAR client-service interfaces, operations, and ports, and maps each Simulink function call to an AUTOSAR client port and operation. For more information, see “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22 and “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15.

Here is a throttle position integration model, which integrates two throttle position sensor components and a throttle position monitor component. The sensor components take a raw throttle position sensor (TPS) value and convert it to a TPS percent value. The monitor component takes the TPS percent values provided by the primary and secondary sensor components and decides which TPS signal to pass through. The sensor components call BSW NvM and Dem services, and the monitor component calls BSW Dem services.

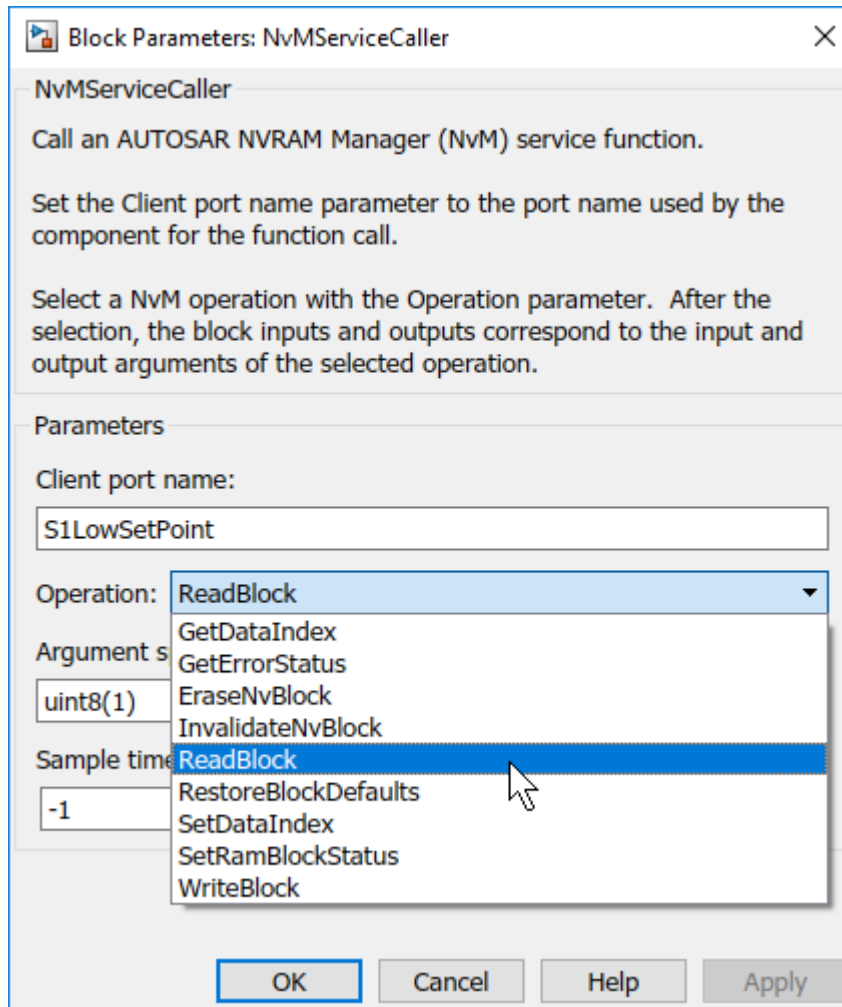
```
open_system('autosar_bsw_presim');
```



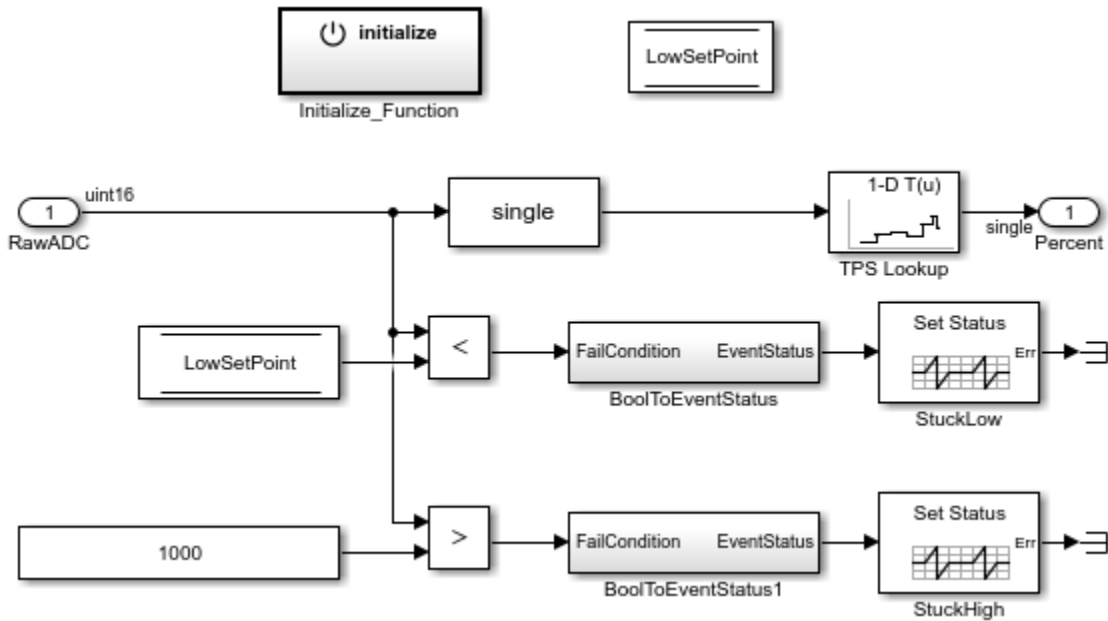
Sensor components `autosar_bsw_sensor1` and `autosar_bsw_sensor2` each contain an Initialize Function block, which calls the NvM service interface `NvMService`. The calls are implemented using the Basic Software library block `NvMServiceCaller`. Each block is configured to call the `NvMService` operation `ReadBlock`. The `ReadBlock` calls use client ports `S1LowSetPoint` and `S2LowSetPoint`. Here is the Initialize Function block for `autosar_bsw_sensor1`.



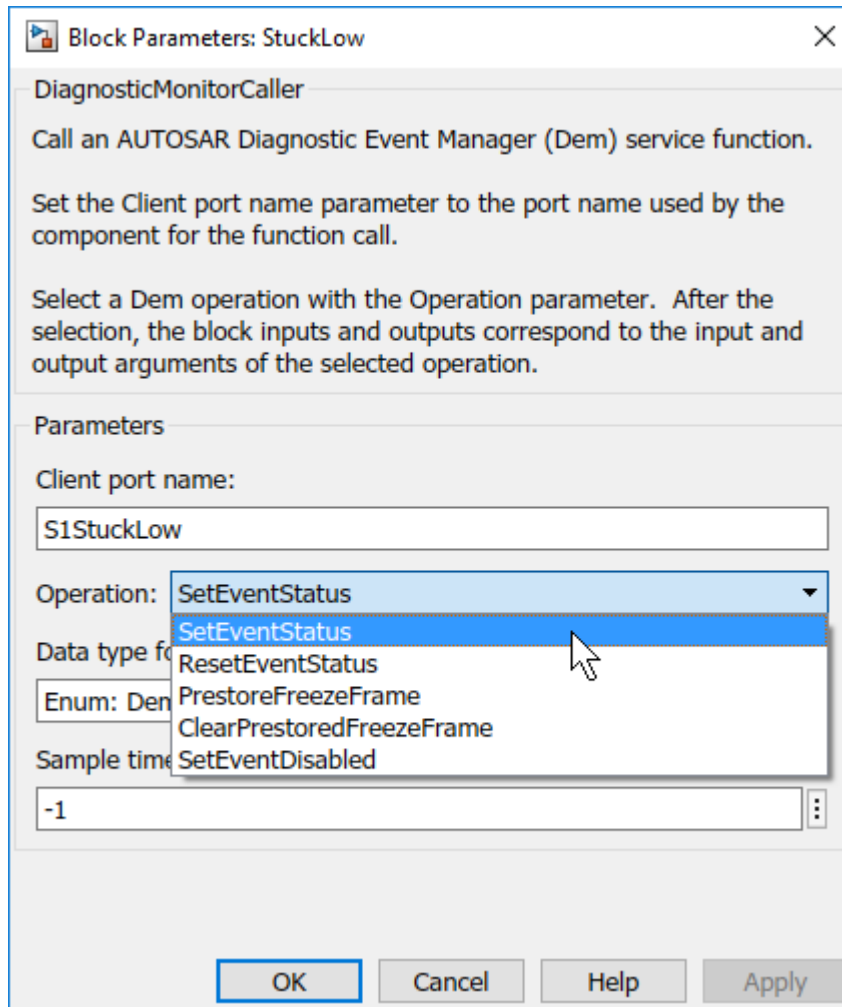
Here is the `NvMServiceCaller` block dialog box for the `ReadBlock` call in the Initialize Function block. For more information, see `NvMServiceCaller`.



Sensor components `autosar_bsw_sensor1` and `autosar_bsw_sensor2` each contain two calls to the DEM service interface `DiagnosticMonitor`. Both calls are implemented using the Basic Software library block `DiagnosticMonitorCaller`. Each block is configured to call the `DiagnosticMonitor` operation `SetEventStatus`. The `SetEventStatus` calls use client ports `S1StuckLow`, `S1StuckHigh`, `S2StuckLow`, and `S2StuckHigh`.



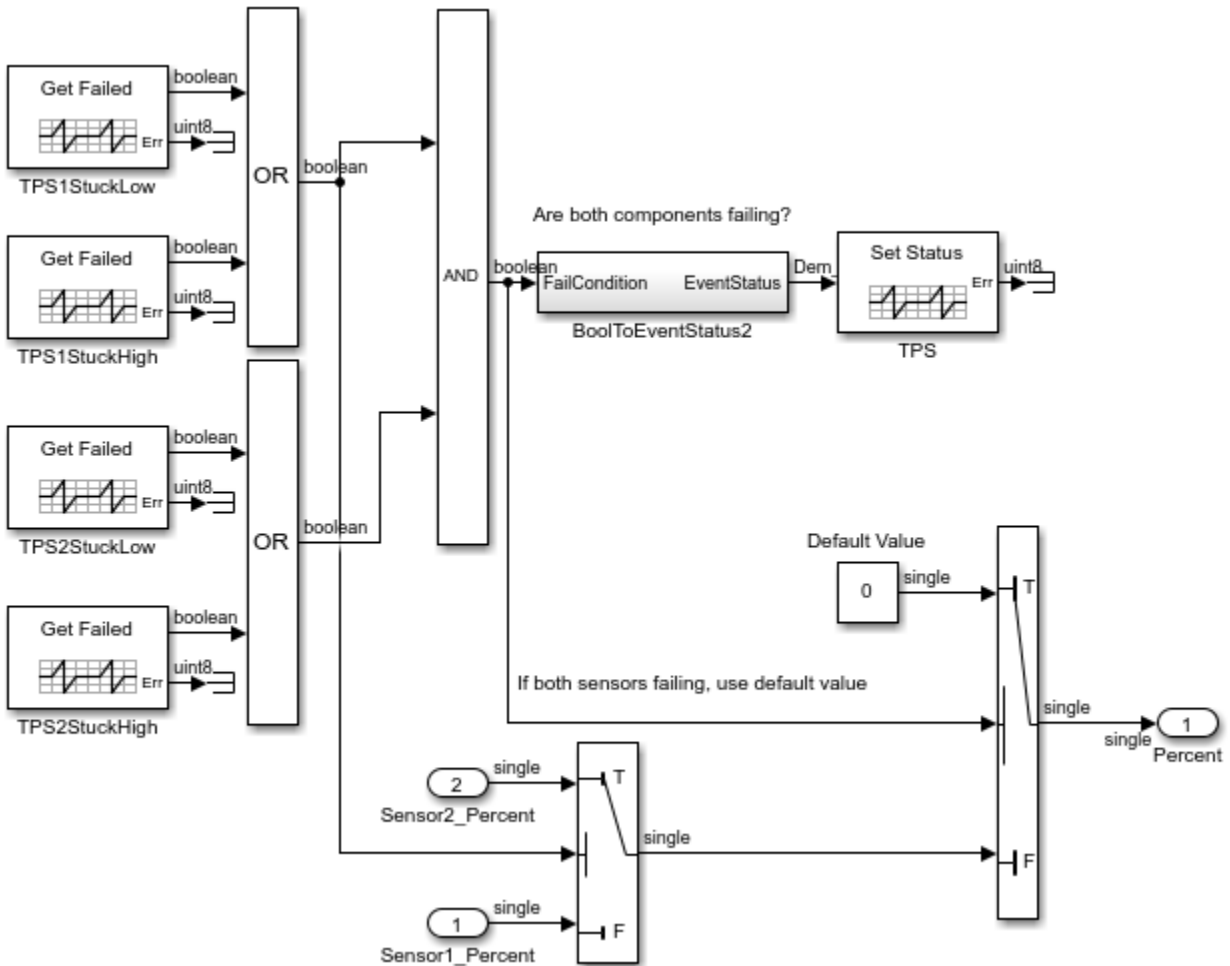
Here is the DiagnosticMonitorCaller block dialog box for the StuckLow call in the first sensor component. For more information, see DiagnosticMonitorCaller.



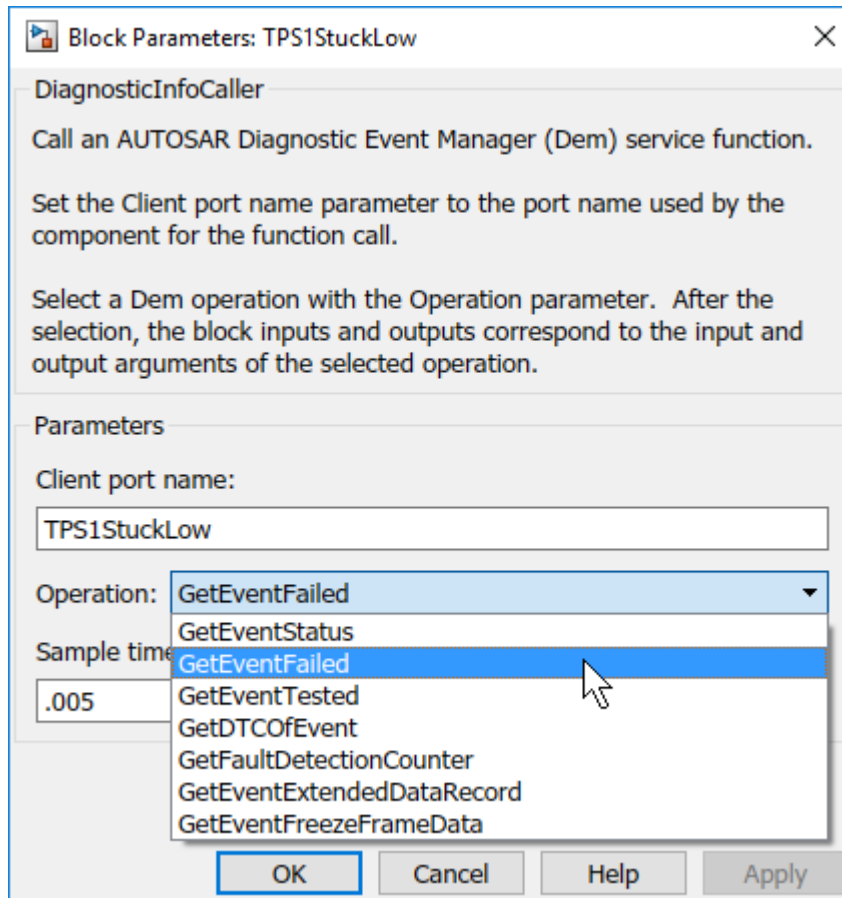
Monitor component `autosar_bsw_monitor` contains a call to the Dem service interface `DiagnosticMonitor` and four calls to the DEM service interface `DiagnosticInfo`.

- As in the sensor component, a `DiagnosticMonitorCaller` block implements the `DiagnosticMonitor` call, and it is configured to call the `SetEventStatus` operation. The client port name is `TPS`.

- The four DiagnosticInfo calls are implemented using the Basic Software library block DiagnosticInfoCaller. Each block is configured to call the DiagnosticInfo operation GetEventFailed. The GetEventFailed calls use client ports TPS1StuckLow, TPS1StuckHigh, TPS2StuckLow, and TPS2StuckHigh.



Here is the DiagnosticInfoCaller block dialog box for the TPS1StuckLow call. For more information, see DiagnosticInfoCaller.



If you have Simulink Coder and Embedded Coder software, you can generate C code and export arxml descriptions for the NvM and Dem service calls. Open and build each component model. For example, to build model `autosar_bsw_monitor`, open the model. Press Ctrl+B or enter the MATLAB command `rtwbuild('autosar_bsw_monitor')`.

To see the results of the model build, examine the code generation report.

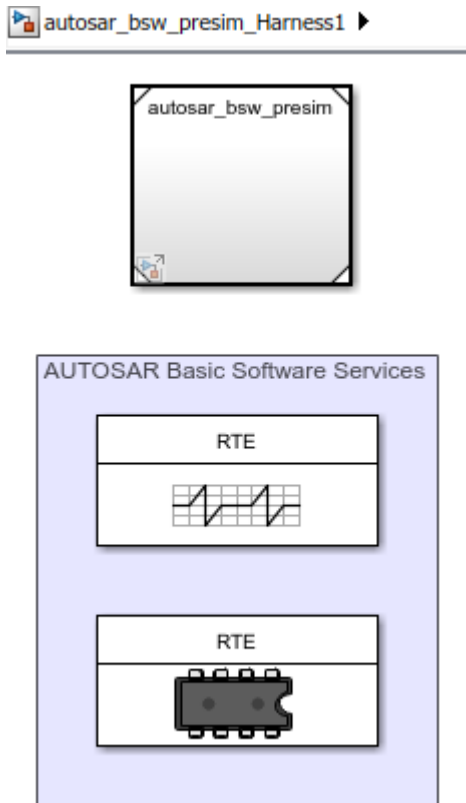
Configure Reference Implementations of AUTOSAR Basic Software Services for Simulation

To simulate an AUTOSAR component model that calls BSW services, create a containing composition, system, or harness model. In that containing model, provide reference implementations of the NvM and Dem service operations called by the component.

The AUTOSAR Basic Software block library includes an NVRAM Service Component block and a Diagnostic Service Component block. The blocks provide reference implementations of NvM and Dem service operations. To support simulation of component calls to the NvM and Dem services, include the blocks in the containing model. You can insert the blocks in either of two ways:

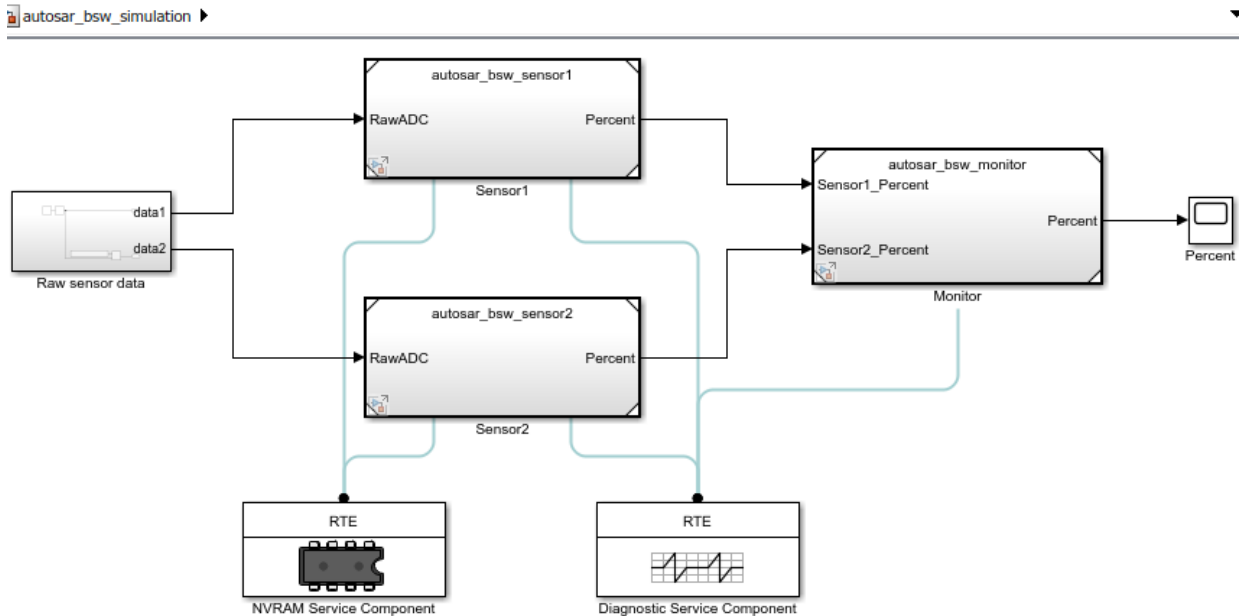
- Automatically insert the blocks by creating a Simulink Test harness model
- Manually insert the blocks into a containing composition, system, or harness model

To insert Service Component blocks automatically for a model that calls BSW NvM and Dem services, open the model (or a containing model) and create a Simulink Test test harness (requires Simulink Test). On the **Apps** tab, click **Simulink Test**. Then, on the **Tests** tab, click **Simulink Test Manager**. Click **Add Test Harness**. In the Create Test Harness dialog box, click **OK**. The software compiles the model, adds NVRAM and Diagnostic Service Component blocks, and creates ports and other elements required for simulation. For example, here is a test harness created for the throttle position integration model.

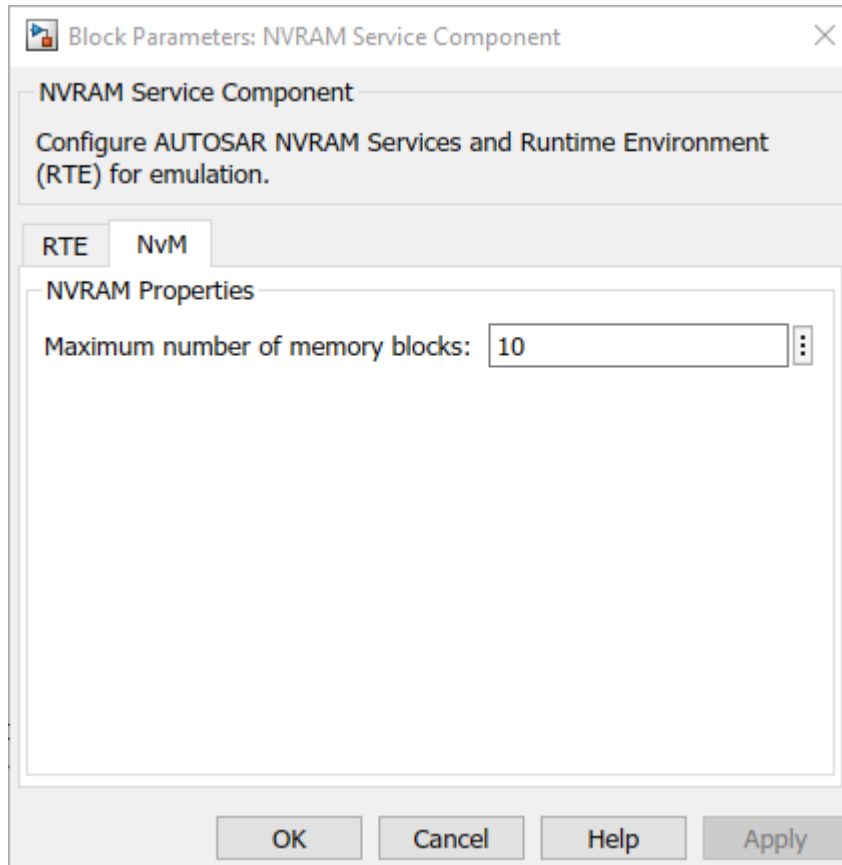


To insert Service Component blocks manually for the NvM and Dem service calls in this example, open the integration model. Using the Library Browser or `add_block` commands, or by typing block names in the model window, add the NVRAM and Diagnostic Service Component blocks to the model.

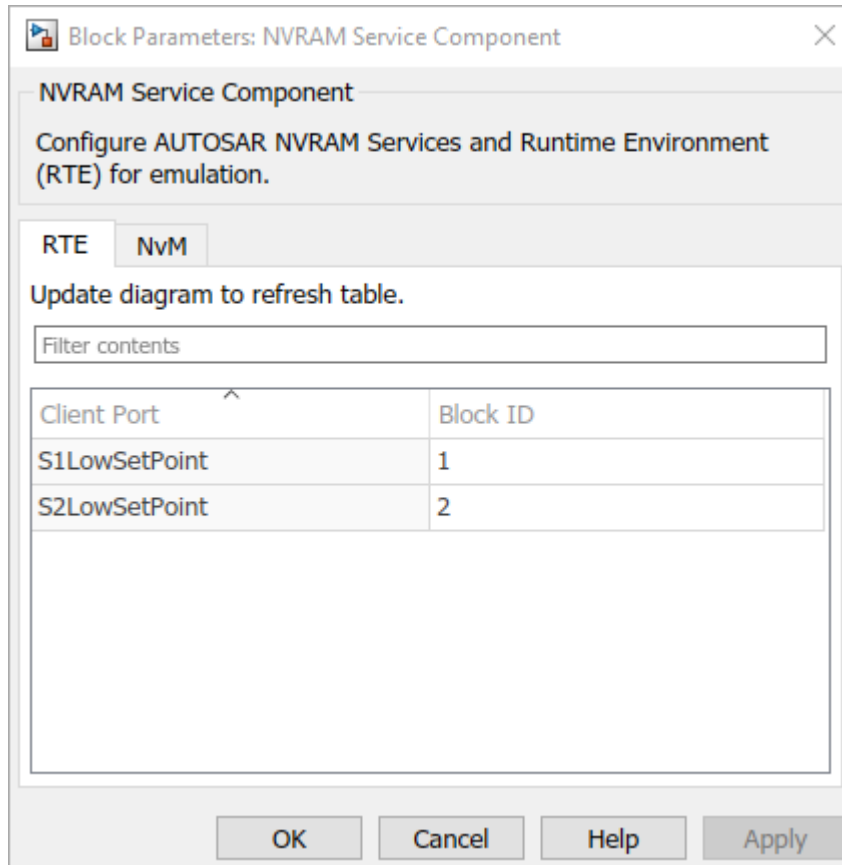
```
open_system('autosar_bsw_presim');  
add_block('autosarlibnvm/NVRAM Service Component','autosar_bsw_presim/NVRAM Service Component');  
add_block('autosarlibdem/Diagnostic Service Component','autosar_bsw_presim/Diagnostic Service Component');  
set_param('autosar_bsw_presim','SimulationCommand','update');
```



The NVRAM Service Component block has prepopulated parameters, including run-time environment (RTE) parameters and **NVRAM Properties** parameters. Examine the parameter settings and consider if any require modifying, based on how you are using the NvM service operations. For more information, see NVRAM Service Component.

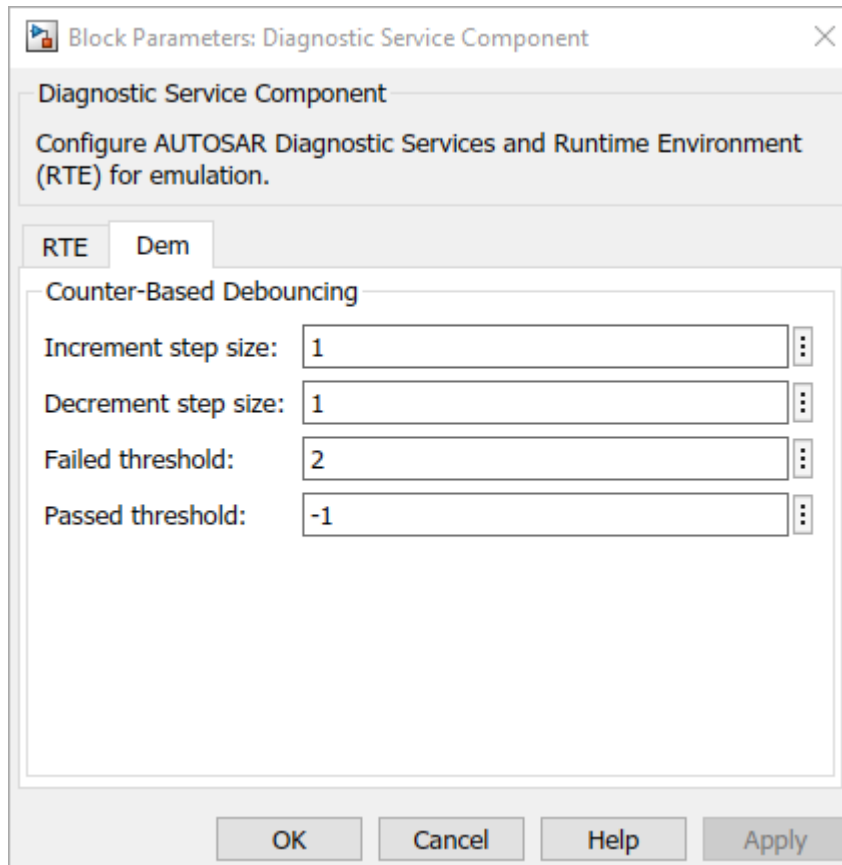


The RTE tab table lists component client ports and their mapping to NvM service block IDs. Each row in the table represents a call into NvM services from a Basic Software caller block. Calls that act on the same NvM block typically use the same block ID. This example maps the NvM ReadBlock client ports to different block IDs.

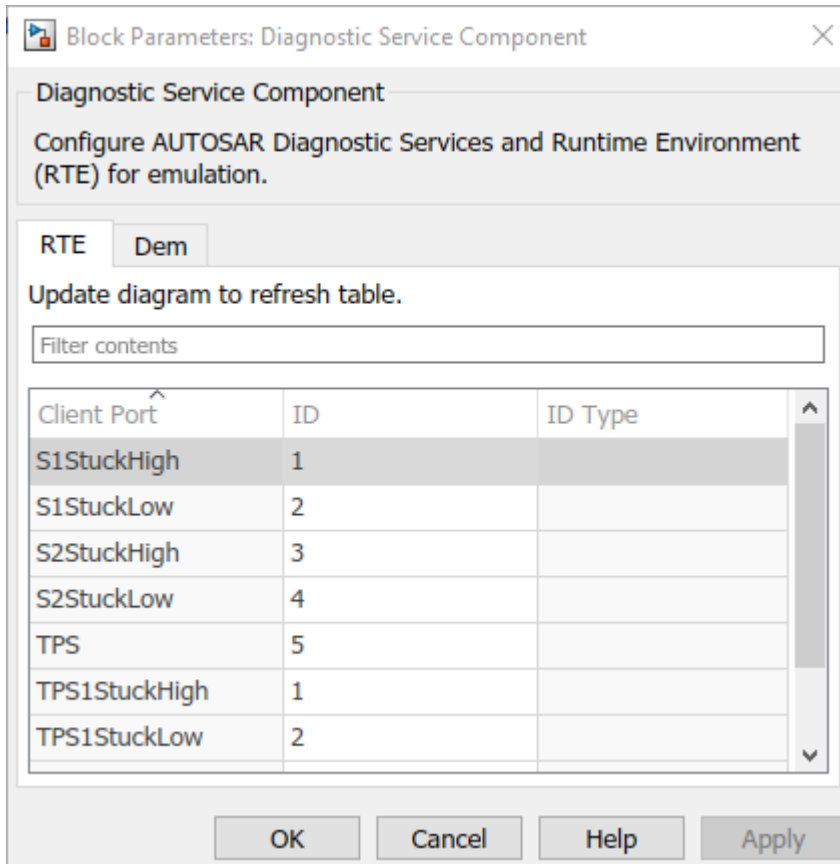


The Diagnostic Service Component block has prepopulated parameters, including RTE parameters and **Counter-Based Debouncing** parameters. Examine the parameter settings and consider if any require modifying, based on how you are using the Dem service operations.

The **Counter-Based Debouncing** parameters control the counter-based debounce algorithm provided by the Dem service reference implementations. During multiple simulation runs, you can tune event step size and threshold parameters and observe the effects. For more information, see Diagnostic Service Component.



The RTE tab table lists component client ports and their mapping to Dem service event IDs. Each row in the table represents a call into Dem services from a Basic Software caller block. Calls that act on the same event typically use the same event ID. This example maps the Dem `SetEventStatus` client ports to different event IDs, and then maps the Dem `GetEventFailed` client ports to event IDs that are shared with `SetEventStatus` ports. For example, `SetEventStatus` port `S1StuckHigh` and `GetFailedEvent` port `TPS1StuckHigh` share event ID 1; `S1StuckLow` and `TPS1StuckLow` share event ID 2; and so on.



Simulate Calls to AUTOSAR NvM and Dem Services

After manually adding NVRAM and Diagnostic Service Component blocks to the integration model, simulate the model. The simulation exercises the AUTOSAR NvM and Dem service calls in the throttle position sensor and monitor component models.

```
open_system('autosar_bsw_simulation');
simOutIntegration = sim('autosar_bsw_simulation');
```

Related Links

- “Model AUTOSAR Basic Software Service Calls” on page 7-13

- “Configure Calls to AUTOSAR NVRAM Manager Service” on page 7-22
- “Configure Calls to AUTOSAR Diagnostic Event Manager Service” on page 7-15
- “Configure AUTOSAR Basic Software Service Implementations for Simulation” on page 7-29

AUTOSAR Software Architecture Modeling

- “Create AUTOSAR Architecture Models” on page 8-2
- “Add and Connect AUTOSAR Compositions and Components” on page 8-5
- “Link AUTOSAR Components to Simulink Requirements” on page 8-12
- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14
- “Configure AUTOSAR Scheduling and Simulation” on page 8-25
- “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38

Create AUTOSAR Architecture Models

An AUTOSAR architecture model provides resources and a canvas for developing AUTOSAR composition and component models for the Classic Platform (requires System Composer). From the architecture model, you can:

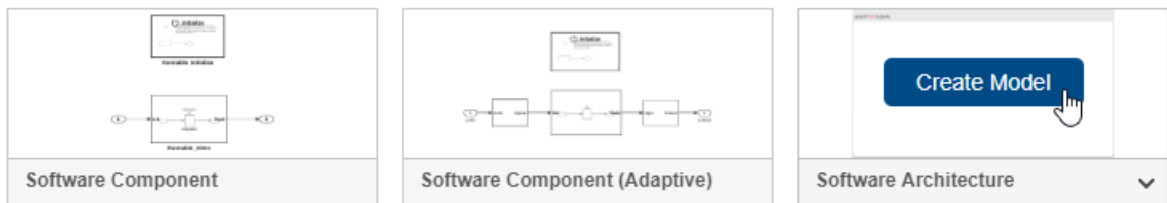
- Add and connect AUTOSAR compositions and components.
- Link components to requirements (requires Simulink Requirements™).
- Add Simulink behavior to components by creating or linking models.
- Configure scheduling and simulation.
- Export composition and component arxml descriptions and generate component code (requires Embedded Coder).

Architecture models provide an end-to-end, top-to-bottom AUTOSAR software design workflow. In Simulink, you can author a high-level application design, implement behavior for application components, add Basic Software (BSW) service calls and service implementations, and simulate the application.

To create an architecture model, open an AUTOSAR Blockset model template from the Simulink Start Page. For example:

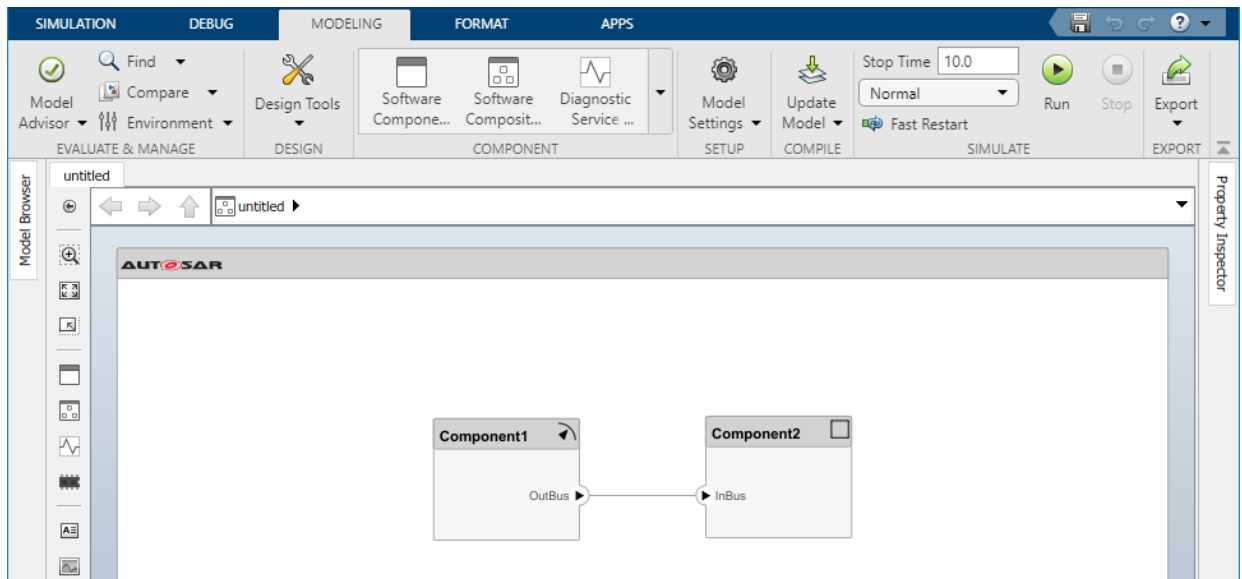
- 1 Open the Simulink Start Page. Enter the MATLAB `simulink` command or select Simulink menu sequences that create a new model.
- 2 On the **New** tab, scroll down to AUTOSAR Blockset and expand the list of model templates. Place your cursor over the **Software Architecture** template and click **Create Model**.

▼ AUTOSAR Blockset



- 3 A new AUTOSAR architecture model opens.
 - In the Simulink Toolstrip, the **Modeling** tab supports common tasks for architecture modeling.

- To the left of the model window, the palette includes icons for adding different types of AUTOSAR components to the model: Software Component, Software Composition, and for Basic Software (BSW) modeling, Diagnostic Service Component and NVRAM Service Component.
- The composition editor provides a view of AUTOSAR software architecture based on the AUTOSAR Virtual Function Bus (VFB). The model canvas initially displays two connected software components.



After you create an AUTOSAR architecture model, you develop the top level of the design. See “Add and Connect AUTOSAR Compositions and Components” on page 8-5.

See Also

Component | Composition | Diagnostic Service Component | NVRAM Service Component

Related Examples

- “Add and Connect AUTOSAR Compositions and Components” on page 8-5
- “Link AUTOSAR Components to Simulink Requirements” on page 8-12

- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14
- “Configure AUTOSAR Scheduling and Simulation” on page 8-25
- “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38

Add and Connect AUTOSAR Compositions and Components

After you create an AUTOSAR architecture model, you begin authoring the top level of an AUTOSAR software design. The composition editor provides a view of AUTOSAR software architecture based on the AUTOSAR Virtual Function Bus (VFB). Use the composition editor and the Simulink Toolstrip **Modeling** tab to add and connect AUTOSAR compositions and components.

In this section...

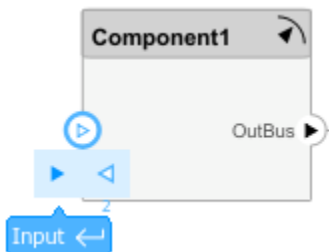
“Configure Component Blocks” on page 8-5

“Configure Composition Blocks” on page 8-8

Configure Component Blocks

To add and connect AUTOSAR software components in an architecture model:

- For each component required by the design, from the **Modeling** tab or the palette, add a Component block. You can use the Property Inspector to set the component **Kind** — Application, ComplexDeviceDriver, EcuAbstraction, SensorAccuator, or ServiceProxy.
- Add component require and provide ports. To add each component port, click an edge of a Component block. When port controls appear, select **Input** for a require port or **Output** for a provide port.



- To connect the Component blocks to other blocks, connect the block ports with signal lines.
- To connect the Component blocks to architecture or composition model root ports, drag from the component ports to the containing model boundary.



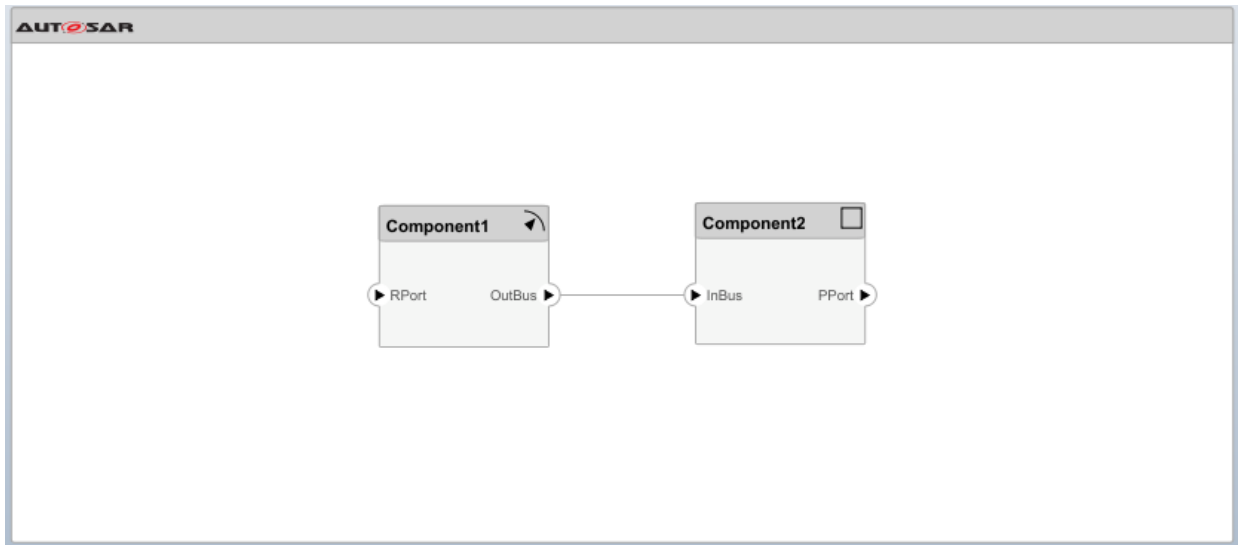
When you release the connection, a root port is created at the boundary.



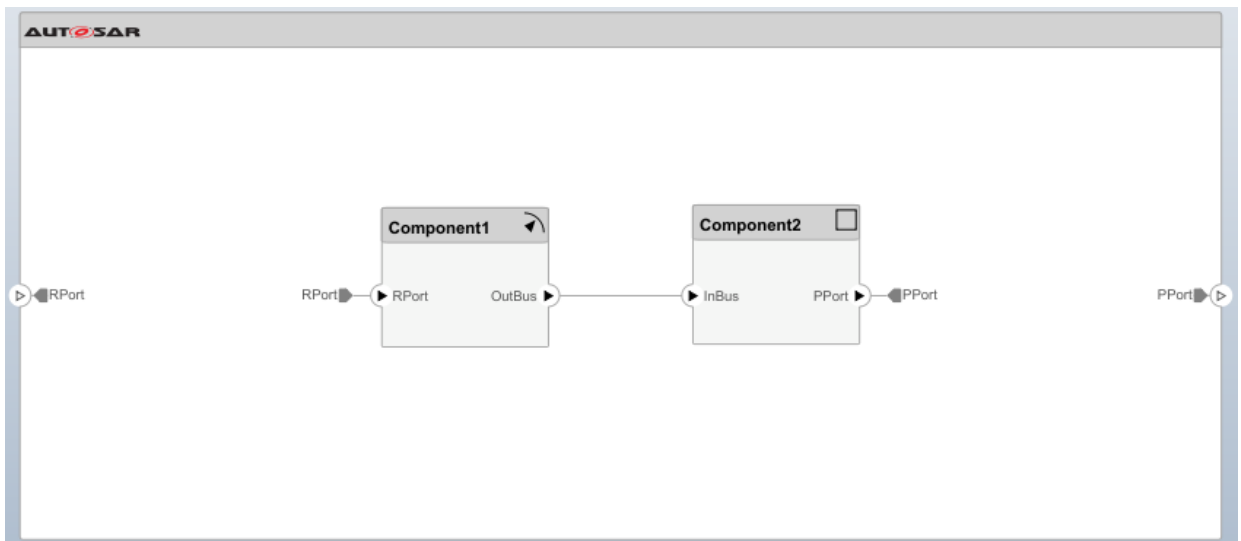
- Configure additional AUTOSAR properties by using the Property Inspector.

For example, to author a simple design:

- 1 Using the Simulink Start Page, create an AUTOSAR architecture model. (For more information, see “Create AUTOSAR Architecture Models” on page 8-2.) The model canvas initially displays two connected software components.
- 2 Add a require (input) port to the left Component block and a provide (output) port to the right Component block.



- 3 Connect the new require and provide ports to architecture model root ports. Drag from each port to the model boundary.



The simple design is complete, but behavior is not yet defined for the AUTOSAR components. The next step is to add Simulink behavior to the AUTOSAR components by

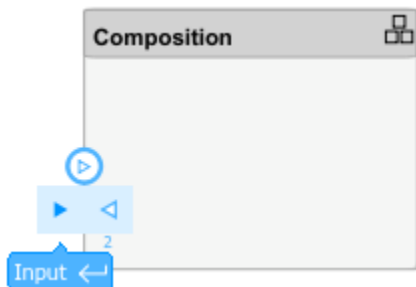
creating, importing, or linking models. See “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14. For a more detailed design example, see “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.

If you have Simulink Requirements software, you can link components in an AUTOSAR architecture model to Simulink requirements. See “Link AUTOSAR Components to Simulink Requirements” on page 8-12.

Configure Composition Blocks

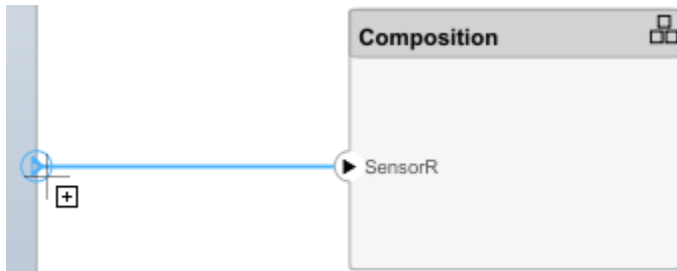
To add and connect an AUTOSAR software composition nested in an architecture model:

- From the **Modeling** tab or the palette, add a Composition block.
- Add composition require and provide ports. To add each composition port, click an edge of the Composition block. When port controls appear, select **Input** for a require port or **Output** for a provide port.

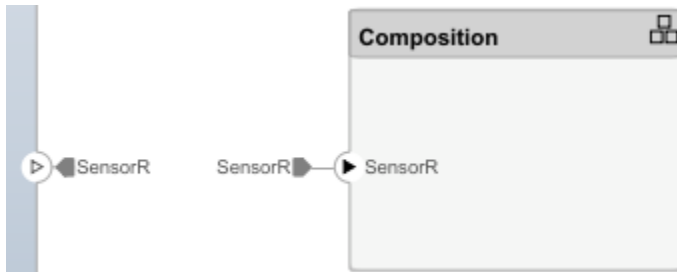


Alternatively, open the Composition block. To add each composition port, click the boundary of the composition diagram. When port controls appear, select **Input** for a require port or **Output** for a provide port.

- To connect the Composition block to other blocks, connect the block ports with signal lines.
- To connect the Composition block to architecture or composition model root ports, drag from the composition ports to the containing model boundary.



When you release the connection, a root port is created at the boundary.

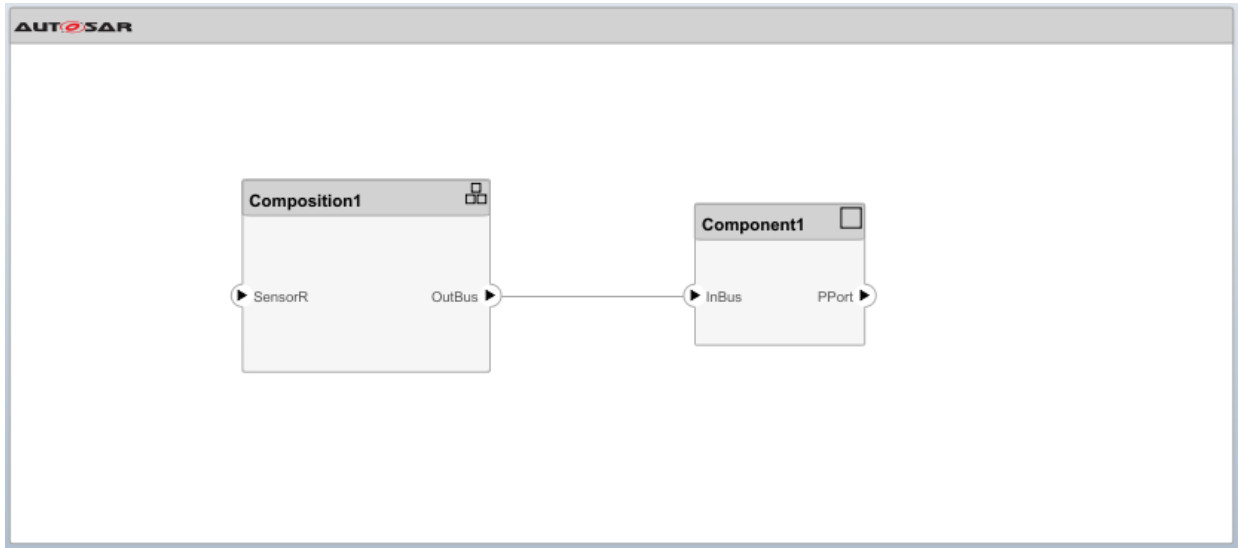


- Configure additional AUTOSAR properties by using the Property Inspector.

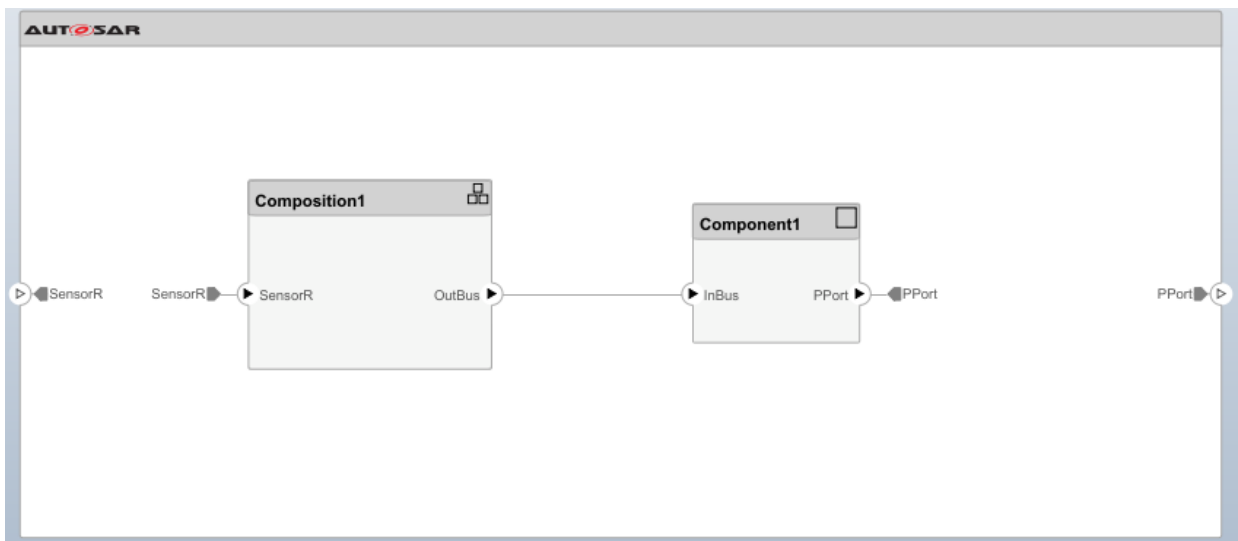
For example, to author a simple nested composition:

- 1 Using the Simulink Start Page, create an AUTOSAR architecture model. (For more information, see “Create AUTOSAR Architecture Models” on page 8-2.) The model canvas initially displays two connected software components.
- 2 Remove the left Component block and in its place, add a Composition block.

Add a require (input) port and a provide (output) port to the Composition block. Also add a provide (output) port to the Component block. Connect the composition provide port to the component require port



- 3 Connect the unconnected require and provide ports to architecture model root ports. Drag from each port to the model boundary.



Typically, an AUTOSAR composition contains a set of AUTOSAR components and compositions with a shared purpose. To populate a composition, open the Composition

block and begin adding more Component and Composition blocks. For a more detailed design example, see “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.

See Also

Component | Composition

Related Examples

- “Create AUTOSAR Architecture Models” on page 8-2
- “Link AUTOSAR Components to Simulink Requirements” on page 8-12
- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14
- “Configure AUTOSAR Scheduling and Simulation” on page 8-25
- “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38

Link AUTOSAR Components to Simulink Requirements

If you have Simulink Requirements software, you can link components in an AUTOSAR architecture model to Simulink requirements. By linking model elements that implement requirements to the associated requirements, you can track implementation of the requirements. If a requirement or an implementation changes, you can make adjustments to keep them in sync.

To link a component to a requirement:

- 1 Open an architecture model, such as example model `autosar_tpc_composition`.
- 2 In the **Apps** tab, click **Requirements Manager**. In the model window, the **Requirements** tab opens, with the Requirements Browser docked at the bottom.
- 3 Create or open a requirements set. If you opened example model `autosar_tpc_composition`, you can use example requirements file `TPC_Requirements.s1reqx`. To copy the requirements file to your working folder, enter this MATLAB command:

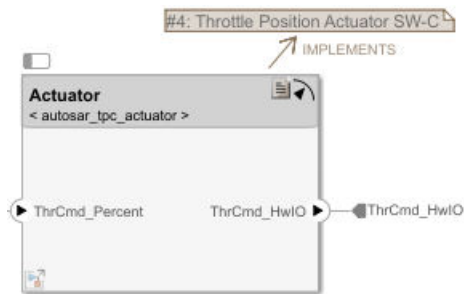
```
copyfile(fullfile(matlabroot, 'examples/autosarblockset/TPC_Requirements.s1reqx'), '.')
```

In the Requirements Browser, open the requirements file.

- 4 The requirements set contains requirements for four components in the model.

Index	ID	Summary
1	#1	Primary Throttle Position Sensor SW-C
2	#2	Secondary Throttle Position Sensor SW-C
3	#3	Accelerator Pedal Position Sensor SW-C
4	#4	Throttle Position Actuator SW-C

- 5 To link requirement 4 to the Actuator component, drag the requirement from the Requirements Browser to the component block.



For more information, see “Link Blocks and Requirements” (Simulink Requirements) and “Author Requirements in Simulink” (Simulink Requirements).

See Also

Related Examples

- “Create AUTOSAR Architecture Models” on page 8-2
- “Add and Connect AUTOSAR Compositions and Components” on page 8-5
- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14
- “Configure AUTOSAR Scheduling and Simulation” on page 8-25
- “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38

More About

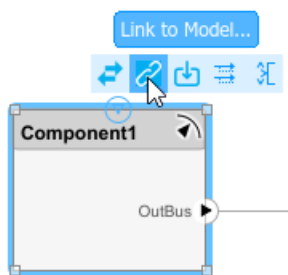
- “Author Requirements in Simulink” (Simulink Requirements)
- “Link Blocks and Requirements” (Simulink Requirements)

Define AUTOSAR Component Behavior by Creating or Linking Models

After you add and connect Component and Composition blocks in an AUTOSAR architecture model, you can add Simulink behavior to the components. For each AUTOSAR Component block, you can:

- Create a model based on the block interface.
- Link to an implementation model.
- Create a model from an AUTOSAR XML (arxml) component description.

To initiate these actions, you can select a Component block, place your cursor over the displayed ellipsis, and select a component model cue — **Create Model**, **Link to Model**, or **Create Component Model from ARXML**.



The selections open dialog boxes that help you create or link a model that defines the Simulink behavior of the component.

After you associate an implementation model with an AUTOSAR component, if you have Embedded Coder software, you can use component block cues or right-click options to generate code and export arxml files. The arxml export uses the XML options of the parent architecture model.

When all of the components in an architecture model have defined behavior, you can simulate the behavior of the aggregated components. See “Configure AUTOSAR Scheduling and Simulation” on page 8-25.

In this section...

“Create Model Based on Block Interface” on page 8-15

In this section...

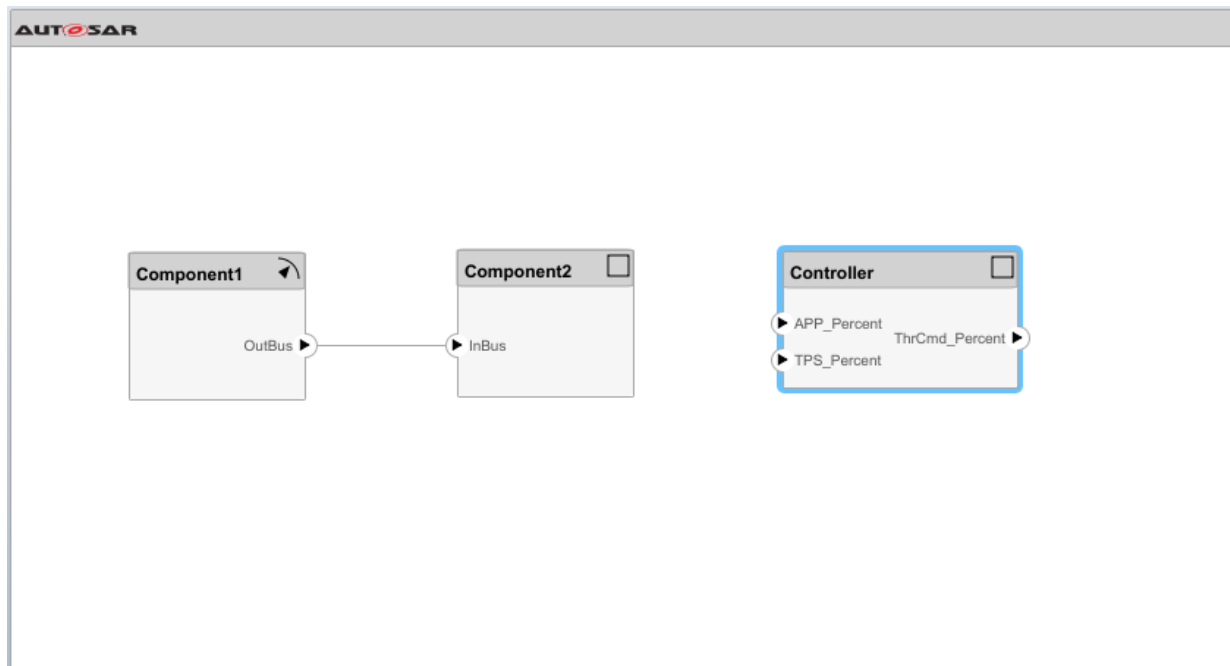
“Link to Implementation Model” on page 8-18

“Create Model from arxml Component Description” on page 8-20

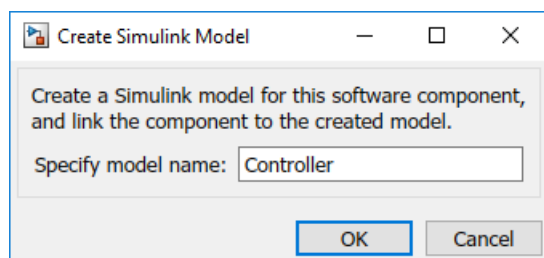
Create Model Based on Block Interface

To create a stub implementation model and map it to an AUTOSAR software component, use the Component block cue **Create Model**. Clicking the cue creates a model based on the interface of the authored component. Any ports that you created on the Component block are present in the implementation model. For example:

- 1 Create or open an architecture model. For example, use the Simulink Start Page to create a model from the AUTOSAR Blockset **Software Architecture** template.
- 2 From the **Modeling** tab or the palette, add a Component block to the model and name it Controller. Leave the component **Kind** property set to **Application**.
- 3 Click the block edges to add require (input) ports named APP_Percent and TPS_Percent and a provide (output) port named ThrCmd_Percent. (For a controller component with the same naming, see the example “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.)



- 4 Select the Controller block, place your cursor over the displayed ellipsis, and select cue **Create Model**. A dialog box opens, in which you can optionally specify a model name other than the block name default.



To create a stub implementation model and map it to the AUTOSAR Controller component, click **OK**.

- 5 Model `Controller.slx` is created in the working folder. To view the initial model content, open the Controller block. The ports are stubbed with Ground and Terminator blocks so that the model can immediately be updated and simulated.

APP_Percent.Value

TPS_Percent.Value

Place your Software Component implementation here.
 For details and examples on how to model internal behavior, see:
[Model AUTOSAR Software Components](#)

ThrCmdPercent.Value

- To view the model mapping and dictionary, open the AUTOSAR Component Designer app. This view shows the mapping and properties of the model port APP_Percent.Value. The model port maps to AUTOSAR component port APP_Percent.

The screenshot displays the AUTOSAR Component Designer interface. The main workspace shows a Controller block with two input ports: APP_Percent.Value and TPS_Percent.Value. A signal line connects APP_Percent.Value to ThrCmd_Percent.Value. The Code Mappings - AUTOSAR SW Component window is open, showing the following table:

Source	DataAccessMode	Port	Element
APP_Percent.Value	ImplicitReceive	APP_Percent	Value
TPS_Percent.Value	ImplicitReceive	TPS_Percent	Value

The Property Inspector on the right shows the configuration for the APP_Percent.Value port:

- Inports: APP_Percent.Value
- NAME: Source, VALUE: APP_Percent.Value
- Design: Dimensions: -1, Sample Time: -1
- Code: DataAccessMode: ImplicitReceive, Port: APP_Percent, Element: Value
- Communication attributes: AliveTimeout: 0, HandleNeverReceived: false, InitValue: 0

- After creating the stub model representation of the AUTOSAR component, use Simulink tools to develop the component implementation. You refine the AUTOSAR configuration and create algorithmic model content. For an example Controller block implementation, see the model `autosar_tpc_controller` provided with example “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.

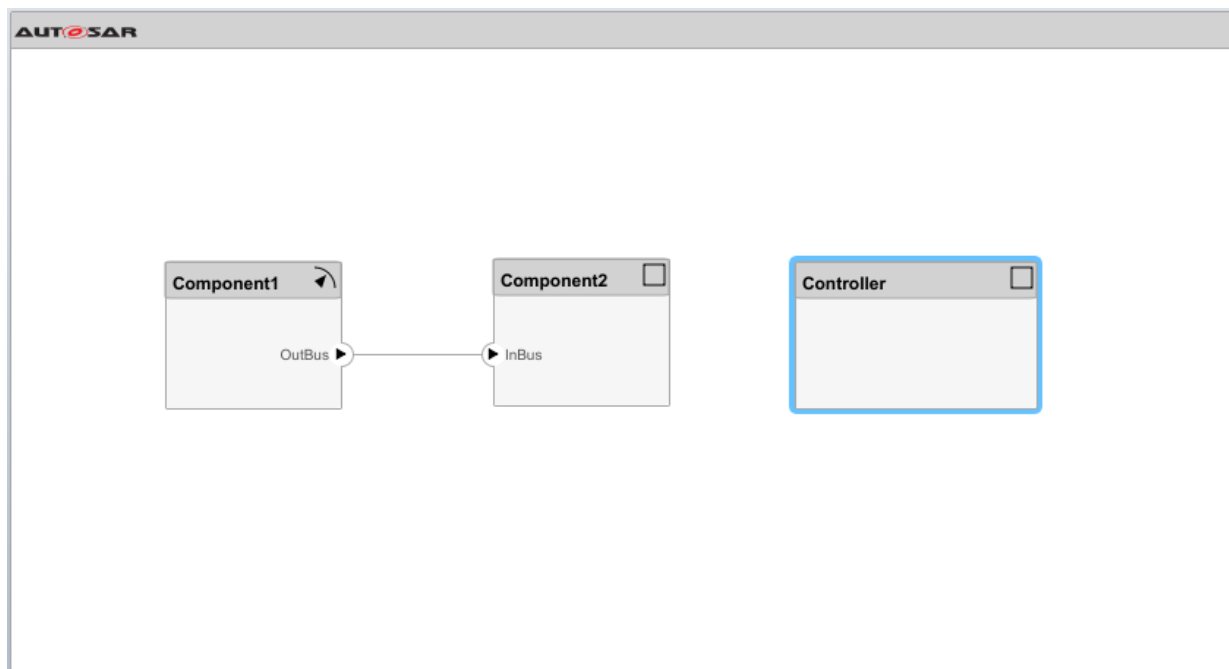
Link to Implementation Model

To reference an existing AUTOSAR implementation model from an AUTOSAR software component, use the Component block cue **Link to Model**. Potentially, model linking allows you to deploy verified implementation models in your AUTOSAR design without requalification.

Clicking the cue links the Component block to a specified model and updates the block and model interfaces to match. If you link to a model that uses root Inport and Outport blocks, the software automatically converts the model signal ports to bus ports. For more information, see “Configure AUTOSAR Ports By Using Simulink Bus Ports” on page 4-219.

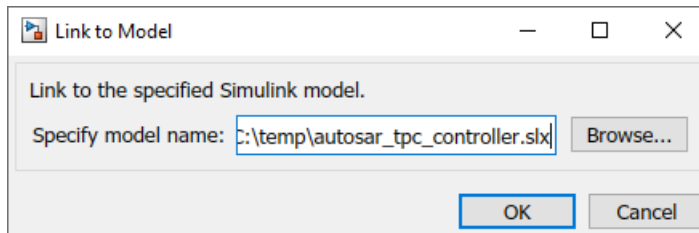
To link an AUTOSAR component to an AUTOSAR implementation model:

- 1 Create or open an architecture model. For example, use the Simulink Start Page to create a model from the AUTOSAR Blockset **Software Architecture** template.
- 2 From the **Modeling** tab or the palette, add a Component block to the model and name it Controller. Leave the component **Kind** property set to **Application**.



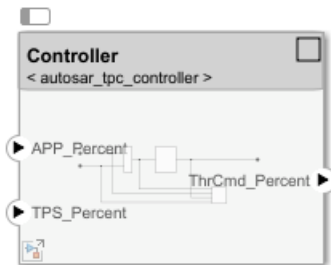
- 3 The example “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38 provides a controller implementation model. To copy the model file to your working folder, enter this MATLAB command:


```
copyfile(fullfile(matlabroot,'examples/autosarblockset/autosar_tpc_controller.slx'),'')
```
- 4 Select the Controller block, place your cursor over the displayed ellipsis, and select cue **Link to Model**. In the Link to Model dialog box, browse to the implementation model `autosar_tpc_controller.slx`.



To reference the controller implementation model from the AUTOSAR Controller component, click **OK**.

- 5 The Controller block is linked to model `autosar_tpc_controller`. The block interface is updated to match the model implementation.

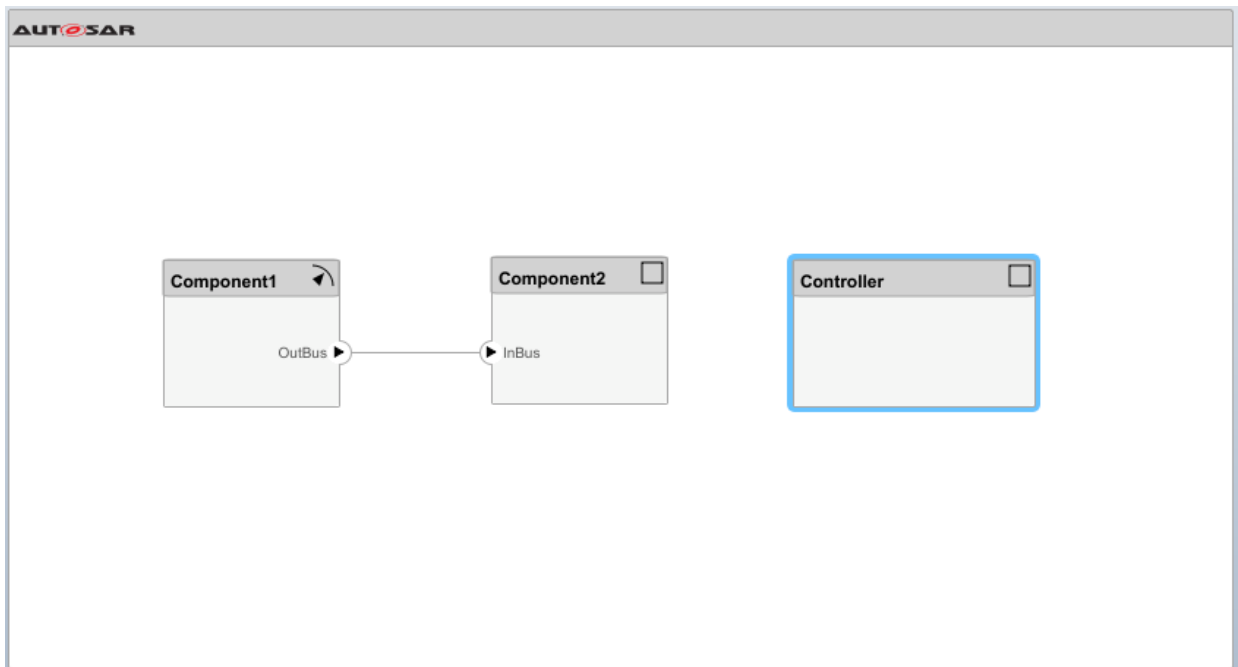


- 6 To view the model content, open the Controller block. In the open model, to view the model mapping and dictionary, open the AUTOSAR Component Designer app.
- 7 After linking the AUTOSAR component to the AUTOSAR implementation model, connect the Component block to other blocks or root ports in the design. For a fully connected controller component, see example “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.

Create Model from arxml Component Description

To create an AUTOSAR implementation model from an arxml component description and map it to an AUTOSAR software component, use the Component block cue **Create Component Model from ARXML**. Clicking the cue creates a model based on a specified arxml description, links the Component block to the model, and updates the block and model interfaces to match. For example:

- 1 Create or open an architecture model. For example, use the Simulink Start Page to create a model from the AUTOSAR Blockset **Software Architecture** template.
- 2 From the **Modeling** tab or the palette, add a Component block to the model and name it Controller. Leave the component **Kind** property set to Application.

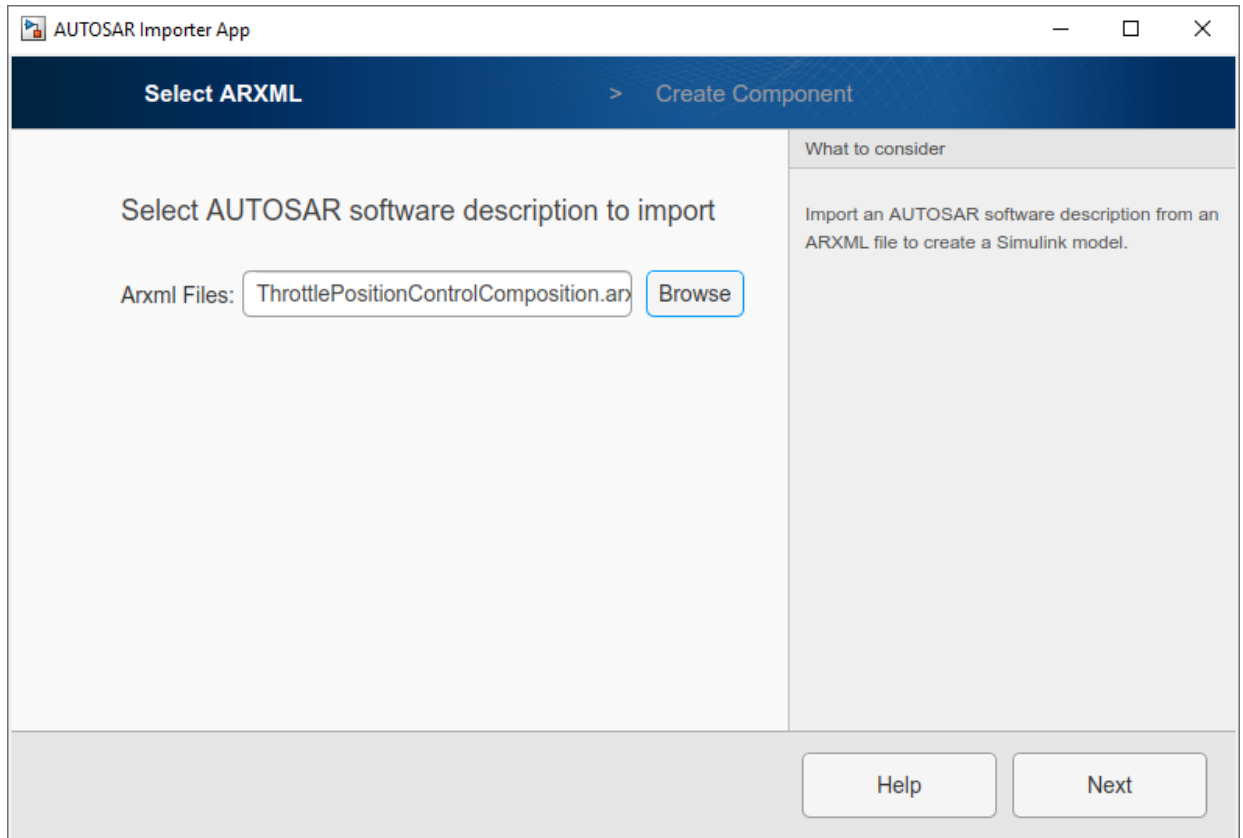


- 3 The example “Import AUTOSAR Software Component” on page 3-19 provides an arxml file that includes a controller component description. To copy the arxml file to your working folder, enter this MATLAB command:

```
copyfile(fullfile(matlabroot,...
    'examples/autosarblockset/ThrottlePositionControlComposition.arxml'),'')
```

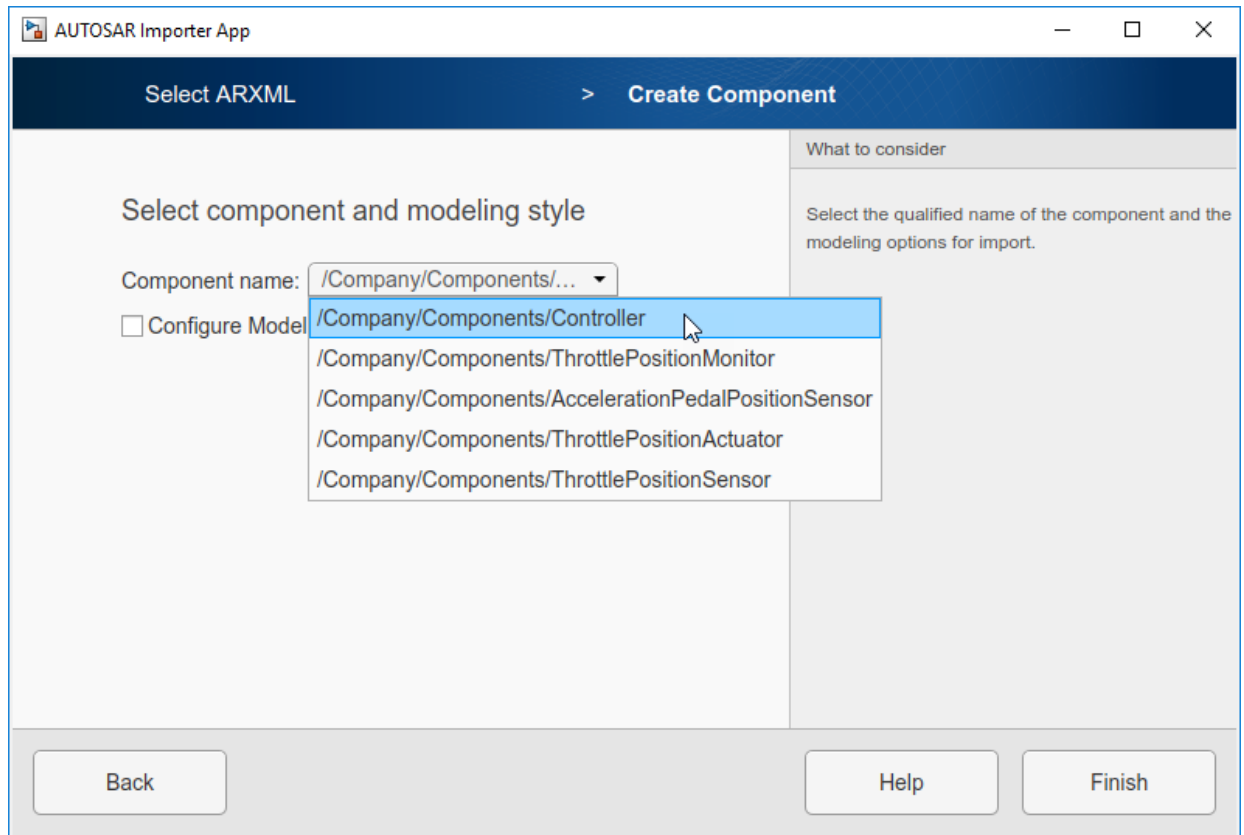
- 4 Select the Controller block, place your cursor over the displayed ellipsis, and select cue **Create Component Model from ARXML**. The AUTOSAR Importer App opens.

Work through the import and model creation procedure.



In the **Select ARXML** pane, browse to the description file `ThrottlePositionControlComposition.arxml`. To import the description file, click **Next**.

- 5 The **Create Component** pane opens.



In the **Select ARXML** pane, select the component from which to create a model. From the five components imported from `ThrottlePositionControlComposition.arxml`, select `Controller`.

To view optional settings for model creation, select **Configure Modeling Options**.

Select component and modeling style

Component name:

Configure Modeling Options

Model periodic runnables as:

Initialization Runnable:

Data Dictionary:

Predefined Variant:

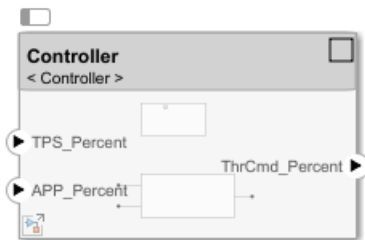
You can:

- Model periodic runnables as atomic subsystems or function-call subsystems, or accept a default modeling style selection (Auto).
- Select an existing AUTOSAR runnable as the initialization runnable for the component. In this example, `Controller_Init` is available for selection.
- Specify a Simulink data dictionary into which to import data objects corresponding to AUTOSAR data types in the XML file. If the specified dictionary does not already exist, the importer creates it. The model is then associated with the data dictionary.
- Select an AUTOSAR `PredefinedVariant` defined in the AUTOSAR XML file to initialize `SwSystemconst` data that serves as input to control variation points. For more information, see “Control AUTOSAR Variants with Predefined Value Combinations” on page 4-277. In this example, no `PredefinedVariant` is available for selection.

For more information about model creation options and behavior, see `createComponentAsModel`.

To create the model and map it to the AUTOSAR Controller component, click **Finish**.

- 6 `Model Controller.slx` is created in the working folder. The block interface is updated to match the model implementation.



- 7 To view the model content, open the Controller block. In the open model, to view the model mapping and dictionary, open the AUTOSAR Component Designer app.
- 8 After creating the AUTOSAR implementation model and linking the AUTOSAR component to it, connect the Component block to other blocks or root ports in the design. For a fully connected controller component, see example “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.

See Also

Component | createComponentAsModel

Related Examples

- “Create AUTOSAR Architecture Models” on page 8-2
- “Add and Connect AUTOSAR Compositions and Components” on page 8-5
- “Link AUTOSAR Components to Simulink Requirements” on page 8-12
- “Configure AUTOSAR Scheduling and Simulation” on page 8-25
- “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38
- “Configure AUTOSAR Ports By Using Simulink Bus Ports” on page 4-219
- “Import AUTOSAR Software Component” on page 3-19
- “Control AUTOSAR Variants with Predefined Value Combinations” on page 4-277

Configure AUTOSAR Scheduling and Simulation

To configure scheduling and simulation for an AUTOSAR architecture model, you can:

- Add Basic Software (BSW) blocks to simulate calls to BSW services.
- Create a test harness model to connect inputs and plant elements to the architecture model.
- Use the Schedule Editor to schedule and specify the execution order of component runnables for simulation.

To simulate the behavior of the aggregated components in an open architecture model, click **Run**.

In this section...

“Simulate Basic Software Service Calls” on page 8-25

“Connect a Test Harness” on page 8-26

“Schedule Component Runnables” on page 8-28

Simulate Basic Software Service Calls

For the AUTOSAR Classic Platform, AUTOSAR Blockset provides Basic Software (BSW) blocks, which allow you to model software component calls to BSW services that run in the AUTOSAR run-time environment. BSW services include NVRAM Manager (NvM) and Diagnostic Event Manager (Dem). In the run-time environment, AUTOSAR software components typically access BSW services using client-server or sender-receiver communication.

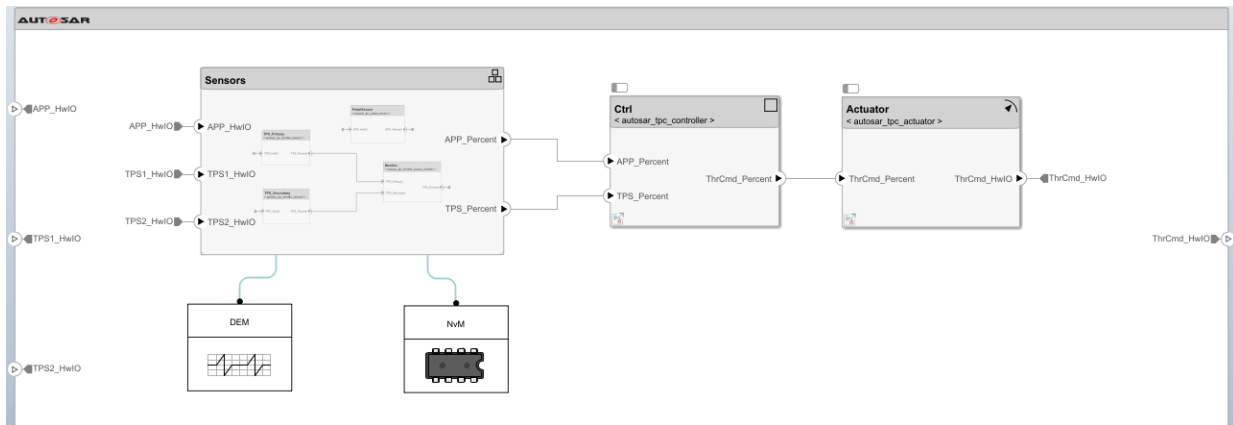
To simulate AUTOSAR components that call BSW services, you create a containing architecture, composition, or test harness model and add preconfigured BSW service component blocks. The blocks provide reference implementations of BSW service operations.

If the components in your architecture model use BSW caller blocks, make sure that the architecture model contains BSW service implementations. For more information, see “Model AUTOSAR Basic Software Service Calls” on page 7-13 and “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

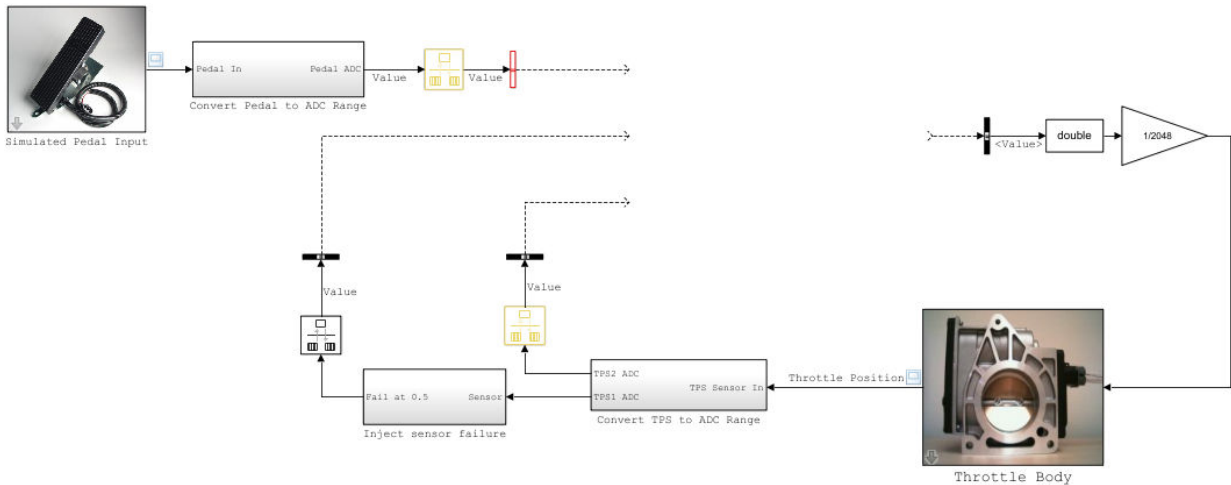
For an example of using BSW blocks in an AUTOSAR architecture model, see “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38.

Connect a Test Harness

After you develop an architecture model, you can connect it to a test harness model that provides meaningful input values and plant model elements. For example, consider the architecture model `autosar_tpc_composition` from example “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38. The model has three require (input) ports and one provide (output) port.



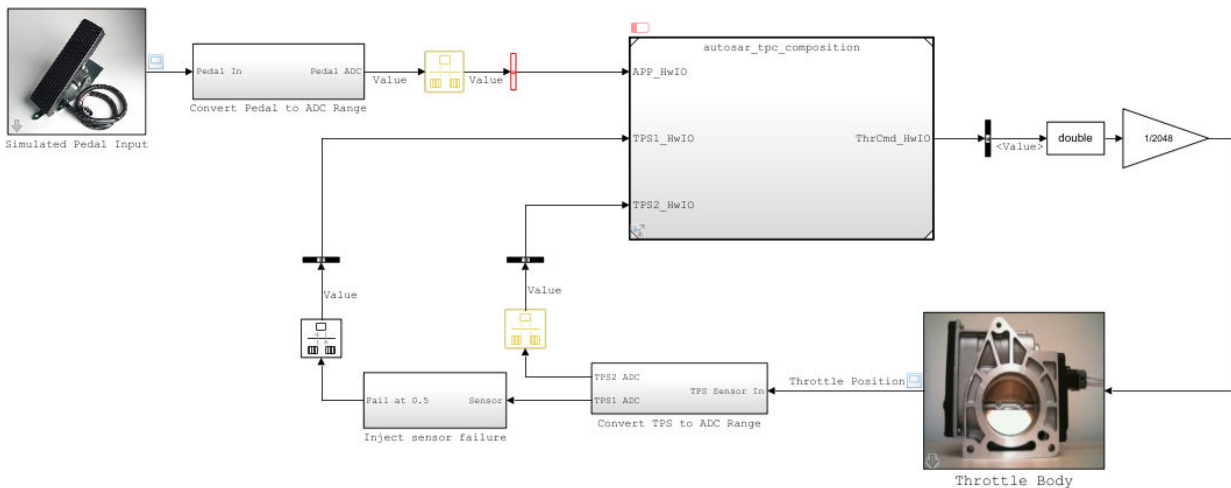
Here is a test harness model for simulating the architecture model `autosar_tpc_composition`. The test harness contains a plant model with a pedal input block and signals that correspond with the architecture model require and provide ports. This model was adapted from example model `autosar_tpc_system`.



To connect the architecture model to the test harness, insert a Model block, and configure the Model block to reference the architecture model.

In the Model block dialog box, select the option **Schedule rates**. For the associated parameter **Schedule rates with**, select **Schedule Editor**. The architecture model components have explicit partitions that you can schedule with the Schedule Editor.

Connect the architecture model ports to the test harness signals.



To view and run the completed test harness model, open example model `autosar_tpc_system`.

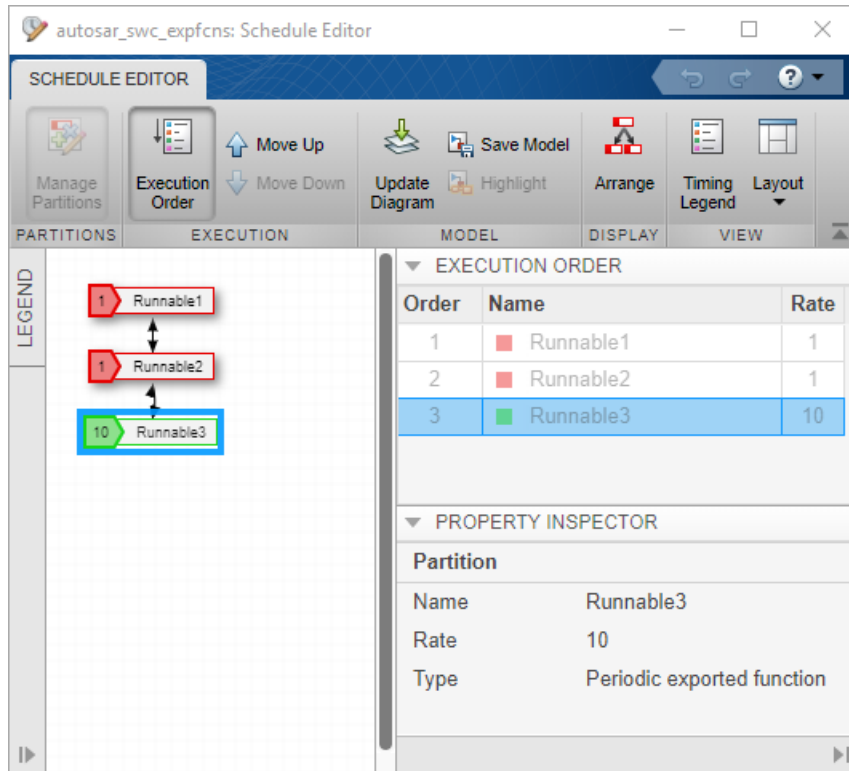
Schedule Component Runnables

To schedule and specify the execution order of AUTOSAR component runnables for simulation, use the Schedule Editor. In the Schedule Editor, you can:

- View a graphical representation of AUTOSAR component runnables as partitions.
- Directly specify the execution order of runnables.

You can open the Schedule Editor from a standalone component model or an architecture model.

In a standalone AUTOSAR component model, to open the Schedule Editor, open the **Modeling** tab and select **Design > Schedule Editor**. Depending on the modeling style of the component, the editor displays the implicit partitions (tasks) or explicit partitions in the model. You can use the editor controls to reorder the partitions or create new explicit partitions. For more information, see “Configure AUTOSAR Runnable Execution Order By Using Schedule Editor” on page 4-228.



In an AUTOSAR architecture model, to open the Schedule Editor, open the **Modeling** tab and select **Design Tools > Schedule Editor**. The editor displays partitions representing every component runnable in the composition hierarchy. Here is the execution order view when you open the Schedule Editor from the example architecture model `autosar_tpc_composition`. You can use the editor controls to modify the execution order of the runnables.

The screenshot displays the 'autosar_tpc_composition: Schedule Editor' window. The interface includes a toolbar with options like 'Manage Partitions', 'Execution Order', 'Move Up/Down', 'Update Diagram', 'Save Model', 'Highlight', 'Arrange', 'Timing Legend', and 'Layout'. The main workspace shows a task graph with nodes: 'D1' (rate 0.005), 'TPS_Primary.D1' (rate 0.005), 'TPS_Secondary.D1' (rate 0.005), 'PedalSensor.D1' (rate 0.005), 'Monitor.D1' (rate 0.005), 'Ctrl.D1' (rate 0.005), and 'Actuator.D1' (rate 0.005). Arrows indicate dependencies: D1 to TPS_Primary.D1 and TPS_Secondary.D1; TPS_Primary.D1 and TPS_Secondary.D1 to Monitor.D1; Monitor.D1 to Ctrl.D1; and Ctrl.D1 to Actuator.D1. A 'LEGEND' on the left shows '0.005 D1'. On the right, the 'EXECUTION ORDER' table lists the tasks in sequence.

Order	Name	Rate
1	D1 <i>implicit</i>	0.005
2	PedalSensor.D1	0.005
3	TPS_Primary.D1	0.005
4	TPS_Secondary.D1	0.005
5	Monitor.D1	0.005
6	Ctrl.D1	0.005
7	Actuator.D1	0.005

Below the table is the 'PROPERTY INSPECTOR' for the selected 'PedalSensor.D1' partition:

Partition	
Name	PedalSensor.D1
Rate	0.005
Type	Explicit periodic partition

For more information, see “Using the Schedule Editor” (Simulink).

See Also

Diagnostic Service Component | NVRAM Service Component | **Schedule Editor**

Related Examples

- “Create AUTOSAR Architecture Models” on page 8-2
- “Add and Connect AUTOSAR Compositions and Components” on page 8-5
- “Link AUTOSAR Components to Simulink Requirements” on page 8-12

- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14
- “Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38
- “Model AUTOSAR Basic Software Service Calls” on page 7-13
- “Design and Simulate AUTOSAR Components and Generate Code” on page 4-103
- “Configure AUTOSAR Runnable Execution Order By Using Schedule Editor” on page 4-228
- “Using the Schedule Editor” (Simulink)

Generate and Package AUTOSAR Composition XML Descriptions and Component Code

If you have Simulink Coder and Embedded Coder software, you can export composition and component AUTOSAR XML (arxml) descriptions and generate component code from an AUTOSAR architecture model. Optionally, you can create a zip file to package build artifacts for the model hierarchy, for example, for relocation and integration.

You can export an entire architecture model, a nested composition, or a single component. If you initiate an export that encompasses a composition, the export includes XML descriptions of the composition, component prototypes, and composition ports and connectors.

To prepare for exporting arxml files, you can examine and modify XML options. XML options specified at the architecture model level are inherited, during export, by each component in the model.

To export arxml files and generate code for an architecture model:

- 1 Open an architecture model, such as example model `autosar_tpc_composition`.
- 2 To examine XML options at the architecture model level, select the **Modeling** tab and select **Export > Configure XML Options**. The AUTOSAR Dictionary opens in the XML Options view. Modifications you make are inherited by every component in the hierarchy.

View and Edit XML Options

Package Paths

Component Package:

Datatype Package:

Interface Package:

Additional Packages

ApplicationDataType Package:

SwBaseType Package:

DataTypeMappingSet Package:

ConstantSpecification Package:

Physical DataConstraints Package:

SystemConstant Package:

SwAddressMethod Package:

ModeDeclarationGroup Package:

CompuMethod Package:

Unit Package:

SwRecordLayout Package:

Internal DataConstraints Package:

Additional Options

ImplementationDataType Reference:

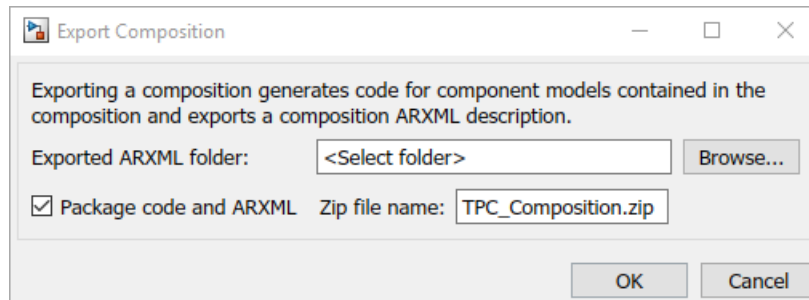
SwCalibrationAccess DefaultValue:

CompuMethod Direction:

Internal DataConstraints Export:

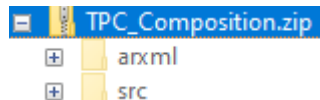
For more information, see “Configure AUTOSAR XML Options” on page 4-63.

- 3 To export the architecture model, in the **Modeling** tab, select **Export > Generate Code and ARXML**. In the Export Composition dialog box, specify the name of the zip file in which to package the generated files. Optionally, you can specify a path to a folder in which to place the exported arxml files. To begin the export, click **OK**.

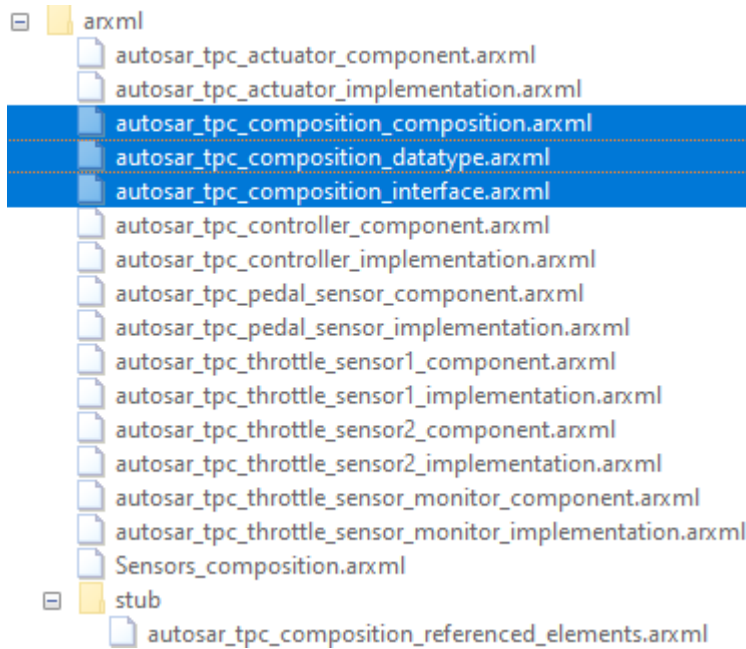


As the architecture model builds, you can view the build log in the Diagnostic Viewer. First the component models build, each as a standalone top-model build. Finally, composition arxml is exported. When the build is complete, the current folder contains build folders for the architecture model and each component model in the hierarchy, and the specified zip file.

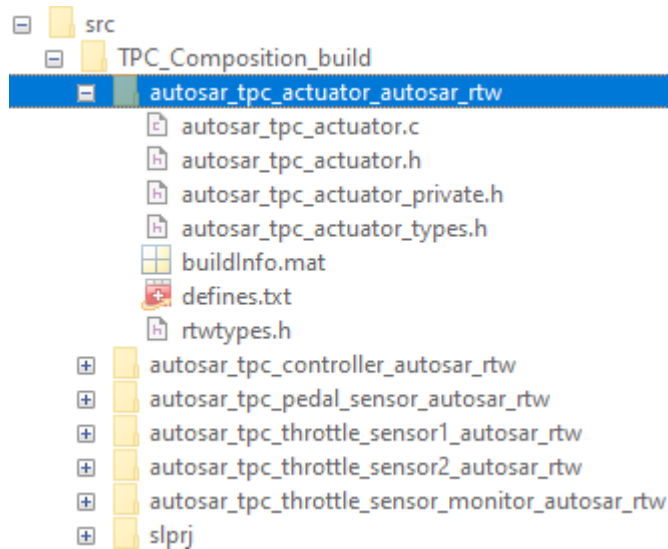
- 4 Expand the zip file. Its content is organized in arxml and src folders.



- 5 Examine the arxml folder. Notice that each AUTOSAR component has component and implementation description files, while the architecture model has composition, datatype, and interface description files. The datatype and interface files aggregate elements from the entire architecture model hierarchy.



- 6 Examine the src folder. Each component model has a build folder that contains artifacts from a standalone model build.



To export a nested composition or a single component in an architecture model, use composition or component block cues or right-click options. For example, right-click a component block and select **Export Component**. Components exported from an architecture model inherit the XML options specified at the architecture model level.

In an architecture model, for export, AUTOSAR schema versions must match between the architecture model and the component models in the hierarchy. If export flags a version difference, you can fix the discrepancy either in the component model or the architecture model. To view the architecture model schema version, open the Configuration Parameters dialog box. In the **Modeling** tab, select **Model Settings**. In the dialog box, navigate to the AUTOSAR code generation options pane.

To export all or part of an architecture model hierarchy programmatically, use the `autosar.api.export` function. For example, to generate and package arxml files and code for nested composition Sensors in `autosar_tpc_composition`:

```
open_system('autosar_tpc_composition');
autosar.api.export('autosar_tpc_composition/Sensors',...
    'PackageCodeAndARXML','SensorsComposition.zip');
```

See Also

Component | Composition | `autosar.api.export`

Related Examples

- “Create AUTOSAR Architecture Models” on page 8-2
- “Add and Connect AUTOSAR Compositions and Components” on page 8-5
- “Link AUTOSAR Components to Simulink Requirements” on page 8-12
- “Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14
- “Configure AUTOSAR Scheduling and Simulation” on page 8-25
- “Author AUTOSAR Compositions and Components in Architecture Model” on page 8-38
- “Generate AUTOSAR C Code and XML Descriptions” on page 5-2

Author AUTOSAR Compositions and Components in Architecture Model

Develop AUTOSAR compositions and components for the Classic Platform by using an architecture model.

An AUTOSAR architecture model provides resources and a canvas for developing AUTOSAR composition and component models. From the architecture model, you can:

- Add and connect AUTOSAR compositions and components.
- Link components to requirements (requires Simulink® Requirements).
- Define component behavior by creating, importing, or linking Simulink models.
- Configure scheduling and simulation.
- Export composition and component aXML descriptions and generate component code (requires Embedded Coder).

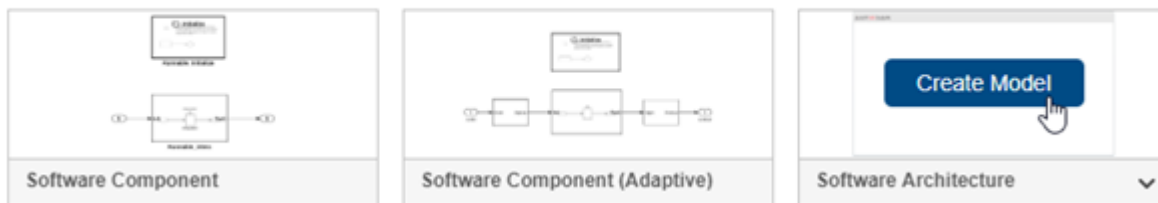
Architecture models provide an end-to-end, top-to-bottom AUTOSAR software design workflow. In Simulink, you can author a high-level application design, implement behavior for application components, add Basic Software (BSW) service calls and service implementations, and simulate the application.

Create Architecture Model

To begin developing AUTOSAR compositions and components in an architectural canvas, create an AUTOSAR architecture model (requires System Composer).

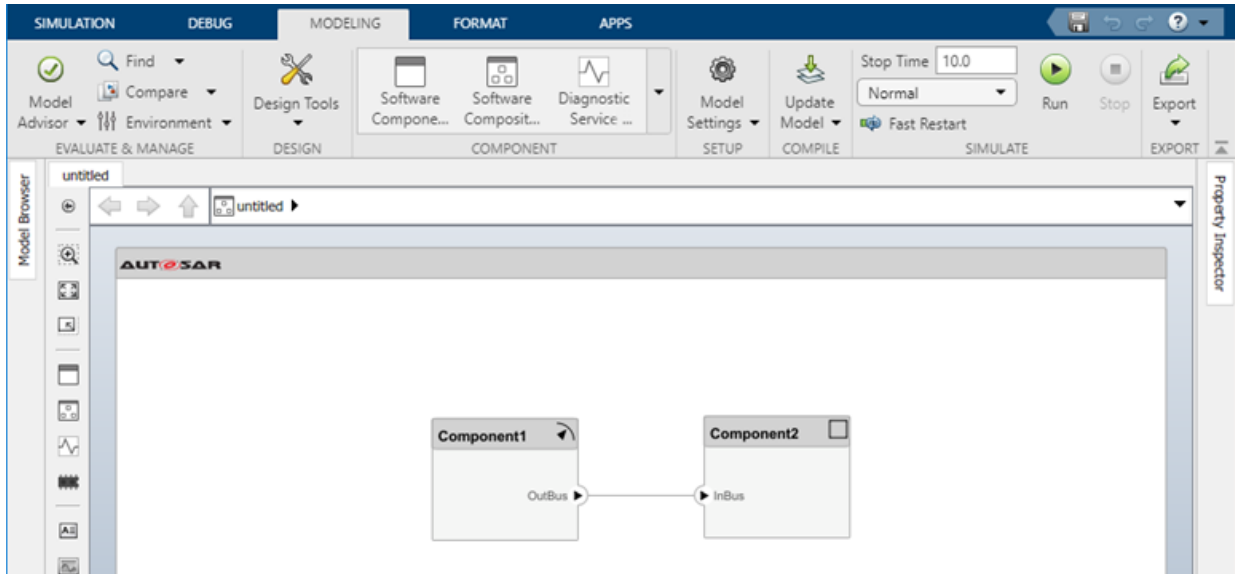
Open the Simulink Start Page by entering the MATLAB command `simulink`. On the **New** tab, scroll down to AUTOSAR Blockset and expand the list of model templates. Place your cursor over the **Software Architecture** template and click **Create Model**.

▼ AUTOSAR Blockset



A new AUTOSAR architecture model opens.

- In the Simulink Toolstrip, the **Modeling** tab supports common tasks for architecture modeling.
- To the left of the model window, the palette includes icons for adding different types of AUTOSAR components to the model: Software Component, Software Composition, and for Basic Software (BSW) modeling, Diagnostic Service Component and NVRAM Service Component.
- The composition editor provides a view of AUTOSAR software architecture based on the AUTOSAR Virtual Function Bus (VFB). The model canvas initially displays two connected software components.



Clear the default content from the window so that you can construct a new composition.

This example constructs a throttle position control application. Perform the steps in a new architecture model or refer to example model TPC_Composition, which shows the end result.

```
% Open example model autosar_tpc_composition for reference
open_system('autosar_tpc_composition.slx')
```

Add Compositions and Components and Link Implementation Models

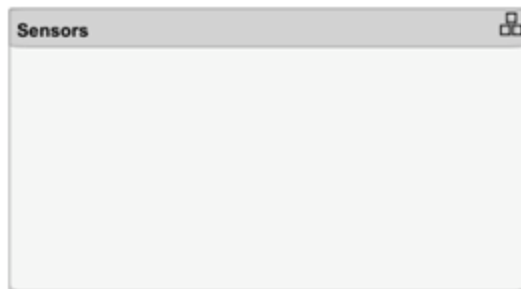
After you create an AUTOSAR architecture model, use the composition editor and the Simulink Toolstrip **Modeling** tab to add and connect compositions and components.

The behavior of the AUTOSAR application is defined by its AUTOSAR components, which you link to Simulink implementation models. For convenience, this example provides a Simulink implementation model for each AUTOSAR component:

- `autosar_tpc_throttle_sensor1.slx` for component `TPS_Primary`
- `autosar_tpc_throttle_sensor2.slx` for component `TPS_Secondary`
- `autosar_tpc_throttle_sensor_monitor.slx` for component `Monitor`
- `autosar_tpc_pedal_sensor.slx` for component `PedalSensor`
- `autosar_tpc_controller.slx` for component `Ctrl`
- `autosar_tpc_actuator.slx` for component `Actuator`

Four of the throttle position control components are sensor components, which this example places in a `Sensors` composition.

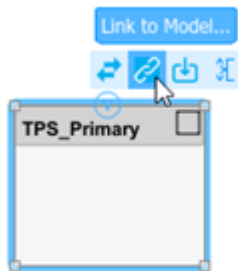
In your architecture model, to create a nested `Sensors` composition, add a `Composition` block. For example, on the **Modeling** tab, select **Software Composition** and insert a `Composition` block in the canvas. In the highlighted name field, enter `Sensors`.



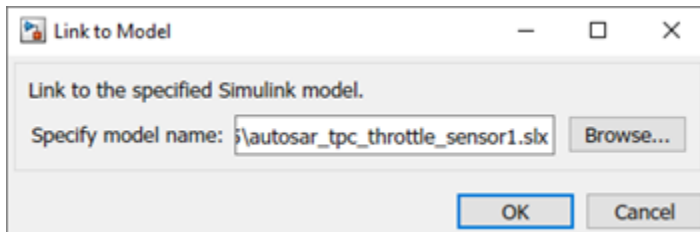
Open the `Sensors` block so that the model canvas shows the composition content. Inside the composition, add AUTOSAR components named `TPS_Primary`, `TPS_Secondary`, `Monitor`, and `PedalSensor`. For example, on the **Modeling** tab, you can select **Software Component** to create each one.



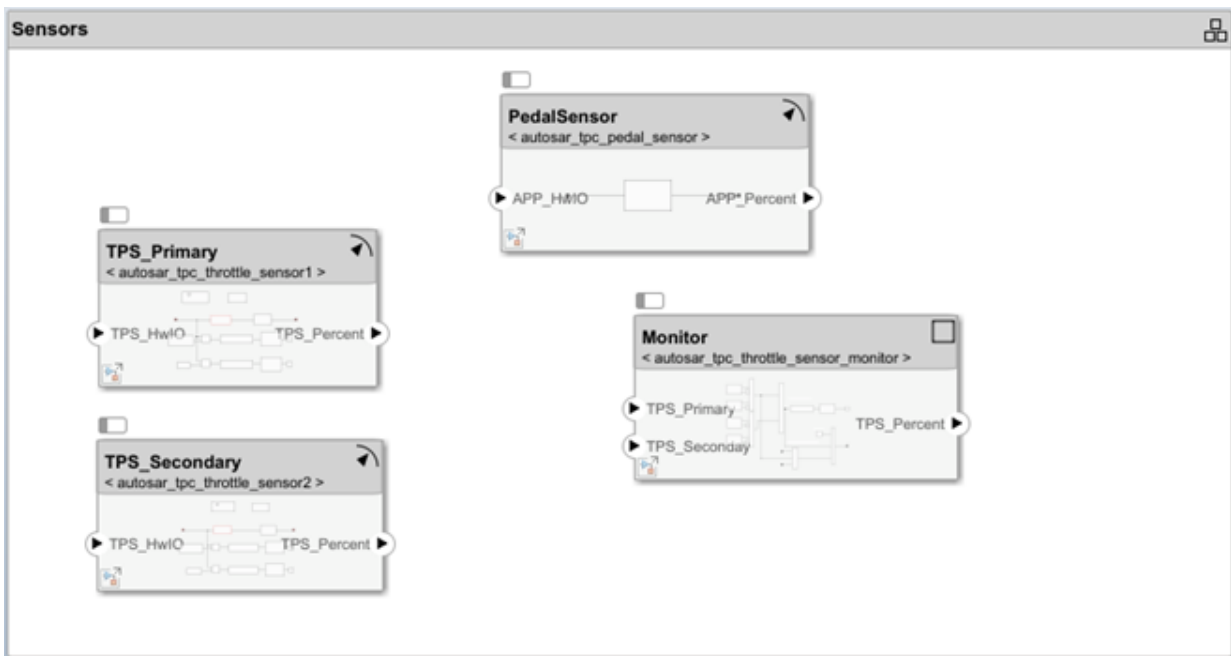
Next, link each AUTOSAR sensor component to a Simulink model that implements its behavior. For example, select the `TPS_Primary` component block, place your cursor over the displayed ellipsis, and select the cue **Link to Model**.



In the Link to Model dialog box, browse to the implementation model `autosar_tpc_throttle_sensor1.slx`.

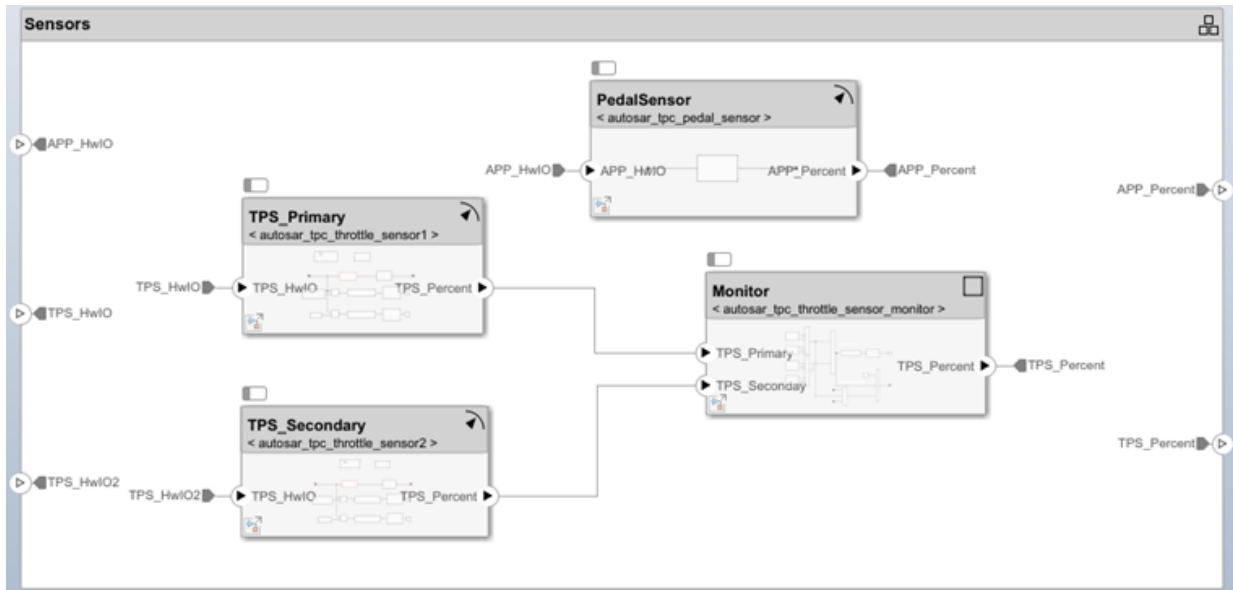


After you link each model, you can resize the associated component block to better display the component ports.

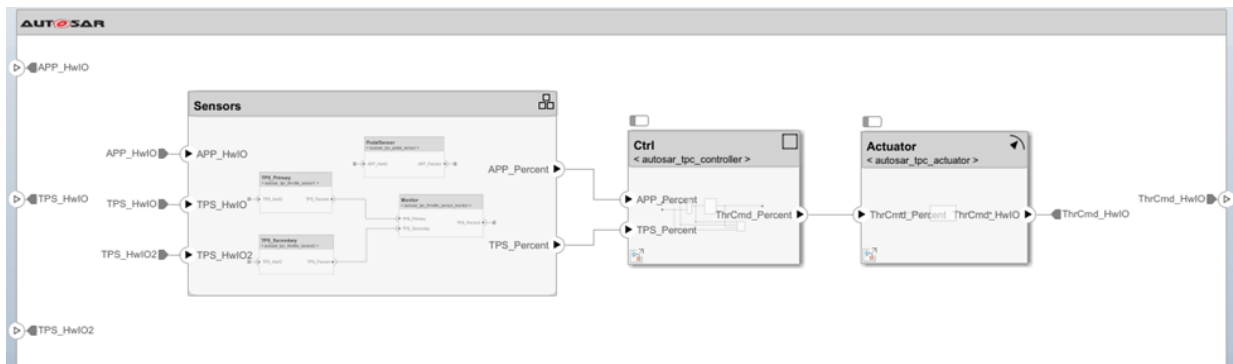


Connect the components to each other and to composition root ports.

- To interconnect components, drag a line from a component provider port to another component receiver port.
- To connect components to Sensors composition root ports, drag from a component port to the Sensors composition boundary.



Return to the top level of the architecture model. To complete the application, add two Component blocks and name them Ctrl and Actuator. Link the AUTOSAR components to their Simulink implementation models, `autosar_tpc_controller.slx` and `autosar_tpc_actuator.slx`. Connect the Sensors composition, Ctrl component, and Actuator component to each other and to the architecture model boundary.



To check for interface or data type issues, update the architecture model. On the **Modeling** tab, select **Update Model**. If any issues are found, compare your model with example model `autosar_tpc_composition.slx`.

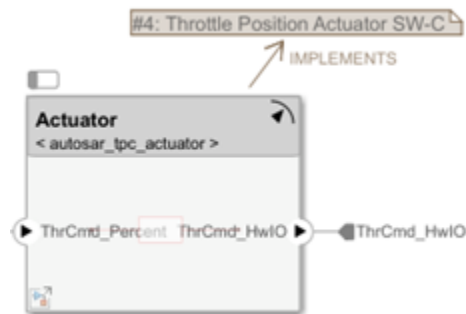
Save the model with a unique name, such as `myTPC_Composition.slx`.

Optional: Link Components to Requirements (Simulink Requirements)

If you have Simulink Requirements software, you can link components in the architecture model to Simulink requirements. The example folder provides sample requirements file `TPC_Requirements.slreqx`. The file contains requirements for four of the throttle position control application components.

To link a component to a requirement, open the **Requirements Manager** app. In the architecture model window, the **Requirements** tab opens, with the Requirements Browser docked at the bottom.

In the Requirements Browser, open requirements set `TPC_Requirements.slreqx`. To link an AUTOSAR component to a requirement, drag the requirement from the browser to the component block. For example, drag requirement 4 to the Actuator component block.



For more information, see “Link AUTOSAR Components to Simulink Requirements” on page 8-12.

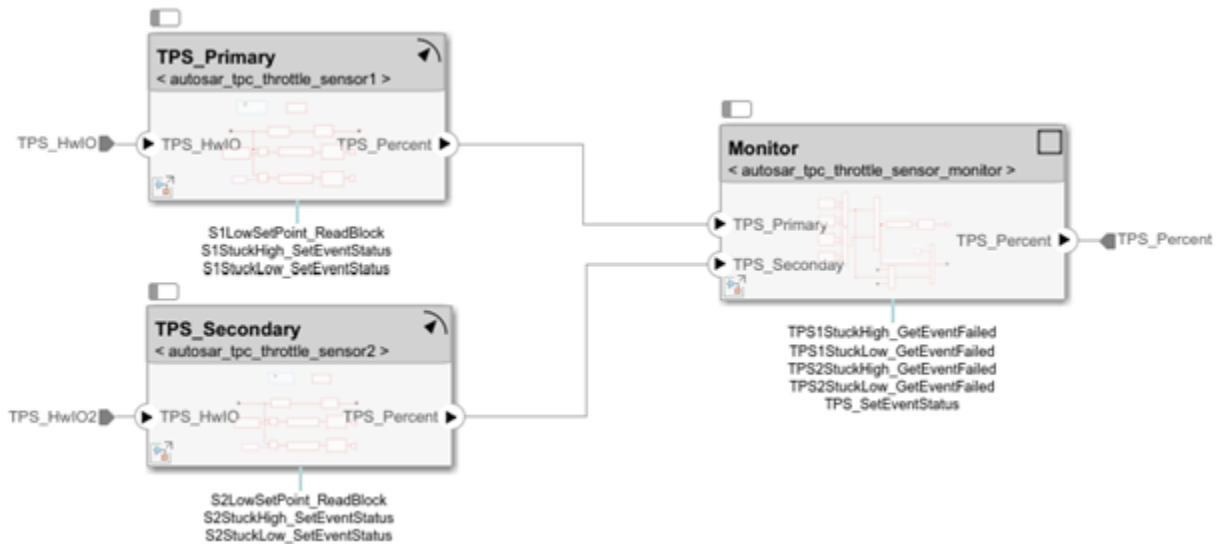
Configure and Run Simulation

To simulate the behavior of the aggregated components in an AUTOSAR architecture model, click **Run**.

If you try to run the architecture model constructed in this example, an error message reports that a function definition was not found for a Basic Software (BSW) function caller

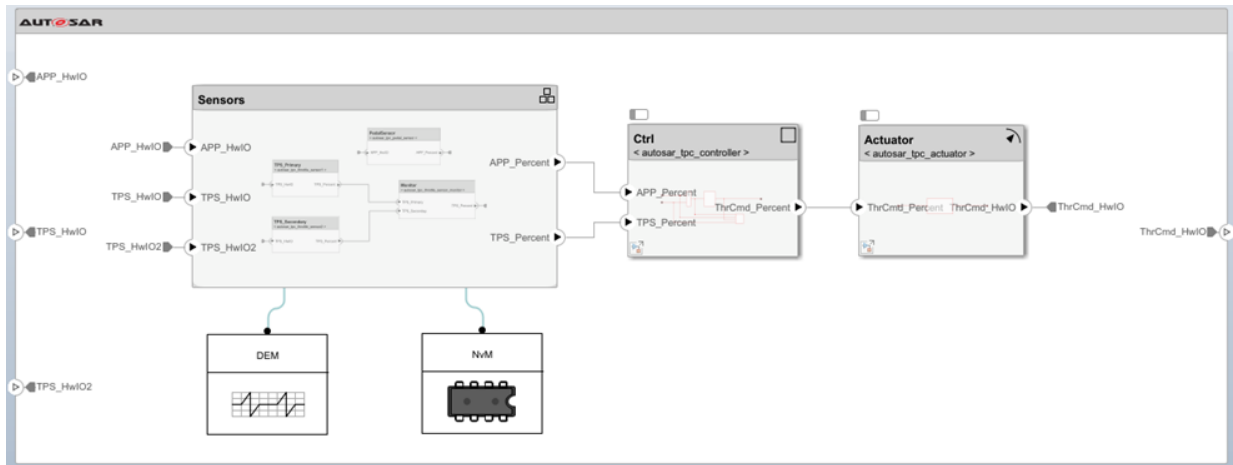
block. Three of the component implementation models contain BSW function calls that require BSW service implementations.

To view those function calls, open your architecture model, for example, `myTPC_Composition.slx`. On the **Debug** tab, select **Information Overlays > Function Connectors**. This selection lists function connectors for each model with functions. To see the models with BSW function calls, open the Sensors composition.



The models contain function calls to Diagnostic Event Manager (DEM) and NVRAM Manager (NvM) services. Before the application can be simulated, you must add Diagnostic and NVRAM Service Component blocks to the top model.

Return to the top level of the architecture model and select the **Modeling** tab. To add the service implementation blocks, select and place an instance of **Diagnostic Service Component** and an instance of **NVRAM Service Component**. To wire the function callers to the BSW service implementations, update the model.



After adding DEM and NvM service blocks to a model, check the mapping of the BSW function-caller client ports to BSW service IDs. DEM client ports map to DEM service event IDs and NvM client ports map to NvM service block IDs. For this example, update the DEM mapping. Open the DEM block dialog box, select the **RTE** tab, and enter the event ID values shown. Click **OK**. For more information about BSW ID mapping, see “Simulate AUTOSAR Basic Software Services and Run-Time Environment” on page 7-34.

Diagnostic Service Component

Configure AUTOSAR Diagnostic Services and Runtime Environment (RTE) for emulation.

RTE Dem

Update diagram to refresh table.

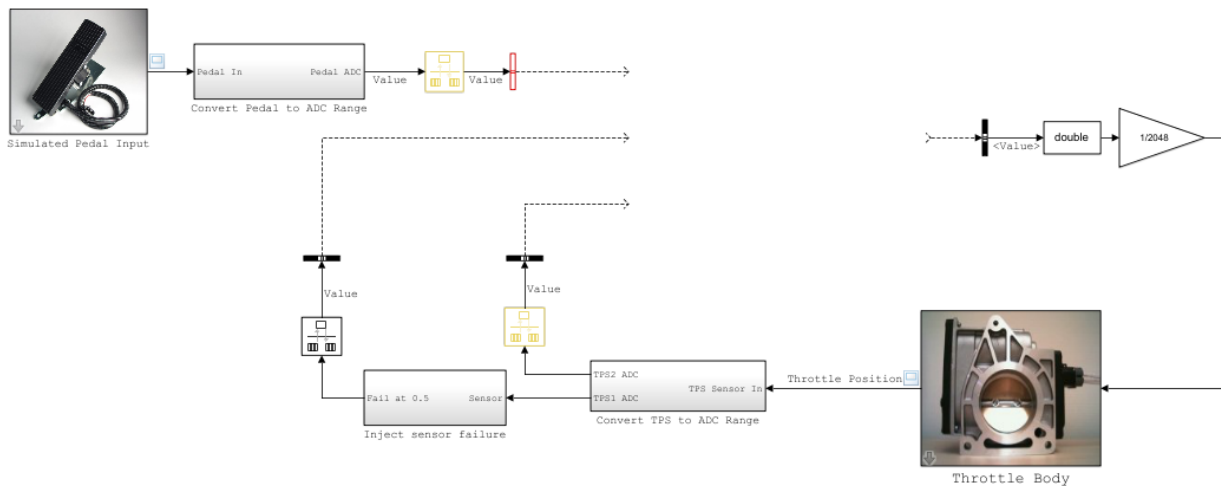
Filter contents

Client Port	ID	ID Type
S1StuckHigh	1	
S1StuckLow	2	
S2StuckHigh	3	
S2StuckLow	4	
TPS	5	
TPS1StuckHigh	1	
TPS1StuckLow	2	
TPS2StuckHigh	3	
TPS2StuckLow	4	

The architecture model is now ready to be simulated. Click **Run**.

Connect Architecture Model to Test Harness Containing Plant Model and Pedal Input

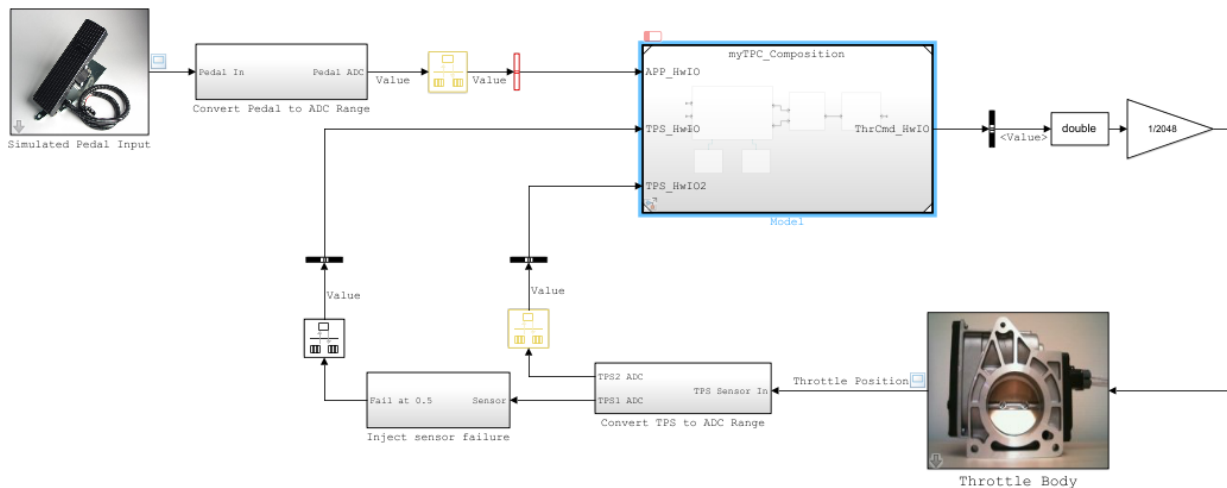
To provide simulated pedal input to the throttle position control simulation, you can place the architecture model in a test harness model. The test harness can provide a plant model with a pedal input block. Refer to example test-harness model `autosar_tpc_system.slx`.



To add the architecture model to the test harness, insert a Model block, and configure the Model block to reference your architecture model, for example, `myTPC_Composition.slx`.

In the Model block dialog box, select the option **Schedule rates**. For the associated parameter **Schedule rates with**, select **Schedule Editor**. The throttle position control components have explicit partitions that you can schedule with the Schedule Editor.

Connect the architecture model ports to the test harness signals.



The test harness model is now ready to be simulated. Click **Run**. When you simulate the application, the throttle position scope indicates how well the throttle-position control algorithms in the architecture model are tracking the accelerator pedal input.

In a test harness model, from the Model block for a referenced AUTOSAR architecture model, you can use the Schedule Editor to schedule rates for component runnables. To open the Schedule Editor, click the Schedule Editor badge immediately above the Model block. In the Schedule Editor display, you can visualize and control the order of execution of the runnables (partitions) in the application components. For more information, see “Using the Schedule Editor” (Simulink), “Configure AUTOSAR Runnable Execution Order By Using Schedule Editor” on page 4-228, and “Configure AUTOSAR Scheduling and Simulation” on page 8-25.

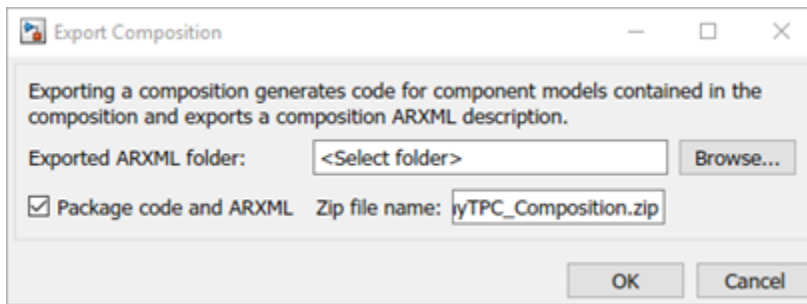
Generate and Package Composition ARXML Descriptions and Component Code (Embedded Coder)

If you have Simulink Coder and Embedded Coder software, you can export composition and component AUTOSAR XML (`arxml`) files and generate component code from an AUTOSAR architecture model. Optionally, you can create a zip file to package build artifacts for the model hierarchy, for example, for relocation and integration.

Open the architecture model constructed in this example or open example model `autosar_tpc_composition.slx`.

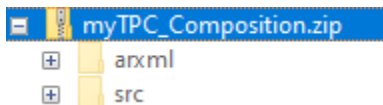
Optionally, to prepare for exporting arxml, you can examine and modify XML options. On the **Modeling** tab, select **Export > Configure XML Options**. XML options specified at the architecture model level are inherited during export by each component in the model.

To generate and package code for the throttle position control application, on the **Modeling** tab, select **Export > Generate Code and ARXML**. In the Export Composition dialog box, specify the name of the zip file in which to package the generated files. To begin the export, click **OK**.

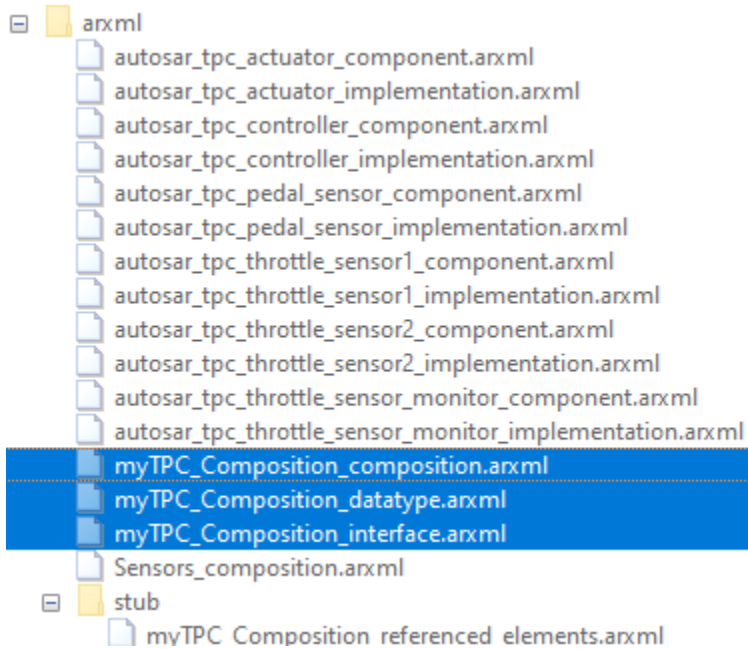


As the architecture model builds, you can view the build log in the Diagnostic Viewer. First the component models build, each as a standalone top-model build. Finally, composition arxml is exported. When the build is complete, the current folder contains build folders for the architecture model and each component model in the hierarchy, and the specified zip file.

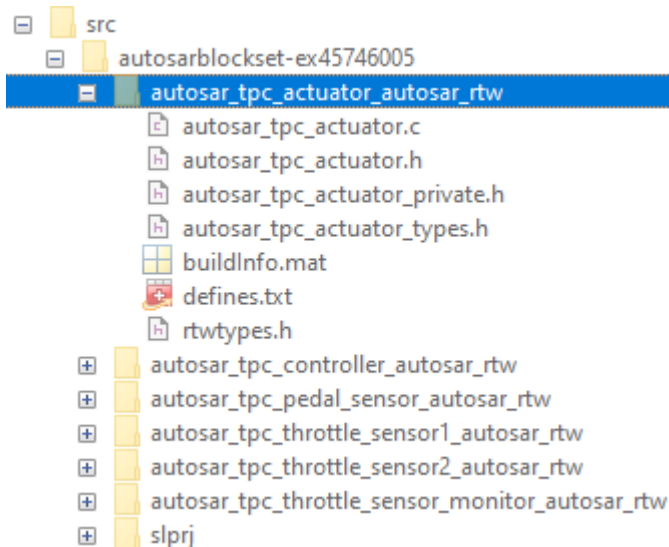
Expand the zip file. Its content is organized in arxml and src folders.



Examine the arxml folder. Each AUTOSAR component has component and implementation description files, while the architecture model has composition, datatype, and interface description files. The composition file includes XML descriptions of the composition, component prototypes, and composition ports and connectors. The datatype and interface files aggregate elements from the entire architecture model hierarchy.



Examine the src folder. Each component model has a build folder that contains artifacts from a standalone model build.



Related Links

- [Component](#)
- [Composition](#)
- [Diagnostic Service Component](#)
- [NVRAM Service Component](#)
- [“Create AUTOSAR Architecture Models” on page 8-2](#)
- [“Add and Connect AUTOSAR Compositions and Components” on page 8-5](#)
- [“Link AUTOSAR Components to Simulink Requirements” on page 8-12](#)
- [“Define AUTOSAR Component Behavior by Creating or Linking Models” on page 8-14](#)
- [“Configure AUTOSAR Scheduling and Simulation” on page 8-25](#)
- [“Generate and Package AUTOSAR Composition XML Descriptions and Component Code” on page 8-32](#)