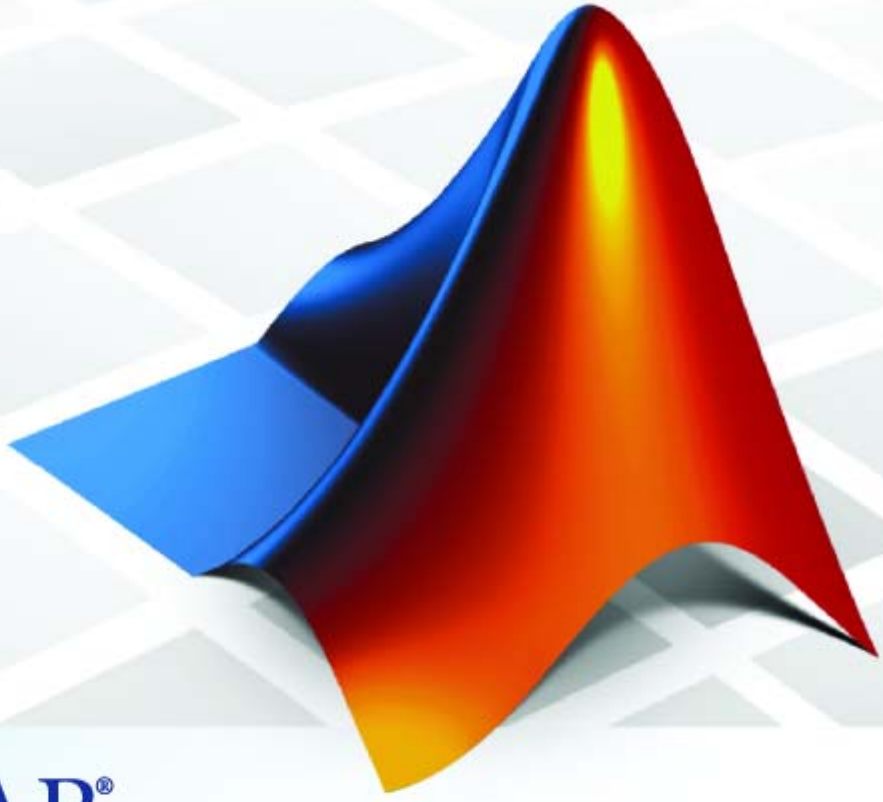
Link for TASKING® 1
User's Guide



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Link for TASKING User's Guide

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Getting Started

What Is Link for TASKING?

Link for TASKING lets you build, test, and verify automatically generated code using MATLAB®, Simulink®, Real-Time Workshop®, and the TASKING integrated development environment. Link for TASKING makes it easy to verify code executing within the TASKING environment using a test harness model in Simulink. This processor-in-the-loop testing environment uses code automatically generated from Simulink models by Real-Time Workshop Embedded Coder. A wide range of DSPs and 8-, 16- and 32-bit microprocessors and microcontrollers are supported including devices from Infineon, Renesas, and Freescale. Link for TASKING provides customizable templates for configuring hardware variants, automating MISRA C code checking, and controlling the build process.

With Link for TASKING, you can use MATLAB and Simulink to interactively analyze, profile and debug target-specific code execution behavior within TASKING. In this way, Link for TASKING automates deployment of the complete embedded software application and makes it easy for you to assess possible differences between the model simulation and target code execution results.

Link for TASKING consists of a Project Generator component, an Automation Interface component, and features for code verification and optimization. The following sections summarize these components and features:

- "Project Generator" on page 1-2
- "Automation Interface" on page 1-3
- "Verification" on page 1-4
- "Optimization" on page 1-4

Project Generator

- Automated project-based build process

  Automatically create and build projects for code generated by Real-Time Workshop or Real-Time Workshop Embedded Coder.

- Highly customizable code generation

Use Link for TASKING with any Real-Time Workshop System Target File (STF) to generate target-specific and optimized code.

- Highly customizable build process

  Support for multiple TASKING Toolsets provides a route to a large number of different target hardware platforms. Further customization is possible by using custom project templates, giving access to all options supported by the TASKING Toolset.

- Automated download and debugging

  Rapidly and effortlessly debug generated code in the CrossView Pro debugger, using either the instruction set simulator or real hardware.

Automation Interface

- MATLAB API for TASKING EDE (IDE)

  Automate complex tasks in the TASKING EDE by writing MATLAB scripts to communicate with the EDE.

  For example, you could

  - Automate project creation, including adding source files, include paths, and preprocessor defines.
  - Configure batch building of projects.
  - Launch a debugging session.
  - Execute CodeWright API Library commands.

- MATLAB API for TASKING CrossView Pro (Debugger)

  Automate complex tasks in the TASKING CrossView Pro debugger by writing MATLAB scripts to communicate with CrossView Pro, or debug and analyze interactively in a live MATLAB session.

  For example, you could

  - Automate debugging by executing commands from the powerful CrossView Pro command language.
  - Exchange data between MATLAB and the target running in CrossView Pro.

- Set breakpoints, step through code, set parameters and retrieve profiling reports

Verification

- Processor-in-the-loop (PIL) cosimulation

  Use cosimulation techniques to verify generated code running in an instruction set simulator or real target environment.

- C Code Coverage

  Use C code instruction coverage metrics from the CrossView Pro instruction set simulator during PIL cosimulation to refine test cases.

- Execution Profiling

  Use execution profiling metrics from the CrossView Pro instruction set simulator during PIL cosimulation to establish the timing requirements of your algorithm.

- Stack Profiling

  Use stack profiling metrics for PIL cosimulation or real-time applications to verify the amount of memory allocated for stack usage is sufficient.

- Bi-Directional Traceability Between Model and Code

  Navigate to the generated code for a given Simulink block or, vice versa, to the Simulink block corresponding to a section of generated code.

- MISRA Checker

  Use the TASKING compiler generated MISRA report to check for an appropriate level of MISRA compliance for your application.

Optimization

- Compiler / Linker Optimization Settings

  Use Template Projects to fully control compiler and linker optimization settings.

- Target Memory Placement / Mapping

  Use Template Projects to fully configure the target memory map.

- Execution Profiling

  Use execution profiling metrics from the CrossView Pro instruction set simulator during PIL cosimulation to guide optimization of your algorithms.

- Stack Profiling

  Use stack profiling metrics for PIL cosimulation or real-time applications to optimize the amount of stack memory required for an application.

- Target Optimized FIR / FFT Blocks for the Infineon TriCore

  Use example FIR / FFT blocks that call target optimized Infineon TriLib routines. These blocks can be over a hundred times faster than the regular blocks in the Signal Processing Blockset. Additionally, create your own optimized blocks to provide more functionality.

Supported TASKING Toolsets

Link for TASKING includes at least one reference template project for each supported toolset. The reference projects were created for specific versions of each TASKING toolset and were used by The MathWorks for qualification testing. The supported toolset versions are:

- Infineon TriCore: TASKING C/C++, CrossView Pro SIM for TriCore v2.4r1 patch 1
- Infineon C166: TASKING Tools for C166/ST10 v8.6 r2
- Renesas M16C: TASKING Tools for M16C v3.1 r1 patch 2
- ARM: TASKING C Compiler for ARM v1.1r1
- Freescale DSP563xx: TASKING Tools for DSP563xx v3.5 r3 patch 2
- 8051: TASKING Tools for 8051 v7.1 r3

The Renesas R8C family is supported by the Renesas M16C TASKING Toolset.

The Freescale DSP566xx Family is supported by the Freescale DSP563xx Toolset.

Support for Other Versions

Check the Link for TASKING Product Support page for patches and additional toolchain version information.

For minor release increments it may be sufficient to create new default template projects. To do this, you must first specify the location of your TASKING toolset in the Target Preferences (see “Setting Target Preferences” on page 1-9) then run the `tasking_generate_templates` command. You must specify your configuration description string, e.g.:

```
tasking_generate_templates('C166', true)
```

or

```
tasking_generate_templates('TriCore', true)
```

Note Make sure you check the Link for TASKING Product Support page for the latest information about toolchains qualified with Link for TASKING. You may be able to obtain patches in order to use other toolsets.

Using This Guide

To get started with Link for TASKING:

1. Follow the instructions in “Setting Target Preferences” on page 1-9.
2. After you set target preferences, follow the instructions in “Working with Configuration Sets” on page 1-15 to see how to set up configurations using an example model.
3. Try the demos to gain experience using Link for TASKING. Access the demos in one of these ways:
   - Click the link: “Link for TASKING Demos.”
   - Select **Start > Simulink > Link for TASKING > Demos**.
   - Enter `demo('simulink', 'link for tasking')` at the MATLAB command line.
4. See “Link for TASKING Menus” on page 1-26 for a quick guide to the functionality available in the menus, with links to more information.

See the following chapters to learn about Link for TASKING features:

- Chapter 2, “Components” explains the Link for TASKING components: the Project Generator build process, and the Automation Interface objects .
- Chapter 3, “Verification” describes how to use PIL cosimulation and other Link for TASKING features for verification.
- Chapter 4, “Optimization” describes how to use Link for TASKING features for optimization.
- Chapter 5, “Tutorials” contains instructions to show you how to create new configurations and template projects, how to use Link for TASKING with existing models, and how to use different build actions.

Setting Target Preferences

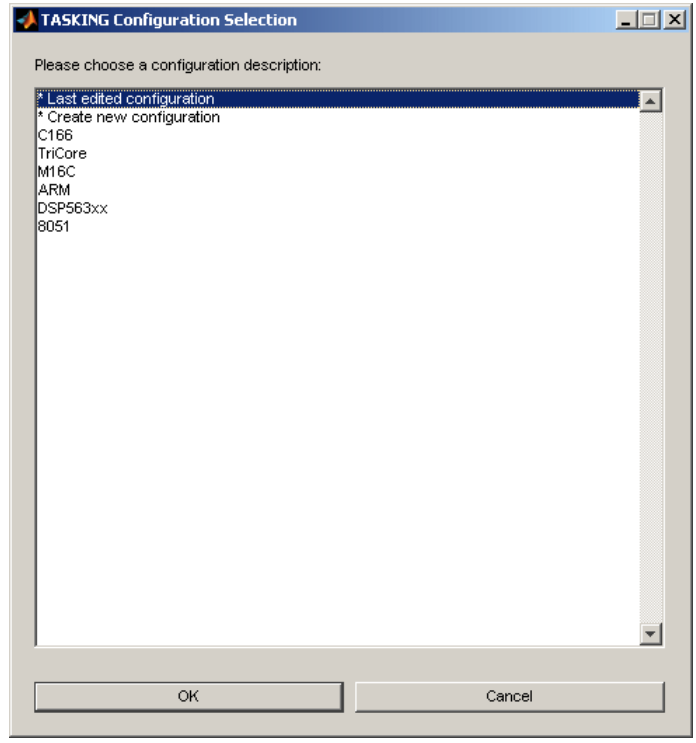
You must configure your target preferences to use Link for TASKING.

Note Target preferences are persistent across MATLAB sessions. If you have used a previous version of Link for TASKING, click **Reset to Default** before setting up your new preferences, to ensure you use the latest values for all fields.

---

1 Select **Start > Simulink > Link for TASKING > TASKING Target Preferences**, or enter `tasking_edit_prefs`.

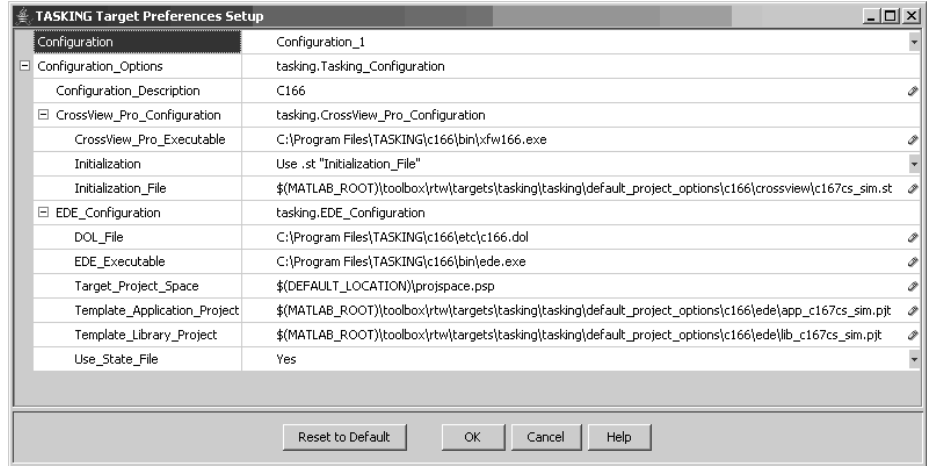
The TASKING Configuration Selection dialog box appears.



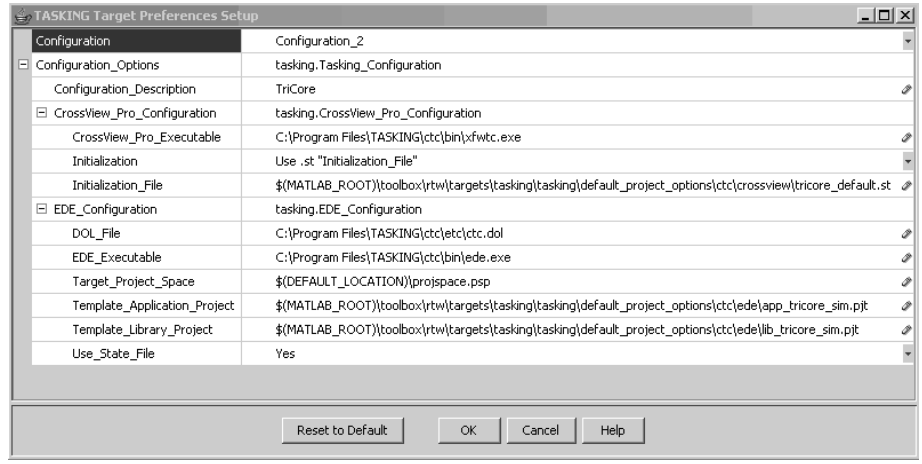
2 Select a predefined configuration from the list that matches your target, or select `Create new configuration` to create a new configuration, and click **OK**. For new configurations, see the tutorial section "Tutorial: Creating a New Configuration" on page 5-6.

The TASKING Target Preferences Setup dialog box appears. You can use this dialog box to configure the location of your toolchain executable and other files.

3 Click the plus to expand `Configuration Options`. Similarly, expand `CrossView_Pro_Configuration` and `EDE_Configuration`, as shown in the example. This example is set up for the Infineon C166 Simulator configuration.



4 Replace the string `<ENTER_TASKING_PATH>` to complete the path to the `CrossView_Pro_Executable`, the `DOL_File`, and the `EDE_Executable`. See the next section, "Target Preference Fields" on page 1-11, for details on each field. The following example is set up for the Infineon TriCore Simulator configuration.



If you have multiple configurations, you have to set them up in your target preferences only once, and then it is simple to switch between them. See the tutorial example “Working with Configuration Sets” on page 1-15.

5 Click **OK** to dismiss the TASKING Target Preferences Setup dialog box.

The next section explains each target preference field.

Target Preference Fields

Open the Target Preference Setup dialog box by selecting **Start > Simulink > Link for TASKING > TASKING Target Preferences**, or enter `tasking_edit_prefs`.

- `Configuration`

  Select a configuration from the drop-down list. There are preconfigured configurations for

  - C166
  - TriCore
  - M16C
  - ARM
  - DSP563xx

- 8051

If you have multiple configurations, you have to set them up in your target preferences only once, and then it is simple to switch between them. You can switch between them using this target preference field.

Select a free configuration number to set up a new configuration from scratch. See "Tutorial: Creating a New Configuration" on page 5-6.

- `Configuration_Description`

  The title of the configuration. After it is created, this title is the name that appears in the TASKING Configuration Description drop-down list in the Configuration Parameters dialog box. Edit this field to change the name of the configuration. These names are predefined for the preconfigured configurations. For a new configuration enter a descriptive name (do not include spaces).

- `CrossView_Pro_Executable`

  Enter the full path to your TASKING CrossView Pro installation to replace the string `<ENTER_TASKING_PATH>`. For example, for `Configuration_1` for Infineon C166 Simulator:

  ```
  D:\Applications\TASKING\c166\bin\xfw166.exe
  ```

- `Initialization`

  This setting determines what the CrossView Pro Debugger executes when it first starts. There are three options.

  - `Use .st Initialization_File` This option is the default setting. "`.st`" files are in an internal file format used by The MathWorks to provide initialization options to CrossView Pro during debugger start up. For example, a `.st` file may specify a CrossView Pro configuration file (`.cfg`) and target type for CrossView Pro to use. Each of the option sets shipped with Link for TASKING specifies a corresponding `.st` file. For example, the `c166_sim` option set specifies the `c166_default.st` file, which includes basic initialization commands for the C166 CrossView Pro Simulator. See "Option Sets" on page 1-30 for related information. To customize your CrossView Pro configuration, you should use one of the `.ini` initialization options.

  - `Use .ini Initialization_File` Use this option if you have a custom `.ini` initialization file. The file should be a valid CrossView Pro

initialization file for your custom configuration. Refer to your CrossView Pro application documentation for details.

- `Use CrossView Pro Default .ini File` Use this option if you want to run CrossView Pro Default `.ini` file when launching the CrossView Pro Debugger. When launching CrossView Pro you may be prompted to make configuration selections. Refer to your CrossView Pro application documentation to find the location of this `.ini` file, and for details of CrossView Pro initialization files.

- `Initialization_File`

  Full path of the initialization file corresponding to the `Initialization` field.

- `DOL_File`

  The full path to the TASKING EDE DOL file. For example, the Infineon_C166_Simulator Configuration has the `<ENTER_TASKING PATH>_\etc\c166.dol` as the dol file. You need to replace `<ENTER_TASKING_PATH>` with your real TASKING installation path.

- `EDE_Executable`

  Enter the full path to your TASKING EDE installation to replace the string `<ENTER_TASKING_PATH>`. For example, for `Configuration_1` for Infineon C166 Simulator, enter

  ```
  D:\Applications\TASKING\c166\bin\ede.exe
  ```

- `Target_Project_Space`

  When you build models, new projects in the TASKING EDE will be created. These projects belong to the project space defined in this entry. The default setting is `$(DEFAULT_LOCATION)\projspace.psp`. The code generation process expands the `$(DEFAULT_LOCATION)` token based on the build directory of the model, the model name, and model configuration settings, including the name of the template application project. It is advisable to avoid changing this default setting.

- `Template_Application_Project`

  When you build a Simulink model with Link for TASKING, the generated projects for your application in the TASKING EDE have the same project settings as the template application project. This template project provides a centric place to manage the project options (e.g., compiler settings, linker

settings, etc.) your Simulink models use during code generation. You can modify the project settings of the default template projects or create new ones. See “Link for TASKING Menus” on page 1-26 for information on creating or opening template projects, and see “Template Projects” on page 2-4.

- `Template_Library_Project`

  The same as the `Template_Application_Project` field, but this is applicable for Library projects.

- `Use_State_File`

  Opens the TASKING EDE in its last saved state. For more information, refer to your TASKING EDE documentation.

Working with Configuration Sets

The following sections explain how to add and use the Link for TASKING configuration set component:

See also "Configuration Sets" in the Simulink documentation for more information.

Adding the Link for TASKING Configuration Set Component

To add Link for TASKING configuration options to a model, select the menu item **Tools > Link for TASKING > Add Link for TASKING Configuration to Model**.

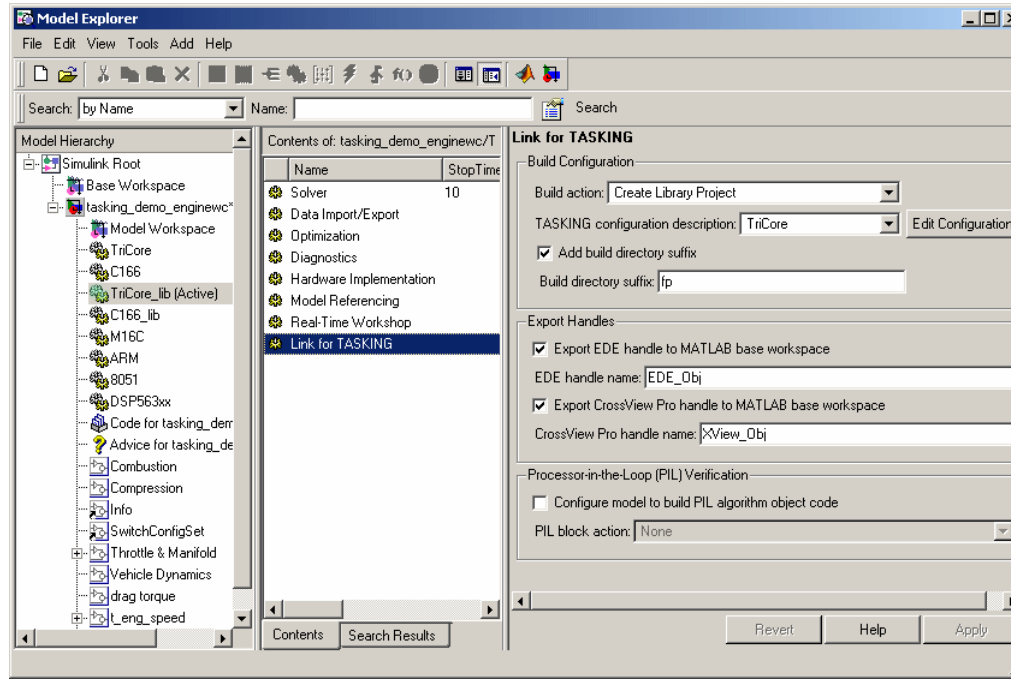
Similarly you can use the menu item **Remove Link for TASKING Configuration from Model** to remove the configuration set component.

Link for TASKING Configuration Set Options

To see Link for TASKING configuration options, navigate to the configuration parameters by any of the following paths:

- **Simulation > Configuration Parameters** in a model
- **Tools > Link for TASKING > Options** in a model
- **View > Model Explorer** in a model
- **Start > Simulink > Link for TASKING > View, Modify and Copy Configuration Sets via Model Explorer** in MATLAB

Click Link for TASKING to see the following options.



The following options are available under **Build Configuration**:

- **Build action**

  Set what action to take after the Real-Time Workshop build process. You can create application and library projects in the TASKING EDE and then stop, or you can also choose to build, execute, or debug. See “Setting Build Action” on page 1-22 for more details.

- **TASKING configuration description**

  Select target preference configurations. The names correspond to the `Configuration Description` for each configuration in the TASKING Target Preferences Setup dialog box. Click **Edit Configuration** to open the TASKING Target Preferences Setup dialog box for the currently selected configuration. See “Using Configuration Sets to Specify Your Target” on page 1-18.

- **Add build subdirectory suffix**

Select the check box to specify a model-specific suffix to be added the regular Real-Time Workshop build directory suffix. This setting is useful to avoid "shared utility function" code generation errors which occur because of conflicts over Real-Time Workshop utility functions shared between different models.

Clear this check box to use the default Real-Time Workshop build directory suffix — not using an additional suffix may result in rebuilding shared libraries unnecessarily. See "Shared Libraries" on page 2-6 and particularly "Supporting Multiple Shared Utility Function Locations: Build Directory Suffix" on page 2-7 for details.

- **Build subdirectory suffix**

  Enter in the edit box a model-specific suffix to be added the regular Real-Time Workshop build directory suffix.

The following options are available under **Export Handles**:

- **Export EDE handle to MATLAB base workspace**

  Select this check box to export the EDE object handle to the workspace.

- **EDE handle name**

  Enter a MATLAB variable name for the exported handle.

- **Export CrossView Pro handle to MATLAB base workspace**

  Select this check box to export the CrossView Pro object handle to the workspace.

- **CrossView Pro handle name**

  Enter a MATLAB variable name for the exported handle.

See "Automation Interface" on page 2-13 for information on using these object handles.

The following options are available under **Processor-in-the-Loop (PIL) Verification**:

- **Configure model to build PIL algorithm object code**

  Select this box to build PIL algorithm code.

- **PIL block action**

  Select one of the following PIL block actions

  - `Create PIL block, then build and download PIL application`

    Select this option to automatically build and download the PIL application after creating the PIL block. This is the default when you select the option to configure the model for PIL.

  - `Create PIL block`

    Choose this to create the PIL block and then stop without building. You can build manually from the PIL block.

  - `None`

    Choose this to avoid creating a PIL block, for instance if you have already built a PIL block and do not want to repeat the action.

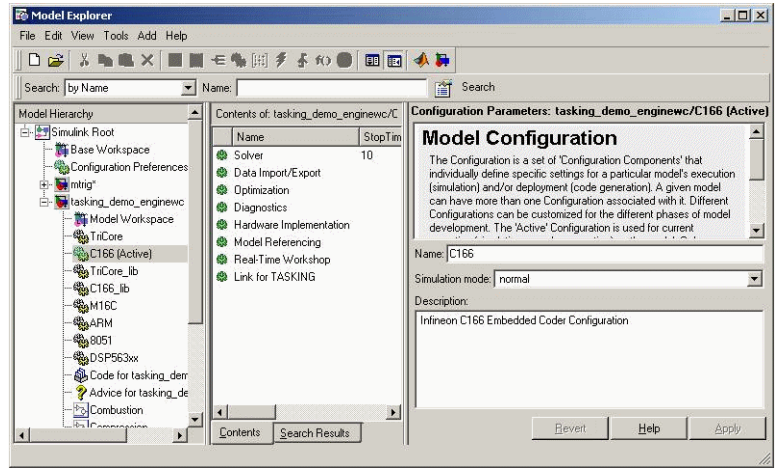
    See "Processor-in-the-Loop (PIL) Cosimulation" on page 3-2 for more information on using PIL settings.

Using Configuration Sets to Specify Your Target

Follow the steps in this example to see where to find and change Link for TASKING settings. These steps are described to help you find the settings you need to get started using the demo models. To use the demos, you need to specify your target by working with configuration sets.

This example describes how to use Link for TASKING to build a project from a demo model using two different toolchains. The instructions refer to C166 and TriCore TASKING toolchains; adapt the instructions to your toolchain as appropriate.

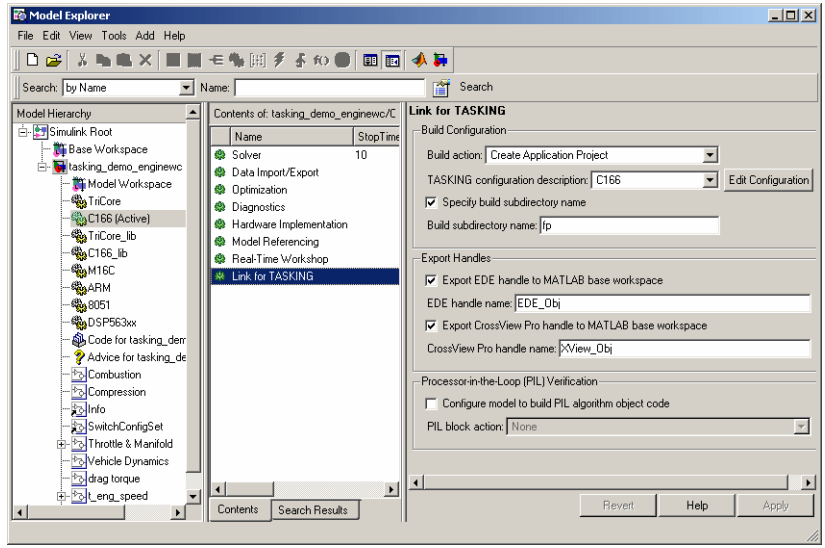
1. Open the model `tasking_demo_enginewc`.
2. Double-click the `Active Configuration Set` block to open the Model Explorer (or select **View > Model Explorer**).



Under `TASKING_demo_enginewc` is a list of configuration sets. The currently selected set is labeled `(Active)`. Inspect the active configuration set.

a The default active configuration set for this model is `C166`. If you want to use a different target, right-click the configuration set that matches your target, and select **Activate**.

b Click **Link for TASKING** to see the configuration settings, as shown following.



c The **TASKING configuration description** drop-down list shows all available target preference configurations. After you have set up target preferences for particular configurations, you can switch between them here (or in the Target Preferences dialog box).

i Click **Edit Configuration** to inspect your current target preferences.

ii Before building, you must replace the string `<ENTER TASKING PATH>` to set up the correct paths to the target preferences `CrossView_Pro_Executable`, the `DOL_File`, and the `EDE_Executable`. See “Setting Target Preferences” on page 1-9.

iii Click **OK** to dismiss the TASKING Target Preferences Setup dialog box.

In the Link for TASKING demos, when you activate a configuration (e.g., `C166`), the appropriate **Tasking configuration description** is automatically selected. You may want to select a different target preference configuration description, e.g., if you have set up a custom configuration (such as `C167_user_hardware`). For an example, see “Tutorial: Creating a New Configuration” on page 5-6.

See “Adding the Link for TASKING Configuration Set Component” on page 1-15 for information on other Link for TASKING settings in the Configuration Parameters.

d Click **Real-Time Workshop** to see the selected system target file.

Note You can use a configuration set specifying any system target file with Link for TASKING.

---

e Click **Hardware Implementation** to see the C166 settings. If you are using a different target, make sure the settings match your device. Select from the **Device type** list. There are custom configurations and preconfigured settings that include the following processors:

- Infineon C16x, XC16x
- Infineon TriCore
- ARM 7/8/9
- Renesas M16C
- 8051 Compatible
- Freescale DSP563xx (16-bit mode)

f Close the Model Explorer.

3 In the model `tasking_demo_enginewc`, right-click the `t_eng_speed` subsystem, and select **Real-Time Workshop > Build Subsystem**. Click **Build** in the dialog box to continue.

Watch the output messages in the MATLAB Command Window as code is generated, your TASKING toolchain EDE is launched, and a new project created.

If you have multiple toolchains, you have to set up your target preferences only once, then it is simple to switch between different configurations. For example, to switch configurations from C166 to TriCore targets:

1 In the model `tasking_demo_enginewc`, double-click the `Active Configuration Set` block to open the Model Explorer.

2 Right-click `TriCore` and select **Activate**. Close the Model Explorer.

3 To rebuild the subsystem with the new settings, right-click the `t_eng_speed` subsystem, and select **Real-Time Workshop > Build Subsystem**.

   Watch the output in the MATLAB Command Window as code is generated, the TASKING C166 EDE is closed, the TASKING TriCore EDE is launched, and the new project created.

You can follow similar steps to specify your target in the other demo models. See the "Link for TASKING Demos."

To switch between simulator and hardware implementations for the same target configuration, you can use option sets. See "Option Sets" on page 1-30.

The next section describes using the build action setting in this example.

Setting Build Action

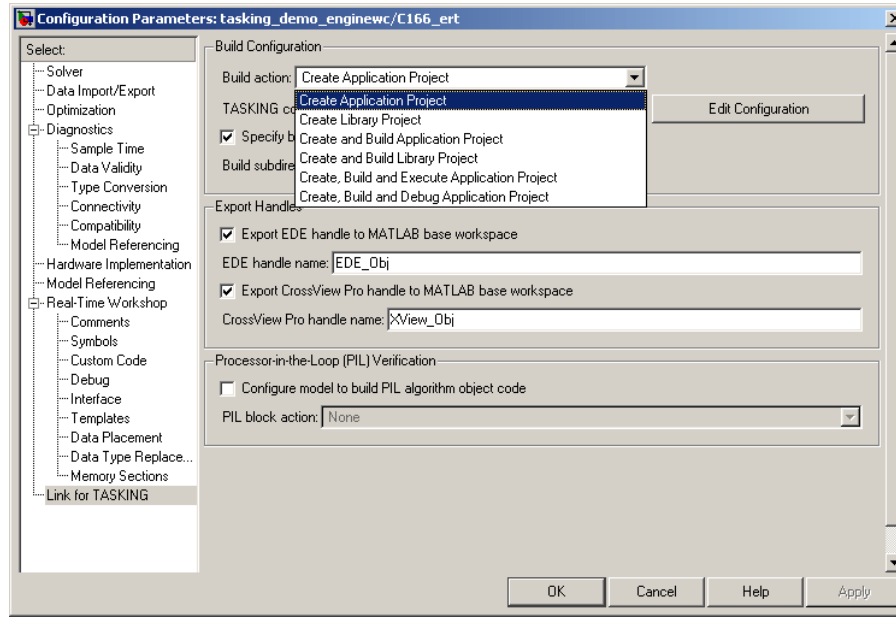
In this example, the model `tasking_demo_enginewc` is set up so the project is created but not built in the TASKING EDE.

To view this setting:

1 In the model `tasking_demo_enginewc`, select **Simulation > Configuration Parameters**.

2 Click **Link for TASKING** to see the **Build Configuration** parameters.

3 Look at the **Build Action** drop-down list.



Using this drop-down list, you can set what action to take after the Real-Time Workshop build process completes. You can create application and library projects in the TASKING EDE and then stop, or you can also choose to build, execute, or debug.

If you choose to build, execute, or debug, CrossView Pro will be launched.

Note The first time you build this model it will take a few minutes to compile the required Real-Time Workshop floating point library. This library is not rebuilt on subsequent builds unless necessary.

You can use the **Build Action** setting to do the following:

- `Create Application Project`

  Generates code for the model or subsystem, creates a TASKING application project for the selected TASKING configuration, connects to the TASKING EDE, and opens the application project (in addition to the required Real-Time Workshop and Signal Processing Library projects, if

required) in the TASKING EDE. This option does not build or execute the application.

An `EDE_Obj` object handle is exported to the MATLAB workspace (if the option **Export EDE handle to MATLAB base workspace** is selected). This object allows you to interact with the TASKING EDE from MATLAB. For more information, see the section on using object handles, "Automation Interface" on page 2-13.

Note To manually build the generated project in the TASKING EDE, right-click on the application project (starts with the same name as the model name), and select **Build**.

- `Create Library Project`

  Performs the same actions as `Create Application Project`, but this option archives the generated code into a library in TASKING. No `main.c` file is generated.

- `Create and Build Application Project`

  Performs the same actions as `Create Application Project`, but also instructs TASKING to build the application project.

Note To manually debug the executable from the application project, click the Debug Application icon in the TASKING EDE.

- `Create and Build Library Project`

  Performs the same actions as `Create Library Project`, but also instructs TASKING to build the Library project.

- `Create, Build and Execute Application Project`

  Performs the same actions as `Create and Build Application Project` and also downloads the executable file to your CrossView Target and runs the executable. No debugging information is downloaded into the target with this option.

A CrossView Pro object handle is exported to the MATLAB workspace (if the option **Export CrossView Pro handle to MATLAB base workspace** is selected). This object allows you to interact with the CrossView Pro debugger from MATLAB. For more information, see the section on using object handles, “Automation Interface” on page 2-13.

- `Create, Build and Debug Application Project`

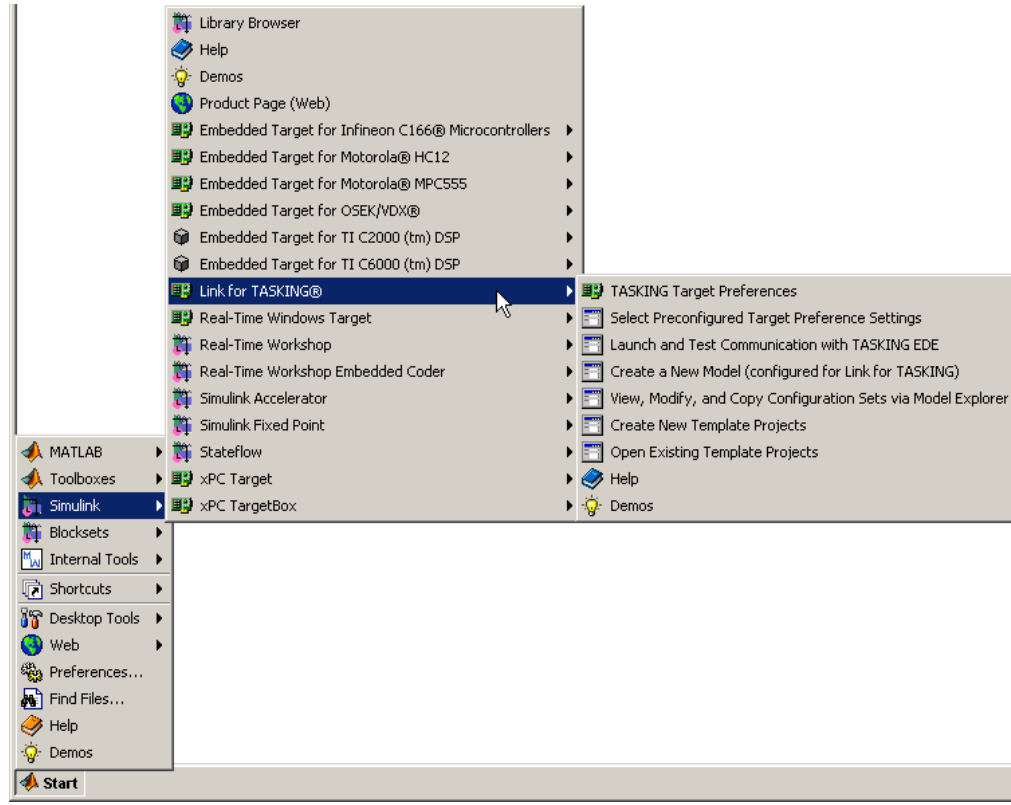
  Performs the same actions as `Create, Build and Execute Application Project` but also downloads debugging information to the target. This option behaves the same way as the Debug Application icon in the TASKING EDE.

Link for TASKING Menus

This section describes the menu items, with links to instructions.

Start Menu Items

Common tasks are available in the **Start** menu. Select **Start > Simulink > Link for TASKING**, as shown in the following figure, to see the following submenu options.



- **TASKING Target Preferences**

  Opens the TASKING Configuration Selection dialog box, and after you choose a configuration to match your target (e.g., `TriCore`), you can edit the TASKING Target Preferences Setup dialog box. In this dialog box, you can modify your TASKING preferences configurations. You can also open this dialog box from the MATLAB prompt by typing `tasking_edit_prefs`.

  You must set up your target preferences before you can use Link for TASKING. See “Setting Target Preferences” on page 1-9.

- **Select Preconfigured Target Preference Settings**

  Opens the TASKING Configuration Selection dialog box. Choose a configuration to match your target and click **OK**. Then you can select a preconfigured option set. Your target preferences are automatically updated according to the option set you select, for example, specifying either hardware or simulator settings. See “Option Sets” on page 1-30.

- **Launch and Test Communication with TASKING EDE**

  Opens the TASKING Configuration Selection dialog box. Choose a configuration and click **OK**, and Link for TASKING tests whether MATLAB can communicate successfully with the EDE for the selected configuration. You see messages at the command line to confirm whether communication is successful.

- **Create a New Model (configured for Link for TASKING)**

  Creates a new untitled Simulink model, with Link for TASKING configuration set options already added. You can also configure an existing model by selecting the Simulink model menu item **Tools > Link for TASKING > Add Link for TASKING Configuration to Model**.

- **View, Modify, and Copy Configuration Sets via Model Explorer**

  Opens the Model Explorer where you can edit all configuration sets available for each currently open model.

- **Create New Template Projects**

  The Link for TASKING product ships with preconfigured application and library template projects for the default configurations in the TASKING Preferences. You might, however, create your own template projects (using preconfigured options as a starting point), and use them with any

configuration. See “Tutorial: Creating New Template Projects” on page 5-4 for an example, and “Template Projects” on page 2-4 for more information.

This option opens the TASKING Configuration Selection dialog box. Choose a configuration and click **OK**, and Link for TASKING launches the appropriate TASKING EDE and creates new template projects for a specific TASKING configuration. You are prompted to choose a project directory, a template name, and an option set. See “Option Sets” on page 1-30 for more details. `app_template_name.pjt` and `lib_template_name.pjt` are created for the configuration you selected.

- **Open Existing Template Projects**

  Opens existing application and library template projects in the TASKING EDE for the selected TASKING configuration. You can modify these options; however, it is preferable to do this by first creating new template projects, which avoids overwriting the default template projects. If you modify the default template projects, you can use the following function to recreate the defaults: `tasking_generate_templates`. You must specify your configuration description string, e.g.: `tasking_generate_templates('C166', true)`.

Note Opening or making changes to template projects causes the regeneration of application and library projects. When making any changes to template projects, it is important to make sure your changes are written to disk by removing the project from the project space, otherwise the changes may not be applied immediately. To remove a current project from the project space, right click on it and choose **Remove from Project Space**.

- **Demos**

  Opens the Link for TASKING Demos page in the Help browser.

Tools Menu Items

In a Simulink model, you can access Link for TASKING items in the **Tools** menu. Select **Tools > Link for TASKING** to see the following submenu items.

- **TASKING Target Preferences**

  As in the **Start** menu, opens the TASKING Configuration Selection dialog box, and once you have chosen a configuration, you can edit the TASKING Target Preferences Setup dialog box. You must set up your target preferences before you can use Link for TASKING. See “Setting Target Preferences” on page 1-9.

- **Add Link for TASKING Configuration to Model**

  Adds Link for TASKING configuration options to the model configuration parameters.

  To see exactly which configuration parameter settings are changed, refer to `tasking_addto_configset.m`. Enter `edit tasking_addto_configset`.

- **Remove Link for TASKING Configuration from Model**

  Removes Link for TASKING configuration options from the model’s configuration parameters.

- **Options**

  Opens the Configuration Parameters dialog box to show Link for TASKING options. See “Link for TASKING Configuration Set Options” on page 1-15.

Option Sets

Option sets are preconfigured settings to specify the target configuration for the TASKING tools. For example, after you set up your target preferences for a TriCore configuration, you can use option sets to switch between using an instruction set simulator configuration, two hardware board configurations, or a simulator with some MISRA-C rule checking.

You can either

- Use option sets to switch between default target configurations, or
- Use option sets when creating new template projects, to set up an initial configuration that you can choose to modify later

See “Tutorial: Using Option Sets” on page 5-2 for instructions.

The following preconfigured option sets are available.

A notation of “*” indicates the default in the Target Preferences. The processor type for the default configurations below is defined by your Tasking toolchain.

- Infineon TriCore:
  - * `tricore_sim`: Default instruction set simulator configuration.
  - `tricore_sim_misra`: As `tricore_sim`, but with some example MISRA-C rule checking enabled. See also the TriCore MISRA-C demo example, `tasking_demo_misra.m`, with instructions under Link for TASKING Demos.
  - `tricore_1796b`: Infineon TriCore 1796b hardware configuration.
  - `tricore_1766b`: Infineon TriCore 1766b hardware configuration.
- Infineon C166:
  - `c166_sim`: Default instruction set simulator configuration.
  - `c167cr` : Phytec kitCON-C167CR serial connection to hardware (`_hw`) and simulator (`_sim`) configurations.
  - *`c167cs` : Phytec phyCORE-C167CS serial connection to hardware (`_hw`) and simulator (`_sim`*) configurations.

  - `st10f269` : Phytec phyCORE-ST10F269 serial connection to hardware (`_hw`) and simulator (`_sim`) configurations.
  - `xc167ci`: On-board parallel port wiggler connection to the Infineon XC167CI Starter Kit hardware (`_hw`) and simulator (`_sim`) configurations.
  - `xc167ci_hw_usb`: USB wiggler connection to the XC167CI

  Note For `xc167ci` targets, you must change jumper 501 when switching between USB wiggler and on-board parallel port wiggler. See your board manual for details.

- Renesas M16C
  - * `m16c_sim`: Default instruction set simulator configuration.
  - `r8ctiny_sim`: Renesas R8C Tiny instruction set simulator configuration.
- ARM:
  - * `arm_sim`: Default instruction set simulator configuration.
  - `arm_sim_big_endian`: As arm_sim, but in big-endian mode.
- Freescale DSP563xx:
  - * `dsp563xx_sim`: DSP563xx Family, 16-bit memory model, instruction set simulator configuration.
  - `dsp566xx_sim`: DSP566xx Family instruction set simulator configuration.
- 8051:
  - * `i8051_sim`: Default, large memory model, no language extensions, floating point, instruction set simulator configuration.

Known Limitations and Tips

The following issues are known limitations with Link for TASKING, with suggestions for workarounds where possible. The information is grouped into these sections:

General

Simulink Configuration Set Reference

The Simulink Configuration Set Reference feature is not supported by Link for TASKING.

For Link for TASKING, make sure your model’s configuration set objects are "Simulink.ConfigSet" objects and not "Simulink.ConfigSetRef" objects.

Serialization of Link for TASKING Objects

Serialization (saving and loading to MATLAB .mat file) of the objects provided with Link for TASKING (eg. tasking.edeapi, tasking.xviewapi) is not possible. If you attempt to load a serialized object from a .mat file you may see the "TASKING Configuration Selection" GUI and / or various warning or error messages.

In some circumstances, a product (for example System Test) or a user script may automatically save all contents of the MATLAB base workspace to a .mat file. In this case, it may be useful to turn off the "Export Handles" settings in the Link for TASKING configuration set component. This will stop EDE and CrossView Pro objects from being exported to the base workspace at the end of a Link for TASKING build process and therefore avoid potential serialization problems.

Build Process

EDE Is Slow, Unresponsive, or Crashes

Tool Suites: All

Problem: Under certain circumstances the TASKING EDE may become slow, unresponsive, or even terminate with virtual memory problems. This limitation is an open issue with the TASKING EDE.

Workaround: Take one or both of the following actions:

- Close the EDE and try building the model again
- Try deleting the symbol database file, `cwright.sbl`, which can be found in the EDE_Executable directory ($TASKINGRootDir\bin)

Signal Processing Blockset Library Build Failures

The following problems have been found with Signal Processing Blockset ("`DSP lib`") library builds:

- With Renesas M16C, building the Signal Processing Blockset library with floating point support enabled results in the following error:

```
TASKING program builder v3.1r1 Build 076 SN 00100552
Assembling qrdc_z_rt.src asm16c E219:
["qrdc_z_rt.src" 1692] expression out of range
(0 and FF hexadecimal)wmk:
*** action exited with value 1.
```

  This limitation is a known issue with the Renesas 16C compiler. Workaround: Disable floating point support in the model.

- With 8051, when trying to build DSP libraries, you may see the following errors with floating- and fixed-point versions:

```
 TASKING program builder v7.1r3 Build 076 SN 00123456
Compiling g711_enc_a_sat_rt.c
cc51 S533: D:\work_dirs\tasking_bugs\8051_fixed_point_dsplib\
g711_enc_a_sat_rt.c: line 34: assertion failed - please report
wmk: *** action exited with value 2.
wmk: "g711_enc_a_sat_rt.src" removed.

TASKING program builder v7.1r3 Build 076 SN 00123456
Compiling burg_a_c_rt.c
wmk: *** action exited with value -1073741571.
wmk: "burg_a_c_rt.src" removed.
```

This limitation is a known issue with the 8051 compiler. Workaround: none.

- With ARM, when trying to build DSP libraries, you may see the following errors with floating- and fixed-point versions:

```
TASKING program builder v1.1r1 Build 078 SN 00123456
Compiling "..\..\..\..\..\..\aetargets with spaces\matlab\
toolbox\rtw\dspblks\c\dspendian\is_little_endian_rt.c"
carm S917: internal consistency check failed - please report
wmk: *** action exited with value 1.

TASKING program builder v1.1r1 Build 078 SN 00123456
Compiling "..\..\..\..\..\..\aetargets with spaces\matlab\
toolbox\rtw\dspblks\c\dspendian\is_little_endian_rt.c"
carm S917: internal consistency check failed - please report
wmk: *** action exited with value 1.
```

  This limitation is a known issue with the ARM compiler. Workaround: none.

Use ERT Target for TASKING TriCore 1766B

The 1766b has no external memory. You should use ERT rather than GRT when targeting this board, due to memory resource constraints. The ERT (embedded real time) target is optimized for size and speed, while the GRT (generic real time) target is designed for ease of prototyping which incurs extra memory usage.

If you use the GRT target you may see compilation errors like the following:

```
ltc E117: conflicting restriction for sections ".text.libc" and
".text.trapvec.000": absolute restrictions overlap
```

Memory Block Freed Twice Error

Occasionally, when Link for TASKING is creating projects in the TASKING EDE, the following error appears: `Memory block freed twice`. This limitation is a known issue with the TASKING EDE.

To work around the problem, click **OK** in the error dialog box, and the code generation process continues as normal.

8051 EDE Cannot Compile Files with Long Names

If you encounter this problem, you receive an error message similar to the following:

```
Assembling tasking_fuel_controller_ert_rtw_pil_cstart.src
asm51 E001: tasking_fuel_controller_ert_rtw_pil_cstart.src: line 1:
syntax error
wmk: *** action exited with value 1.
```

This message indicates that the full path of the model or subsystem you are trying to build is too long. Consider moving the model to a shorter directory name, or renaming the model, subsystem, or both to use shorter names.

8051 Compiler Bug: Assertion Failure

When building 8051 projects you may see the following error:

```
TASKING program builder v7.1r3 Build 076 SN 00123456

Compiling compilerassertion.c

cc51 S518: D:\Applications\tasking\8051\v7.1r3\examples\banksw\
compilerassertion.c: line 23: assertion failed - please report

wmk: *** action exited with value 2.

wmk: "compilerassertion.src" removed.
```

This limitation is a known issue with the 8051 compiler. Workaround: None.

8051 GRT Limitation

GRT application builds link against an example main (`grt_main.c`) file which includes a main function with `argc` and `argv` parameters for handling command-line arguments. When executing the application in CrossView Pro, these parameters are uninitialized and application execution terminates early. This is in contrast to other toolsets, where these parameters are initialized to 0 (`argc`) and the null pointer (`argv`).

To work around this issue on 8051, you can manually set `argc` to `0` in CrossView Pro before beginning execution.

Alternatively, you can create a library project for algorithm export that does not link against `grt_main.c` - see “Setting Build Action” on page 1-22 for more detail.

DSP563xx Toolset Support Limitations

The following limitations affect use of the DSP563xx Toolset:

- Only 16-bit mode for the DSP563xx Family is supported. Real-Time Workshop `grt.tlc`-based targets and the "GRT Compatible Call interface" option in the Real-Time Workshop Interface settings are not supported. This limitation is because of the non-standard size of single- and double-precision floating-point datatypes on this architecture (`tmwtypes.h` will not compile)
- The DSP5600x Toolset is NOT supported because none of the processors supported by this toolset have 16-bit memory models.
- Both 16-bit memory models of the DSP563xx Family produce watch errors (wrong values displayed) in CrossView Pro because of an issue with the TASKING toolset. CrossView Pro does not know that the datatype sizes should be different according to the selected memory model. This issue does not affect the DSP566xx Family.

“Create, Build and Execute Application Project” Build Action Fails

Tool Suites: Renesas M16C

Executing the application project, rather than debugging (via “Create, Build and Debug Application Project) does not work correctly, because the CrossView Pro Simulator does not know the start address when debugging information is not loaded. The application does not execute.

Workaround: After CrossView Pro launches:

1. Stop execution by clicking the Halt button.
2. Execute the following command in the CrossView Pro command window to determine the application entry point stored at location 0xfffffc:

```
*((unsigned long *)0xfffffc)/x
```

Example output for this command is:

```
0xfffffc = 0x000d0000
```

3. Change the execution position to the application entry point by executing the "gi" command, using the output of the previous command. For example, `0xd0000 gi`

4. Resume execution by clicking the Run/Continue button.

Alternatively, use the “Create, Build and Debug Application Project” build action.

C166 Toolset Warnings

When using the C166 toolset you may see warnings similar to the following:

```
Warning: missing "sdc_lia" or "sdc_lip" lifetime record
```

This warning is caused by a problem with the TASKING toolset and has been registered with Altium as PR35043. It is related to debug life time information.

The warning can be ignored safely.

Build Error From Root Drive Location

Platforms: C166, 8051

Due to a limitation of the TASKING toolset, build errors may occur if you build from a root drive location such as `c:\` or `d:\`.

Following is an example error with the C166 toolset:

```
cc166: E 014: invalid control:
Files\MATLAB\R2007a_nortwec\toolbox\rtw\targets\c166\c166demos" -Wcp"-IC:\Program
wmk: *** action exited with value 1.
```

Workaround: Always build from a sub-directory location such as `c:\work` or `d:\MATLAB\work`.

"Save data to workspace" Causes Error

Simulink scope blocks with the "Save data to workspace" option checked cause a link error when building with GRT. This error occurs because this setting causes GRT to log data to a MAT-file during execution. However, MAT-file logging is not supported by Link for TASKING. When using ERT, Link for TASKING makes sure the "MAT-file logging" configuration set option under Real-Time Workshop > Interface is not checked, and therefore this error is avoided.

Supporting Non-Finite Values

Non-finite support issues:

1 If you encounter similar linking errors when building your model:

```
undeclared identifier "rtMinusInf"
undeclared identifier "rtNaN"
undeclared identifier "rtInf"
```

then this means that:

- Your model uses non-finite values, and
- You are using a stubbed version of `rt_nonfinite.c` which does not define `rtMinusInf`, `rtNan`, or the other non-finite identifiers required by Real-Time Workshop.

Workarounds:

- Do not use non-finite values in the model. This is not desirable for embedded applications. Non-finite elements on targets other than TriCore are not supported with Link for TASKING.
- If you want to use non-finite values and your target is TriCore, then you can use the following workaround. You do not need to use a stubbed version of `rt_nonfinite.c` since the default one should compile correctly on this 32-bit target. In the configuration set, under Real-Time Workshop in **TLC Options**, remove `-aCustomNonFinites="genrtnonfinite_stub.tlc"`, then delete the generated `rt_nonfinite.c` file in the build area before attempting to build the model again. This should generate a new `rt_nonfinite.c` file which correctly defines the undeclared identifiers above.

2 If you encounter compilation errors in `rt_nonfinite.c` similar to the following:

```
Compiling and assembling rt_nonfinite.c
..\..\slprj\ert_c167cs_sim\_sharedutils\rt_nonfinite.c:
    47:         uint32_T fraction : 23;
E 134: bitfield size out of range - set to 1
    57:           uint32_T fraction1 : 20;
E 134: bitfield size out of range - set to 1
    69:       (*(LittleEndianIEEESingle*)&rtNaN).fraction = 0x7FFFFF;
W 195: constant expression out of range -- truncated
    78:         (*(LittleEndianIEEESingle*)&rtNaN).fraction = 0x7FFFFF;
W 195: constant expression out of range -- truncated
    89:         (*(LittleEndianIEEEDouble*)&rtNaN).wordL.fraction1 = 0xFFFFF;
W 195: constant expression out of range -- truncated
    90:         (*(LittleEndianIEEEDouble*)&rtNaN).wordH.fraction2 = 0xFFFFFFFF;
W 196: constant expression out of range due to signed/unsigned type mismatch
    98:         uint32_T fraction : 23;
E 134: bitfield size out of range - set to 1
   105:           uint32_T fraction1 : 20;
E 134: bitfield size out of range - set to 1
   118:       (*(BigEndianIEEESingle*)&rtNaN).fraction = 0x7FFFFF;
W 195: constant expression out of range -- truncated
   127:         (*(BigEndianIEEESingle*)&rtNaN).fraction = 0x7FFFFF;
W 195: constant expression out of range -- truncated
   138:         (*(BigEndianIEEEDouble*)&rtNaN).wordL.fraction1 = 0xFFFFF;
W 195: constant expression out of range -- truncated
   139:         (*(BigEndianIEEEDouble*)&rtNaN).wordH.fraction2 = 0xFFFFFFFF;
W 196: constant expression out of range due to signed/unsigned type mismatch
total errors: 4, warnings: 8
wmk: *** action exited with value 1.
wmk: *** action exited with value 1.
```

then this means that you are compiling the default Real-Time Workshop `rt_nonfinite.c` on a target that does not support it. The only target which can compile the default `rt_nonfinite.c` is TriCore. Non-finite elements on targets other than TriCore are not supported with Link for TASKING.

Workaround — Follow these steps:

a Make sure you are using the stubbed out version of this file. In the configuration set, under Real-Time Workshop in **TLC Options**, add the following: `-aCustomNonFinites="genrtnonfinite_stub.tlc"`

b Delete the `rt_nonfinite.c` file from the build area before attempting to rebuild the model in the same build area.

Memory warning / error messages in the CrossView Pro command window when using the instruction set simulator

Due to a limitation in the TASKING C166 toolset you may see messages similar to the following in the CrossView Pro command window during execution of an application in the instruction set simulator:

```
GPR registers could not be scheduled to 0xF200
GPR registers could not be scheduled to 0xF220
```

and

```
Reading register "R0" (0) failed: memory failure at
memory space 0 range 0x00FC00-0x00FC01
```

These messages occur because the CrossView Pro feature "Use map file for memory map" does not work correctly.

The workaround suggested by Altium TASKING is to not use this feature, in which case the debugger assumes that the entire memory range that the processor can address is available to the application. You can create custom Link for TASKING template projects and a custom CrossView Pro initialization file to disable this feature. For example, in the custom template application project, uncheck the project option, **CrossView Pro > Initialization > Use map file** for memory mapping.

C++ Code Generation Not Supported

C++ code generation is not supported. If you try to use this option, you see an error message like the following:

```
Link for TASKING does not support the RTW C++ Target
Language option. Please set the "Language" setting to
"C" in the Real-Time Workshop configuration parameters of
the model.
```

Video and Image Processing Blockset Library Not Supported

The Video and Image Processing Blockset Real-Time Workshop library is not supported by Link for TASKING. If you include blocks from the Video and Image Processing Blockset library in your model then you may see compilation or link errors.

Workaround: None.

Noninlined S-functions Calling "rt_matrx.c" Not Supported

Noninlined S-functions that use routines in `rt_matrx.c` are not supported. This is because `rt_matrx.c` contains functions that can allocate memory dynamically. Dynamic memory allocation is not supported by Link for TASKING. You may see errors like the following:

```
Linking and locating to rt_matrx_test.out
E 222: module _nmalloc.obj (_NMALLOC_C): symbol '?C166_NHEAP_TOP': unreso
E 222: module _nmalloc.obj (_NMALLOC_C): symbol '?C166_NHEAP_BOTTOM':
       unresolved
total errors: 2, warnings: 0
```

Workaround: None

Model Reference Error ("Could not find information file")

If your models are incorrectly configured for Model Reference with Link for TASKING, then you may see an error similar to the following:

```
Error encountered when creating the model reference RTW target
for sldemo_mdlref_basic :
Error using ==> rtwinfomatman.m>load_method at 47
Could not find information file: C:\work_dirs\targets\
slprj\grt_c167cs_sim\sldemo_mdlref_counter\tmwinternal\binfo_mdlref.mat
```

This error occurs under the following circumstances:

- The top level model is configured for Link for TASKING (contains a Link for TASKING configuration set component), but a referenced model is not configured for Link for TASKING.
- A referenced model is configured for Link for TASKING, but the top level model is not configured for Link for TASKING.

Solution: Make sure that the top level model and all referenced models are configured for Link for TASKING. All models should have the same "Hardware Implementation" settings and the same "TASKING configuration description" setting.

Model Reference Error ("Reference to non-existent field 'model'")

If your models are incorrectly configured for Model Reference with Link for TASKING then you may see an error similar to the following:

```
Error building Real-Time Workshop target for block diagram
'sldemo_mdlref_basic'.
MATLAB error message:
Reference to non-existent field 'model'.
```

This error occurs when a referenced model does not have the "TASKING configuration description" setting (in the Link for TASKING configuration set component) configured correctly. For example, if you have not set a configuration, the default value of "TASKING Configuration Description Not Set" causes this error.

Solution: Make sure that the top level model and all referenced models have the same "Hardware Implementation" settings and the same valid, non-default, "TASKING configuration description" setting.

Processor-in-the-Loop (PIL)

The following issues affect the use of PIL:

10-Second Pause on Termination of the CrossView Pro Debugger

When you terminate an instance of the CrossView Pro debugger application that was launched by Link for TASKING, there is a pause of about 10 seconds before the CrossView Pro window closes. This 10-second pause is the intended behavior of CrossView Pro when acting as a COM server; CrossView Pro pauses for the 10 seconds to wait for clients such as MATLAB to release their COM references.

8051 Link-Order Issue Can Cause PIL Application Failure

When building PIL applications for 8051 you may see linker warnings similar to the following:

```
link51 W001: unresolved external symbol
 '_?BINARYSEARCH_S16', module t_fuelsys.obj
link51 W001: unresolved external symbol
'_?DotProduct_s32s16', module t_fuelsys.obj
link51 W001: unresolved external symbol
 '_?INTERPOLATE_S16_S16_SAT', module t_fuelsys.obj
```

If such a message appears, the PIL block reports that an error has occurred during cosimulation.

Workaround: if you encounter this you can contact TASKING for a patch to make it possible to use the multipass option to rescan multiple libraries.

DSP563xx Link-Order Issue Can Cause PIL Application Failure

When building PIL applications for DSP563xx you may see linker errors similar to the following:

```
lk563 E208 (0): Found unresolved external(s):
            FDotProduct_s32s16            - (fuelsys0.a:fuelsys0.obj)
            FLook2D_S16_S16_S16_SAT       - (fuelsys0.a:fuelsys0.obj)
            FBINARYSEARCH_S16             - (fuelsys0.a:fuelsys0.obj)
            FINTERPOLATE_S16_S16_SAT      - (fuelsys0.a:fuelsys0.obj)
            FINTERPOLATE_EVEN_S16_S16_SAT - (fuelsys0.a:fuelsys0.obj)
wmk: *** action exited with value 1.
```

Workaround: if you encounter this you can contact TASKING for a patch to make it possible to use the multipass option to rescan multiple libraries.

Buses and Mux Signals Not Supported at PIL Component Boundary

Buses and MUX Signals are not supported at the PIL component boundary.

Workaround: None.

Signals with Custom Storage Classes Not Supported at PIL Component Boundary

Signals with Custom Storage Classes are not supported at the PIL component boundary.

Workaround: None.

However, note that the standard noncustom storage classes, like ExportedGlobal, are supported.

Continuous Sample Times Not Supported

Continuous sample times are not supported by PIL. If you encounter this you see the following error:

```
??? Processor-in-the-Loop (PIL) does not support continuous
time. Please uncheck "continuous time" in the RTW Interface
configuration set options or disable PIL.
```

Workaround: None. You must use discrete sample times.

Real-Time Workshop "grt.tlc"-Based Targets Not Supported

Real-Time Workshop "grt.tlc"-based targets are not supported for PIL.

Workaround: Use a Real-Time Workshop "ert.tlc"-based target.

Enabled / Triggered Subsystems Are Not Supported

Enabled / Triggered subsystems are not supported for PIL.

Workaround: None.

No Support for TASKING Feature "Treat double as float"

You can enable the feature in a TASKING project to treat the double precision floating point datatype "double" as the single precision floating point datatype "float". Usually, this means that double precision floating point datatypes are represented in 4 bytes rather than 8 bytes.

PIL always assumes that the "double" datatype is represented normally. If you enable the "Treat double as float" override, PIL does not correctly transfer "double" datatypes between host and target, and cosimulation errors occur. The default templates that ship with Link for TASKING do not enable the override.

Workarounds:

- Do not use the option to treat "double" as "float". In this case, double precision floating point values are represented normally.
- Use the "single" datatype in Simulink rather than "double". In this case, the option to treat "double" as "float" will have no effect on PIL, because no "double" datatypes are used.

TASKING Optimization Settings May Cause Incorrect Cosimulation Results

Sometimes, you may observe differences between simulation and PIL cosimulation results. The code compiled and running in the TASKING environment may not always behave correctly, even when the generated code is correct. One cause of this issue, particularly with the TriCore toolset, is the compiler optimization configuration used to build the generated code.

Workaround: If you see differences between simulation and PIL cosimulation results, try setting the compiler optimization settings in the template projects to either `No optimization`, `Debug purpose`, or a similar equivalent for your TASKING toolset. Then, build the PIL algorithm and PIL application again and try repeating the cosimulation.

To create new template projects and modify their project settings see "Tutorial: Creating New Template Projects" on page 5-4.

Export Functions Feature Is Not Supported

The Real-Time Workshop feature "Export Functions" is not supported.

Workaround: None.

Fixed-Point Tool Data Type Override Not Supported at PIL Component Boundary

Signals with data types overridden by the Fixed-Point Tool **Data type override** parameter are not supported at the PIL component boundary.

Workaround: None.

2

Components

Project Generator

Overview of the Project Generator Component

The Link for TASKING Project Generator Component provides a customizable build process that is designed to work with the highly customizable code generation process provided by Real-Time Workshop. See “Project Generator” on page 1-2 for a summary.

To explain the separation of duties between Real-Time Workshop and Link for TASKING, the following sections discuss the terms *code generation process* and *build process*.

Code Generation Process

The code generation process is performed by the Real-Time Workshop family of products and is the process of translating a Simulink model into C code.

Customized code generation, perhaps to create target-specific device drivers or target-optimized code, is often a key requirement for users who want to generate code from Simulink models.

Real-Time Workshop and Real-Time Workshop Embedded Coder provide a variety of mechanisms for users to customize the code generation process. For example, the standard code generation process, using the regular system target files (like `grt.tlc` and `ert.tlc`) can be customized by making changes to the model’s configuration parameters. Alternatively, for an even greater

level of customization, including the ability to define custom Real-Time Workshop options, you can use a user created system target file.

The demos that come with Link for TASKING make use of the first type of customization with regular system target files. That is, the standard code generation process has been tailored for the appropriate target platform simply by changing the model's configuration parameters.

For greater flexibility, you should use a custom system target file. For further details on customizing the code generation process, see the Real-Time Workshop and Real-Time Workshop Embedded Coder documentation.

Build Process

The build process is performed by Link for TASKING and is the process of taking the C code produced by the code generation process and building (assembling, compiling, and linking) it for the target platform.

A customized build process, perhaps to use optimized compiler and linker settings, or perhaps to produce a MISRA compliance report, is often a key requirement for users wishing to build code produced from Simulink models.

Link for TASKING provides access to the full build process customization capabilities of the TASKING tools by allowing the user to set up the exact required configuration in TASKING. Link for TASKING then uses this configuration as a template for the build process.

Memory Placement Example

As an example, to consolidate the descriptions above of code generation and the build process, consider the common task of placing program data into a particular area of memory on a target platform.

Usually, this is achieved by using compiler-specific notations (like #pragmas) to define special memory sections and to assign data definitions to those sections. Additionally, a linker command file defines the different available memory regions on the target, and where in these regions the different memory sections should be located.

Splitting this task between the processes of code generation and building could be done as follows:

1. Customized code generation defines memory sections and assigns data.
2. Customized build process defines memory regions and assigns memory sections.

Project-Based Build Process

The Link for TASKING build process automatically creates TASKING EDE projects representing the application and libraries to be built.

A Real-Time Workshop application usually consists of some application code that makes references to modules that are part of libraries like the Real-Time Workshop library. Another common library is the Signal Processing Blockset library, used with the Signal Processing Blockset.

Link for TASKING creates separate projects for the main application code and each required library. The required libraries are included in the main application projects as subprojects.

Although the build process is project-based, underlying the projects are "makefiles" that can be used independently of the EDE. For an example of how to obtain the appropriate make command, see the demo instructions in `tasking_demo_objects.m` .

Target Project Space

Link for TASKING places projects in a project space known as the *target project space*. The location of the target project space is controlled by the `Target_Project_Space` setting in the Target Preferences, and usually depends on the `$(DEFAULT_LOCATION)` token, which is expanded based on the current directory at the time the build process is invoked, the model name, and model configuration settings, including the name of the template application project.

Template Projects

Template projects are regular TASKING EDE projects that are used by Link for TASKING to allow customization of the build process. Template projects

are tied to particular TASKING Configurations as set up in the Target Preferences.

There are two types of template projects: application, and library template projects.

The application template project is used as the template for application projects and the library template project is used as the template for library projects.

Relocation of Template Projects

During the build process, the template project is copied to a target project location, and is then populated with the information relating to how to build the generated code.

Therefore, the project options of the template project become the project options of the target project, and hence the build process is customized according to the template project.

On subsequent build processes, Link for TASKING determines whether the template project has been updated since it was last copied to the target project location. If it has, then the target project is updated with a new copy of the template project. Otherwise, the target project is not updated from the template project.

Note Project options should be updated in the template project and not in the target project.

How the Build Process Modifies the Relocated Template Project

The Link for TASKING build process determines if any changes (preprocessor defines, include paths and source files) to the target project are required to build the code associated with a particular model, and updates the target project only if required. Thus, unnecessary project rebuilding is avoided.

Any include paths and preprocessor defines in the template project are always maintained in the target project. Maintaining this information is useful for keeping the include path to the compiler's standard header files, and setting global defines.

Additionally, the optional startup code file automatically generated by the EDE is also maintained.

Note Adding any other source files to your template project is not supported and will result in errors. Instead, you should add source files to the project by adding them to the Real-Time Workshop Build Info object by using either the Real-Time Workshop Custom Code settings in the configuration parameters, the `rtwmakecfg.m` mechanism, or by writing your own post code generation command (taking care not to overwrite any existing commands). See the Real-Time Workshop documentation for details.

Shared Libraries

Link for TASKING models that share the same target project space share required libraries such as the Real-Time Workshop library. Sharing of libraries means that a library is only built the first time a model that requires it is built.

The advantages of this shared library approach are

- No unnecessary per-model building of libraries; models with similar library requirements (e.g., integer code only) can share libraries.
- Libraries are built with the project options specified in the corresponding template project.
- Multiple sets of libraries, each with custom model, project options, or both can coexist.

Utility Function Generation: Shared Location

The shared library approach uses the Real-Time Workshop "Utility Function Generation" feature.

By setting utility function generation to use a shared location, rather than the model-specific default, you can ensure that the library projects created have no dependence on model-specific generated code. This feature is the key to allowing library projects to be shared between models.

As an example, consider the generated header file, `rtwtypes.h`, that contains the set of Real-Time Workshop data types available for compiling code modules, including any libraries.

With the utility function generation set to the default, individual `rtwtypes.h` files are generated into each code generation directory. Therefore, multiple definitions of `rtwtypes.h` would exist for a library shared between these models. The problem is, how can one of these `rtwtypes.h` files be chosen to build the library?

Setting the utility function generation to use a shared location provides a solution. In this case, a single `rtwtypes.h` file is generated into a directory shared between a set of models. This single file can be used to build the library without any dependence on the model-specific generated code.

Supporting Multiple Shared Utility Function Locations: Build Directory Suffix

The approach outlined in the previous section works well for a single set of models that have the same shared utility requirements.

However, what happens if you have two sets of models, each set with different shared utility requirements?

Normally, the Real-Time Workshop code generation process uses the current working directory as the location for generated files. In this location, it supports only a single shared utilities directory for each system target file. Therefore, it is possible for conflicts over the contents of the shared utility directory to occur.

Example 1. For example, conflicts would occur if the Hardware Implementation settings were different for two models using the same system target file. If the standard `grt.tlc` or `ert.tlc` code generation process is customized by changing configuration set parameters, this situation is highly likely to occur.

To work around this problem, when using a `Target_Project_Space` (specified in the Target Preferences) containing the `$(DEFAULT_LOCATION)` token, Link for TASKING automatically appends the name of the current template application project to the regular Real-Time Workshop build directory suffix. This creates code generation and project directories that are specific to the current template application project, and so also specific to the current Hardware Implementation settings. Different Hardware Implementation settings always have different template projects.

Example 2. Another common example of this conflict, for two models sharing the same system target file, would be if one model was configured to support floating-point numbers and the other was configured to support integer code only.

To work around this conflict, use the Link for TASKING options **Add build subdirectory suffix** and **Build subdirectory suffix**.

If you select the **Add build subdirectory suffix** check box, then the **Build subdirectory suffix** you enter is appended to the regular Real-Time Workshop build directory suffix (before the name of the template application project discussed earlier, see “Template Projects” on page 2-4). This creates code generation and project directories that are specific to both the **Build subdirectory suffix** setting and the template projects.

For example, you can add `fp` for floating point models and `int` for non-floating-point models.

Note Using the same build subdirectory suffix for a similar set of models allows them to generate code into their own working directory, avoiding conflict with other models, while still allowing a shared utilities directory.

This feature of Link for TASKING removes the need for the user to manually manage changing directories to avoid shared utility directory conflicts.

See the demo models for examples of using this setting: Link for TASKING Demos.

Build Process — Directory Structure

The following table shows the typical directories that are created, relative to the current working directory, during the Real-Time Workshop code generation process and the Link for TASKING build process.

Directory	Contents

`$(REG_SUFFIX)_$(MODEL_SUFFIX)_$(TEMPLATE_NAME)\pjt_$(MODEL)`
e.g,
`ert_rtw_int_tricore_sim\pjt_fuelsys0`
	Main project: `$(MODEL).pjt` and associated files.

`$(REG_SUFFIX)_$(MODEL_SUFFIX)_$(TEMPLATE_NAME)\pjt_rtwlib`	Real-Time Workshop library project: `rtwlib.pjt` and associated files.
`$(REG_SUFFIX)_$(MODEL_SUFFIX)_$(TEMPLATE_NAME)\pjt_rtwshared` (if required)	Shared utilities library project: `rtwshared.pjt` and associated files.

`$(MODEL)_$(REG_SUFFIX)_$(MODEL_SUFFIX)_$(TEMPLATE_NAME)`
e.g.,
`fuelsys0_ert_rtw_int_tricore_sim`
	Real-Time Workshop code generation directory.

Key	
`$(MODEL)`	Real-Time Workshop code generation model name (e.g., `fuelsys0`).
`$(TEMPLATE_NAME)`	Token expanded from the name of the template application project in the target preferences (e.g., `tricore_sim`). If the project name is prefixed with "`app_`" this token is removed.
`$(REG_SUFFIX)`	Regular Real-Time Workshop build directory suffix (e.g., `ert_rtw`).
`$(MODEL_SUFFIX)`	Model-specific build directory suffix (e.g., `int`).

See the next section, "Command Line Project Information" on page 2-10, for details about finding file names, paths, and other build information.

Command Line Project Information

When you build an application you can see information containing links at the MATLAB command line. You can use these links to get further details such as paths to projects, preprocessor defines, include paths, added files and their locations.

The following example shows a typical output:

```
### Building the PIL Application...
### Updating EDE projects according to BuildInfo object.
Please wait...
Creating project: t_shift_alg_ert_rtw_pil.pjt
Updating preprocessor defines in project:
t_shift_alg_ert_rtw_pil.pjt
Updating include paths in project:
t_shift_alg_ert_rtw_pil.pjt
Adding source files to project:
t_shift_alg_ert_rtw_pil.pjt
```

You can click the hyperlinks within these messages to get more information. The build messages are more readable with this information hidden, and the links provide access when you require more details.

Click the project file name (e.g., `t_shift_alg_ert_rtw_pil.pjt`) to see the full path to the project being built, like the following example:

```
Project path: D:\MATLAB\\work\tricore_fp\tricore_sim\
pjt_t_shift_alg_ert_rtw_pil\t_shift_alg_ert_rtw_pil.pjt
```

Click `preprocessor defines` to see a list of preprocessor defines similar to the one in the following example:

```
t_shift_alg_ert_rtw_pil.pjt preprocessor defines:

ADD_MDL_NAME_TO_GLOBALS=1
INTEGER_CODE=0
MAT_FILE=0
MODEL=t_shift_alg
MT=0
MULTI_INSTANCE_CODE=0
NCSTATES=0
NUMST=1
ONESTEPFCN=1
TERMFCN=1
TID01EQ=0
```

Click `include paths` to see a list of include paths similar to the one in the following example:

```
t_shift_alg_ert_rtw_pil.pjt include paths:

$(PRODDIR)\include
D:\MATLAB\work\tricore_fp\t_shift_alg_ert_rtw
D:\MATLAB\work\tricore_fp
D:\MATLAB\matlab\toolbox\rtw\targets\tasking\taskingdemos
D:\MATLAB\matlab\extern\include
D:\MATLAB\matlab\simulink\include
D:\MATLAB\matlab\rtw\c\src
D:\MATLAB\matlab\rtw\c\libsrc
D:\MATLAB\matlab\rtw\c\ert
D:\MATLAB\work\tricore_fp\slprj\ert\_sharedutils
D:\MATLAB\matlab\toolbox\rtw\targets\tasking\tasking\pil
D:\MATLAB\work\tricore_fp\t_shift_alg_ert_rtw_pil
```

Click `source files` to see a list of files added and their full paths.

```
t_shift_alg_ert_rtw_pil.pjt added files:

D:\MATLAB\toolbox\rtw\targets\tasking\tasking\pil\
pil_interface.h
D:\MATLAB\toolbox\rtw\targets\tasking\tasking\pil\
pil_interface_common.h
D:\MATLAB\toolbox\rtw\targets\tasking\tasking\pil\
pil_interface_lib.c
D:\MATLAB\toolbox\rtw\targets\tasking\tasking\pil\
pil_interface_lib.h
D:\MATLAB\toolbox\rtw\targets\tasking\tasking\
tasking_pil_main.c
D:\MATLAB\work\tricore_fp\t_shift_alg_ert_rtw_pil\
pil_interface.c
D:\MATLAB\work\tricore_fp\t_shift_alg_ert_rtw_pil\
pil_interface_data.h
D:\MATLAB\work\tricore_fp\tricore_sim\
pjt_exp_t_shift_alg_ert_rtw\exp_t_shift_alg_ert_rtw.pjt
D:\MATLAB\work\tricore_fp\tricore_sim\pjt_rtwlib\rtwlib.pjt
```

Automation Interface

Overview of Automation Interface Component

The Link for TASKING Automation Interface Component provides powerful MATLAB API's for automating interacting with the TASKING EDE and CrossView Pro Debugger. See "Automation Interface" on page 1-3 for a summary.

Objects for Link for TASKING

Link for TASKING uses object-oriented programming techniques and requires a basic knowledge of some object-oriented terminology. The following are some fundamental terms you should understand:

- Object — Something you can operate on. An object is an instance of a class, created by calling the class constructor.
- Class — A class defines the properties and methods common to all objects of the class.
- Constructor — A function that creates an object, based on the class definition, and initializes it.
- Method — An operation on an object, defined as part of the class definition.

- Property — Part of an object, treated as a variable at times, that is defined as part of the class definition.
- Handle — A mechanism to access any object that Link for TASKING creates. Used in this guide to refer to the object. Often the handle is the name you assign when you create the object.

The following sections describe how to use and get help for Link for TASKING objects. See “Objects Demo Example” on page 2-18 for an example demonstrating some basic capabilities of Link for TASKING objects.

Classes

The following table shows the different classes that are provided with Link for TASKING.

Class	Description
`tasking.edeapi`	Represents the TASKING EDE.
`tasking.edeprojectspace`	Represents a project space in the TASKING EDE.
`tasking.edeproject`	Represents a project in the TASKING EDE.
`tasking.xviewapi`	Represents the TASKING CrossView Pro debugger.
`tasking.Tasking_Configuration`	Property of a `tasking.edeapi` class representing TASKING configuration details.
`tasking.EDE_Configuration`	Property of a `tasking.tasking_Configuration` representing EDE configuration details.
`tasking.CrossView_Pro_Configuration`	Property of a `tasking.tasking_Configuration` representing CrossView Pro configuration details.

Using Objects

The topics in this section are:

Creating an Object

To find out how to create an object of a particular class you can use the `tasking_help` function to find help for the constructor. At the MATLAB command prompt, enter

```
tasking_help <classname>.<constructorname>
```

For example, for the `tasking.edeapi` class, enter

```
tasking_help tasking.edeapi.edeapi
```

For the `tasking.edeprojectspace` class, enter

```
tasking_help tasking.edeprojectspace.edeprojectspace
```

Follow these steps to create example objects.

1 To create a `tasking.edeapi` object, you call the constructor as follows:

```
Ede = tasking.edeapi
```

The name on the left side of the “=” could be any valid MATLAB identifier and is the handle to the object.

You must choose a configuration, then communication is tested with the TASKING EDE. At the command line you see the configuration target preferences.

2 To create a `tasking.edeprojectspace` object, you call the constructor as follows:

```
tasking.edeprojectspace(projspace, edeapi)
```

where `projspace` is the absolute path of the TASKING Project Space this object will relate to, and `edeapi` is a `tasking.edeapi` object, as shown in the following example:

```
 ps = tasking.edeprojectspace('D:\MATLAB\work\
myprojspace.psp', Ede)
```

3 To create a `tasking.edeproject` object, you call the constructor as follows:

```
tasking.edeproject(proj, edeprojspace)
```

where `proj` is the absolute path of the TASKING Project this object relates to, and `edeapiprojspace` is a `tasking.edeprojectspace` object, as shown in the following example:

```
proj = tasking.edeproject('D:\MATLAB\work\myproj.pjt', ps)
```

4 To create a `tasking.xviewapi` object, you call the constructor as follows

```
xv = tasking.xviewapi
```

You must choose a configuration, then communication is tested with CrossView Pro. At the command line, you see the configuration target preferences.

Determining the Available Methods for a Class

After you create an object, you can find the available methods by running the "methods" function.

1 For example, to find the methods available on the `tasking.edeapi` object created above (in "Creating an Object" on page 2-15), enter `methods(Ede)`.

2 To find the methods available on the `tasking.edeprojectspace` object previously created, enter `methods(ps)`.

3 To find the methods available on the `tasking.edeproject` object previously created, enter `methods(proj)`.

4 To find the methods available on the `tasking.xviewapi` object previously created, enter `methods(xv)`.

To see the methods available, refer to the tables in "List of Methods" on page 2-18.

Obtaining Help for a Class Method

To get help for a class method, you can use the `tasking_help` function.

For example, to find out more about the `getProject` method of the `tasking.edeapi` class, you could enter the following command:

```
tasking_help tasking.edeapi.getProject
```

MATLAB returns the following output:

```
GETPROJECT - get the active Project in the EDE
project = getProject
project: edeproject object representing the active Project
 in the EDE
project will be empty if there is no open project
```

To see the methods available, refer to the tables in "List of Methods" on page 2-18.

Calling a Method

When you know the details of a class method, you can call it using dot (.) notation.

For example, to get a `tasking.edeproject` object representing the active project, run the following command:

```
project = Ede.getProject
```

Determining the Available Properties for a Class

After you create an object, you can find the available properties by running the `get` function.

For example, to find the properties available on the `tasking.edeapi` object created above, enter

```
get(Ede)
```

Accessing a Property

You can access a property of a class using dot (.) notation.

For example, to get the "configuration" property of the `tasking.edeapi` object created above, enter:

```
config = Ede.configuration
tasking.Tasking_Configuration (handle)
      Configuration_Description: 'C166'
              EDE_Configuration: [1x1 tasking.EDE_Configuration]
    CrossView_Pro_Configuration: [1x1 tasking.CrossView_Pro_
Configuration]
```

Objects Demo Example

For experience using objects, you can work through the demo example, `tasking_demo_objects.m`, found under Link for TASKING Demos.

This example provides step-by-step instructions for using Link for TASKING objects to communicate with the TASKING EDE and CrossView Pro debugger from the MATLAB command line. You can use any command available in the powerful CrossView Pro command language. The demo illustrates using objects during the process of building and debugging projects.

List of Methods

See the following tables for lists of available methods:

The public methods are shown in the tables (methods beginning with “p” or “p_” are private methods and should not be used).

Methods for Class tasking.edeapi

close	getOptionSetNames
disp	getProject
display	getProjectSpace
edeapi	getTargetProject
exec	getToolchainInfo
execApiMacro	newProject
execRetNumeric	newProjectSpace
execRetString	newProjectTemplates
getCreatedEDEProcess	newProjectTemplatesViaUI
getOptionSet	newTempProjectSpaceIfNoneOpen
openProjectTemplates	processTemplateProject
pwd	validateToolchainDirectory
hilite_system	connect
isconnected	

Methods for Class tasking.edeprojectspace

add	deleteParentDir
getEDE	isopen
checkValid	disp
getOriginalPath	new
checkValidProject	display
getPath	open
close	edeprojectspace
isequal	remove

Methods for Class tasking.edeproject

add	getEDE	isopen
build	getFiles	new
checkValid	getHyperlink	open
close	getIncludes	rebuild
debug	getMakeCmd	remove
disp	getOriginalPath	run
display	getPath	setCDefines
edeproject	getProjectSpace	setIncludes
getBuildOutput	getTarget	setPerformToolchainName-Check
getCDefines	hasFile	
getDir	isequal	

Methods for Class tasking.xviewapi

addBreakpointCallback	getEventReporting
getFunctionConfiguration	debug

disp	halt
removeBreakpointCallbacks	display
isRunning	setEventReporting
downloadAndRun	execute
xviewapi	executeAndWait
getCommandResponse	getExecutable
getProject	hilite_system
readMemoryUnits	writeMemoryUnits
reset	stackProfile
stackProfileReset	

Details of Particular Methods

The following methods of the `tasking.xviewapi` object simplify reading from and writing to target memory units (the smallest addressable unit in the memory of the target).

- `readMemoryUnits`

  To see help for this function, enter

  ```
  tasking_help tasking.edeapi.readMemoryUnits
  ```

  at the MATLAB command line.

- `writeMemoryUnits`

  To see help for this function, enter

  ```
  tasking_help tasking.edeapi.writeMemoryUnits
  ```

  at the MATLAB command line.

Use these functions with the MATLAB functions, `typecast` and `swapbytes`, for reading and writing data of different datatypes.

To see examples of syntax, see the demo example, `tasking_demo_objects.m`, found under Link for TASKING Demos.

3

Verification

Processor-in-the-Loop (PIL) Cosimulation

Processor-in-the-Loop Overview

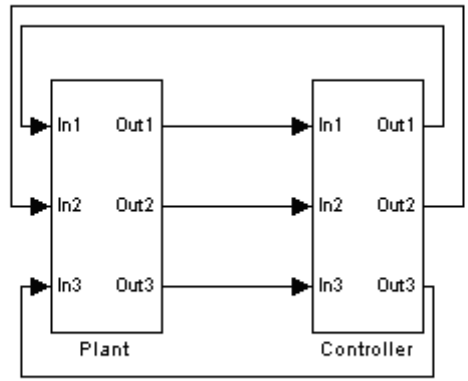
Overview of PIL Cosimulation

Processor-in-the-loop (PIL) cosimulation is a technique designed to help you evaluate how well a candidate algorithm (e.g., a control system) operates on the actual target processor selected for the application.

During the Real-Time Workshop Embedded Coder code generation process, you can create a PIL block from one of several Simulink components including a model, a subsystem in a model, or subsystem in a library. You then place the generated PIL block inside a Simulink model that serves as the test harness and run tests to evaluate the target-specific code execution behavior.

Why Use Cosimulation?

PIL cosimulation is particularly useful for simulating, testing, and validating a controller algorithm in a system comprising a plant and a controller. In classic closed-loop simulation, Simulink and Stateflow® model such a system as two subsystems and the signals transmitted between them, as shown in this block diagram.



Your starting point in developing a plant/controller system is to model the system as two subsystems in closed-loop simulation. As your design progresses, you can use Simulink external mode with standard Real-Time Workshop targets (such as GRT or ERT) to help you model the control system separately from the plant.

However, these simulation techniques do not help you to account for restrictions and requirements imposed by the hardware (e.g., limited memory resources, or behavior of target-specific optimized code). When you finally reach the stage of deploying controller code on the target hardware, you may need to make extensive adjustments to the controller system. After these adjustments are made, your deployed system may diverge significantly from the original model. Such discrepancies can create difficulties if you need to return to the original model and change it.

PIL cosimulation addresses these issues by providing an intermediate stage between simulation and deployment. The term *cosimulation* reflects a division of labor in which Simulink models the plant, while code generated from the controller subsystem runs on the actual target hardware. In a PIL cosimulation, the target processor participates fully in the simulation loop — hence the term *processor-in-the-loop*.

Definitions

PIL Algorithm

The algorithmic code (e.g., the control algorithm) to be tested during the PIL cosimulation. The PIL algorithm resides in compiled object form to allow verification at the object level.

PIL Application

The executable application to be run on the target platform. The PIL application is created by linking the PIL algorithm object code with some wrapper code (or test harness) that provides an execution framework that interfaces to the PIL algorithm.

The wrapper code includes the `string.h` header file so that the `memcpy` function is available to the PIL application. The PIL application uses `memcpy` to facilitate data exchange between Simulink and the cosimulation target.

Note Whether the PIL algorithm code under test uses `string.h` is independent of the use of `string.h` by the wrapper code, and is entirely dependent on the implementation of the algorithm in the generated code.

How Cosimulation Works

In a PIL cosimulation, Real-Time Workshop generates efficient code for the PIL algorithm. This code runs (in simulated time) on a target platform. The plant model remains in Simulink without the use of code generation.

During PIL cosimulation, Simulink simulates the plant model for one sample interval and exports the output signals (`Yout` of the plant) to the target platform via the CrossView Pro debugger. When the target platform receives signals from the plant model, it executes the PIL algorithm for one sample step. The PIL algorithm returns its output signals (`Yout` of the algorithm) computed during this step to Simulink, via the CrossView Pro debugger. At this point, one sample cycle of the simulation is complete and the plant model proceeds to the next sample interval. The process repeats and the simulation progresses.

PIL tests do not run in real time. After each sample period, the tests halts to ensure that all data has been exchanged between the Simulink test harness and object code. You can then check functional differences between the model and generated code.

Note Outputs at the top level of the PIL model or subsystem are logged and available for verification during PIL co-simulation. If you want to examine an internal signal, you can manually route the signal up to the top level, or use GoTo and From blocks. Set the **Icon Display** parameters in these blocks to `Tag and signal name` to view the signal names at the top level.

PIL Metrics

The following metrics provide verification information to be used in conjunction with the main "signal level" cosimulation results:

- C Code Coverage reports
- Execution profiling
- Stack profiling

PIL Workflow

You can work through the PIL verification workflow demo for a hands-on example illustrating using SIL and PIL for system and unit testing: `tasking_demo_system_simulation.mdl`, found under Link for TASKING Demos.

By running this demo you will learn how to:

- Use Software-in-the-Loop (SIL) to verify correct behavior of source code, generated by Real-Time Workshop Embedded Coder and executing on the host processor
- Use Processor-in-the-Loop (PIL) to verify correct behavior of object code and generate metrics; the object code is cross-compiled from source code generated by Real-Time Workshop Embedded Coder and executes on a target embedded processor
- Create system and unit test models

- Work with multiple heterogeneous target processors
- Include existing / legacy algorithms for SIL and PIL verification
- Export a generated algorithm for inclusion in an existing project
- Generate a fully deployable model-based application

Using `target_block_verify`

The function `target_block_verify` is used in the PIL Verification Workflow demo, `tasking_demo_system_simulation.mdl`.

You can use `target_block_verify` to verify a generated PIL or SIL block and compare the results with the simulation or algorithm block.

```
[LOG_SIGS1, LOG_SIGS2] = target_block_verify('BLOCK1', 'BLOCK2')
```

turns on signal logging for the outports of `BLOCK1`, the model containing `BLOCK1` is simulated and the logged signals are returned in `LOG_SIGS1`.

Next, `BLOCK1` and `BLOCK2` are swapped, the same model is simulated again, and the logged signals for `BLOCK2` are returned in `LOG_SIGS2`.

To verify a SIL or PIL block, set `BLOCK1` to the simulation or algorithm block, and set `BLOCK2` to the generated PIL or SIL block for `BLOCK1`.

Use full path names of Simulink blocks for `BLOCK1` and `BLOCK2`.

`BLOCK2` may be in the same model as `BLOCK1`, or in its own model. The model(s) containing `BLOCK1` and `BLOCK2` are loaded.

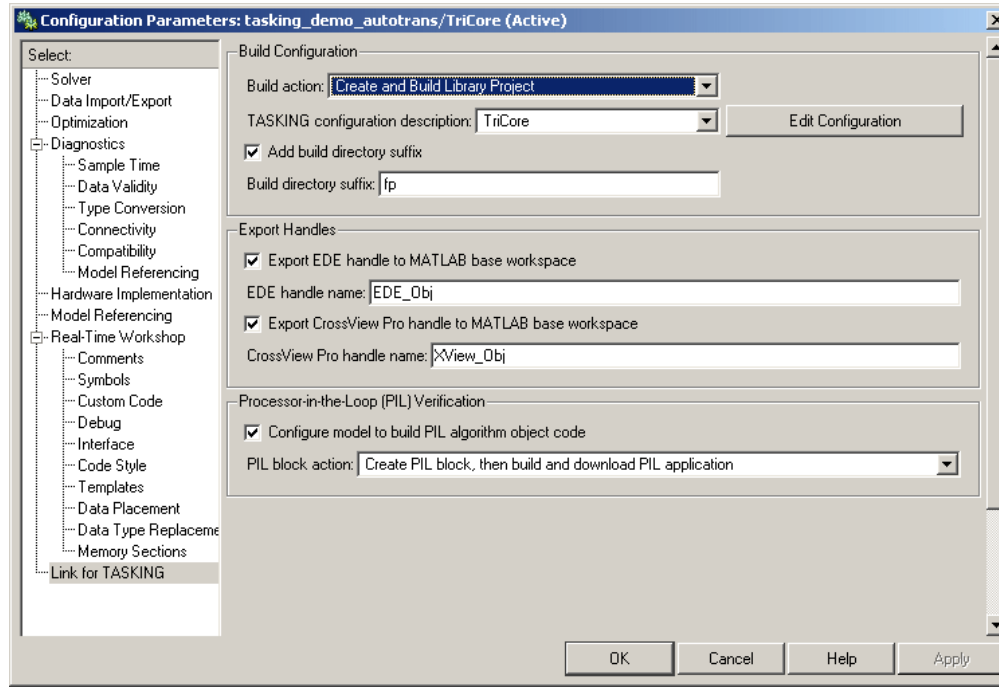
`LOG_SIGS1` and `LOG_SIGS2` are ModelDataLogs objects containing all the logged signals for the outports of `BLOCK1` and `BLOCK2` respectively. The data returned for each outport is a Timeseries object that allows comparison and plotting capabilities.

If `BLOCK1` and `BLOCK2` are in the same model, then one `LOG_SIGS` output is returned containing the data for both `BLOCK1` and `BLOCK2`.

Caution `target_block_verify` makes temporary changes to the model by swapping `BLOCK1` and `BLOCK2` in addition to setting some logging options. Although `target_block_verify` restores the original settings of the model, it is recommended that you save a copy of your model first.

Creating a PIL Block

The PIL settings can be found in the Configuration Parameters dialog box under the Link for TASKING settings.



The following options are available under **Processor-in-the-Loop (PIL) Verification**

- **Configure model to build PIL algorithm object code**

Select this box to create PIL algorithm object code as part of the Real-Time Workshop code generation process.

- **PIL block action**

  Select one of the following PIL block actions:

  - `Create PIL block, then build and download PIL application`

    Select this option to automatically build and download the PIL application after creating the PIL block. This option is the default when you select the option to configure the model for PIL.

  - `Create PIL block`

    Choose this option to create the PIL block and then stop without building. You can build manually from the PIL block.

  - `None`

    Choose this option to avoid creating a PIL block, for instance if you have already built a PIL block and do not want to repeat the action.

After you create and build a PIL block, you can either:

- Copy it into your model to replace the original subsystem (save the original subsystem in a different model so it can be restored), or
- Add it to your model to compare with the original subsystem during cosimulation.

See “Building, Running, and Debugging PIL Applications” on page 3-11 for more details.

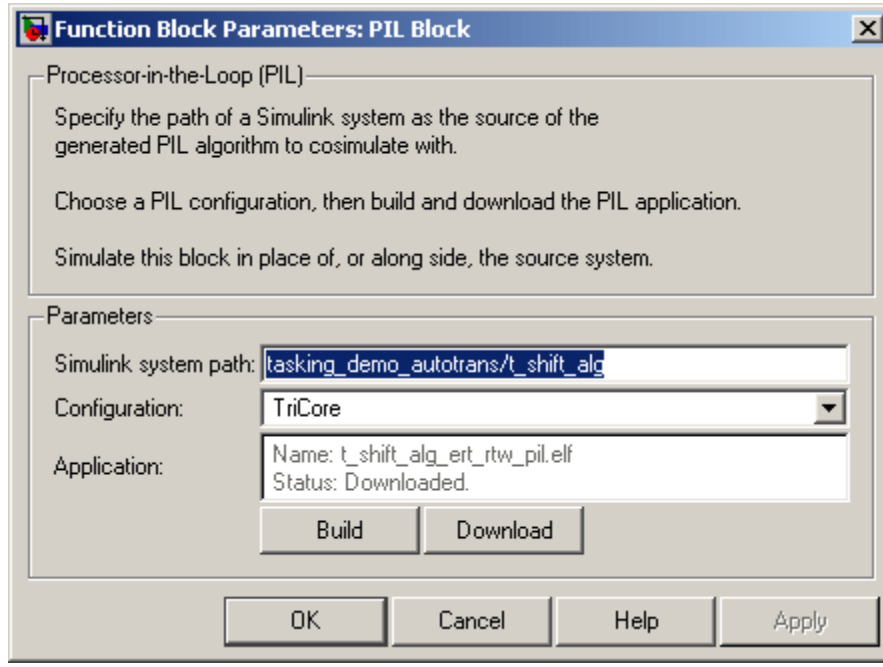
The PIL Cosimulation Block

The PIL cosimulation block is the Simulink block interface to PIL. The Simulink inputs and outputs of the PIL cosimulation block are configured to match the input and output specification of the PIL algorithm.

The block is a basic building block that allows you to:

- Select a PIL algorithm
- Choose a PIL configuration

- Build and download a PIL application
- Run a PIL cosimulation



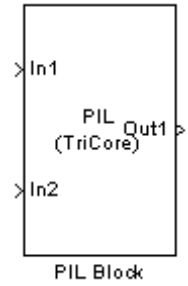
To build and download the PIL application manually:

1. Double-click the PIL block to open the mask.
2. Click **Build**. Wait until the **Application** name in the mask is updated and you see the “build complete” message.
3. Click **Download**.
4. Wait until the output in the MATLAB command window stops and you see the “download complete” message in the PIL block, and then click **OK** to close the block mask.

The PIL Application is now ready. To cosimulate with it, you must copy the PIL block into your model, either to replace the original subsystem

or in addition to it for comparison. Click **Start Simulation** to run a PIL cosimulation.

The PIL block takes the same shape and signal names as the parent subsystem, like those in the following example. This inheritance is convenient for copying the PIL block into the model to replace the original subsystem for cosimulation.



Block Parameters:

- **Simulink system path** — Allows you to select a PIL algorithm. You specify the path of a Simulink system (model or subsystem) as the source of the generated PIL algorithm to use for cosimulation.

  The Simulink system path is the full path to the system and "/" must be escaped to "//". For example, a subsystem named "fuel/sys" inside a model named "demo_fuelsys" would have the escaped system path:

  ```
  demo_fuelsys/fuel//sys
  ```

  The correct system path can be obtained by clicking on the system and then running the `gcb` command. In this example,

  ```
  >> gcb
  ans =
  demo_fuelsys/fuel//sys
  ```

- **Configuration** — Allows you to specify a PIL configuration to use for building the PIL application and running the subsequent cosimulation.

Building, Running, and Debugging PIL Applications

This section includes the following topics:

Building and Downloading PIL Applications

After you create a PIL block, you must build and download it before you can use it for cosimulation. You can use the **PIL Block Action** setting in the Configuration Parameters to automatically build and download the PIL application after the PIL block is created (select `Create PIL block, then build and download PIL application`). If you choose not to use this option, you can use the PIL block to build and download manually.

To build and download the PIL application manually:

1. Double-click the PIL block to open the mask.
2. Click **Build**. Wait until the **Application** name in the mask is updated and you see the "build complete" message.
3. Click **Download**.
4. Wait until the output in the MATLAB command window stops and you see the "download complete" message in the PIL block, and then click **OK** to close the block mask.

The PIL Application is now ready. To cosimulate with it, you must copy the PIL block into your model, either to replace the original subsystem or in addition to it for comparison. Click **Start Simulation** to run a PIL cosimulation.

After the test, Link for TASKING returns execution profiling, code coverage, and stack profiling reports to MATLAB for your review. See "PIL Metrics" on page 3-5 for more information.

Note When copying PIL blocks to be used in the same model or in different models that simulate simultaneously, you must click the **Download** button in the PIL block mask in the new block after copying.

Clicking **Download** creates new connections (handles) to the TASKING EDE and CrossView Pro debugger. Otherwise, the same debugger handle may be used by multiple PIL blocks simultaneously and cosimulation errors or incorrect results may occur. This concern does not apply when copying PIL blocks created automatically as part of the build process because the untitled model and test harness are typically not simulated together.

See the Link for TASKING demo models for examples with instructions to enable you to build and download PIL blocks and use them in cosimulation.

PIL Block Parameters. Link for TASKING creates PIL blocks with both the "Simulink system path" and "Configuration" properties automatically configured.

The available **Configurations** correspond to the TASKING configuration descriptions in the Target Preferences.

Some guidelines for choosing a valid configuration:

1. The configuration must generate debugging information because Link for TASKING requires this information to communicate with the PIL application.

2. The configuration must be compatible with the TASKING configuration description that was used to build the PIL algorithm. The fact that these two configurations need not match exactly allows the flexibility for the PIL algorithm to be compiled as if for a production environment, for example, without generating debugging information. However, you must be careful to ensure that the configurations are compatible in terms of linking, otherwise build errors occur when building the PIL application. In many cases, it is appropriate to use exactly the same configuration for building both the PIL algorithm and PIL application and therefore no errors can ever occur because of incompatibilities between configurations.

PIL Debugging

Prior to PIL cosimulation you can use the CrossView Pro debugger to set breakpoints, so that you can step through the code and watch variables during cosimulation. To do this, you must set breakpoints in CrossView Pro prior to starting the cosimulation as follows:

1. When the build process completes, a minimized CrossView Pro window should appear on your Windows Start menu. Maximize the CrossView Pro window.

2. In CrossView Pro, select **File > Open Source**, and choose a source file to open. A typical choice would be to open the main generated file associated with the algorithm, e.g. *`model`*`.c`.

3. Choose a location in the file to set a breakpoint and click the "breakpoint" button to the left of the line. A typical location for setting a breakpoint in the *`model`*`.c` file would be one of the `step` functions.

   Note You can set multiple breakpoints in multiple files if you wish.

4. To add a variable to the watch, double-click the variable, and then click **Add Watch** in the Expression Evaluation window. A typical variable to add to the watch would be either the external inputs or external outputs structures, which usually represent all of the inputs and outputs of the algorithm.

5. Start the PIL cosimulation in Simulink. When the breakpoint is hit, Simulink pauses. CrossView Pro is available for debugging, and watch variables are updated. You can step through the code, set more breakpoints, and analyze data.

6. When you are finished debugging, you can continue running by clicking the "play" button in CrossView Pro. This will allow the PIL cosimulation to continue. If you left the breakpoint in place then the cosimulation stops at that point again. To return to uninterrupted cosimulation, remove the breakpoints.

Caution Never remove the PIL synchronization breakpoint (usually set on the `pilaction` function). This breakpoint is used to maintain synchronization between Simulink and CrossView Pro.

As an alternative to manual configuration in CrossView Pro, you can obtain a handle to the `tasking.xviewapi` object associated with a PIL block by using the `tasking_pil_crossview_handle` command as follows:

```
crossview = tasking_pil_crossview_handle('block')
```

where `block` is the full Simulink system path to the PIL block. You can use `gcb` to obtain the system path after clicking on the PIL block.

This handle can be used prior to PIL cosimulation to configure breakpoints, etc., by using the CrossView Pro command language.

Caution This handle should not be used during PIL cosimulation as this could lead to incorrect PIL results or termination of the PIL cosimulation.

10-Second Pause on Termination of the CrossView Pro Debugger. When terminating an instance of the CrossView Pro debugger application that was launched by Link for TASKING, there is a pause of about 10 seconds before the CrossView Pro window closes. This 10-second pause is the intended behavior of CrossView Pro when acting as a COM server; CrossView Pro pauses for the 10 seconds to wait for clients such as MATLAB to release their COM references.

C Code Coverage Reports

After you download a PIL application and run a cosimulation, you can view reports in MATLAB. The reports available depend on the target configuration. For example, for C166 Simulator you can view C code coverage, profiling and cumulative profiling reports.

For each report, a hyperlink is provided in the MATLAB command window towards the end of the Real-Time Workshop build log, as shown in the following example:

```
PIL reports available from CrossView Pro for block: fuelsys
Coverage ("covinfo"):  Yes (pil_coverage_report)
Profiling ("proinfo"): Yes (pil_profiling_report)
Cumulative profiling ("cproinfo"):  Yes
(pil_cumulative_profiling_report)
```

Click the variable name hyperlinks (e.g., `pil_coverage_report`) to view the reports, similar to the following example:

```
pil_coverage_report =

Module:   ..\..\fuelsys0_ert_rtw_pil\pil_interface.c    81%
 Function: pilInitialize                        77%
 Function: initUDataProcessing                  76%
 Function: processUData                        100%
 Function: checkDataProcessingComplete         100%
 Function: pilStep                              71%
 Function: initYDataProcessing                  76%
 Function: processYData                        100%
 Function: pilTerminate                         75%
Module:   ..\..\..\..\..\..\aetargets with spaces\matlab\
toolbox\rtw\targets\tasking\tasking\pil\
pil_interface_lib.c    90%
 Function: getNextSymbol                       100%
 Function: processData                          90%
 Function: resetLibSymbolState                 100%
 Function: checkDataProcessing                  78%
Module:   ..\..\..\..\..\..\aetargets with spaces\matlab\
toolbox\rtw\targets\tasking\tasking\tasking_pil_main.c    72%
```

```
 Function: singleshotStep                      97%
 Function: taskingStep                         75%
 Function: taskingProcessUData                 95%
 Function: taskingProcessYData                 95%
 Function: pilaction                           39%
 Function: main                                80%
Module:   ..\..\fuelsys0_ert_rtw\fuelsys0.c    42%
 Function: Sens_Failure_Counter                13%
 Function: Fueling_Mode                        16%
 Function: Init_controllogic                  100%
 Function: controllogic                        48%
 Function: fuelsys0_step                       45%
 Function: fuelsys0_initialize                100%
 Function: fuelsys0_terminate                 100%
Module:   MEMCPY_C                           100%
Module:   MEMSET_C                           100%
Module:   CPNNW                               50%
Module:   MUL                                  0%
Module:   ..\..\slprj\ert\_sharedutils\
binarysearch_s16.c    89%
 Function: BINARYSEARCH_S16                    89%
Module:   ..\..\slprj\ert\_sharedutils\
dotproduct_s32s16.c     0%
 Function: DotProduct_s32s16                    0%
Module:   ..\..\slprj\ert\_sharedutils\
interpolate_even_s16_s16_sat.c     0%
 Function: INTERPOLATE_EVEN_S16_S16_SAT         0%
Module:   ..\..\slprj\ert\_sharedutils\
interpolate_s16_s16_sat.c    56%
 Function: INTERPOLATE_S16_S16_SAT             56%
Module:   ..\..\slprj\ert\_sharedutils\
look2d_s16_s16_s16_sat.c   100%
 Function: Look2D_S16_S16_S16_SAT             100%
Module:   ..\..\slprj\ert\_sharedutils\
div_s32_sat_floor.c    67%
 Function: div_s32_sat_floor                   67%
Module:   ..\..\slprj\ert\_sharedutils\
fix2fix_s16_s32_sat.c    75%
 Function: FIX2FIX_S16_S32_SAT                 75%
Module:   UDIL                                29%
```

```
Module:   UMOL                                  24%
Module:   fuelsys0_ert_rtw_pil                   0%
Module:   CSTART                                 0%
Module:   ..\..\fuelsys0_ert_rtw\fuelsys0_data.c     0%
```

Execution Profiling

CrossView Pro Execution Profiling

After you download a PIL application and run a cosimulation, you can view reports in MATLAB. The reports available depend on the target configuration. For example, for C166 Simulator you can view C code coverage, profiling and cumulative profiling reports.

For each report, a hyperlink is provided in the MATLAB command window towards the end of the Real-Time Workshop build log, as shown in the following example:

```
PIL reports available from CrossView Pro for block: fuelsys
Coverage ("covinfo"):  Yes (pil_coverage_report)
Profiling ("proinfo"): Yes (pil_profiling_report)
Cumulative profiling ("cproinfo"):  Yes
(pil_cumulative_profiling_report)
```

Click the variable name hyperlinks (e.g., `pil_profiling_report`) to view the reports, similar to the following example:

```
pil_profiling_report =

Total Execution Time:   473348
                                                 Cycles %Cycles
Function: pilInitialize                              18 0.004%
Function: initUDataProcessing                      2828 0.597%
Function: processUData                             1616 0.341%
Function: checkDataProcessingComplete              2020 0.427%
Function: pilStep                                  2626 0.555%
Function: initYDataProcessing                      2828 0.597%
Function: processYData                             1616 0.341%
Function: pilTerminate                               16 0.003%
Function: getNextSymbol                            37370 7.895%
Function: processData                              61610 13.02%
```

```
Function: resetLibSymbolState                  2828 0.597%
Function: checkDataProcessing                  8080 1.707%
Function: singleshotStep                      15150 3.201%
Function: taskingStep                          1616 0.341%
Function: taskingProcessUData                  9898 2.091%
Function: taskingProcessYData                  9898 2.091%
Function: pilaction                            5716 1.208%
Function: main                                 1886 0.398%
Function: Sens_Failure_Counter                 3000 0.634%
Function: Fueling_Mode                         8800 1.859%
Function: Init_controllogic                      62 0.013%
Function: controllogic                        17366 3.669%
Function: fuelsys0_step                       66864 14.13%
Function: fuelsys0_initialize                    54 0.011%
Function: fuelsys0_terminate                      4 0.001%
Function: BINARYSEARCH_S16                    41002 8.662%
Function: DotProduct_s32s16                       0 0.000%
Function: INTERPOLATE_EVEN_S16_S16_SAT            0 0.000%
Function: INTERPOLATE_S16_S16_SAT             28678 6.059%
Function: Look2D_S16_S16_S16_SAT              32320 6.828%
Function: div_s32_sat_floor                   31782 6.714%
Function: FIX2FIX_S16_S32_SAT                  4980 1.052%
Module:   MEMCPY_C                            23230 4.908%
Module:   MEMSET_C                              536 0.113%
Module:   CPNNW                               22624 4.780%
Module:   MUL                                     0 0.000%
Module:   UDIL                                10624 2.244%
Module:   UMOL                                10292 2.174%
Module:   fuelsys0_ert_rtw_pil                    0 0.000%
Module:   CSTART                                  0 0.000%
147:    switch(tasking_pil_main_action) {
```

For cumulative profiling, command line messages like the following inform you that you must configure CrossView Pro to specify which functions to collect data for. Select **Tools > Cumulative Profiling Setup**, and then run the cosimulation again to get the report.

```
NOTE: Cumulative profiling requires manual setup in
CrossView Pro.
See Tools->Cumulative Profiling Setup
```

```
DO NOT add function, pilaction, to the list of functions
to profile.
You must then run the PIL simulation again
to generate the report.

pil_cumulative_profiling_report =

CrossView Cumulative Profiling Report
-------------------------------------
Total Execution Time:  3790326
Function                              Calls    Recursive
Min.Time   Max.Time   Avg.Time   Total Time %Time
```

For information on build messages containing links at the command line, see "Command Line Project Information" on page 2-10.

Task Execution Profiling Kit for Real-Time Workshop Targets

This kit, available on MATLAB Central, provides instructions and examples on how to implement real-time task based execution profiling on a custom target. A graphical representation of on-target execution and a HTML report are provided for analysis. You can implement this for your own custom system target file that uses the Link for TASKING project generator.

For details, see
http://www.mathworks.com/matlabcentral/fileexchange/loadFile.do?objectId=12731

Stack Profiling

Stack profiling gives you a maximum bound on the stack usage of an application. The stack profiling feature works by first writing a signature to the stack memory region, then when the application executes normally, the signature pattern is overwritten by the application stack data. Finally the stack memory is read into MATLAB and analyzed to determine how much of the stack memory was used during execution.

PIL Applications

Stack profiling is automatically reported after PIL cosimulation. The report gives you a maximum bound on the stack usage of the algorithm under test.

Output at end of PIL (bold indicates hyperlinks):

```
Maximum stack usage during PIL (including the PIL
test framework overhead):
TriCore User Stack: 24/2048 (1%) words used.
TriCore Interrupt Stack: 0/256 (0%) words used.
```

The hyperlinks for the individual stacks expand to more information about that stack, as shown in the following example.

```
PIL reports available from CrossView Pro for block: fuelsys

Coverage ("covinfo"):              No
Profiling ("proinfo"):             Yes (pil_profiling_report)
Cumulative profiling ("cproinfo"): Yes (pil_cumulative_profiling_report)

Maximum stack usage during PIL (including the PIL test framework overhead):

TriCore User Stack: 24/2048 (1%) words used.
TriCore Interrupt Stack: 0/256 (0%) words used.

         name: TriCore User Stack
  baseAddress: 0xA0080130 (2684879152 decimal)
   endAddress: 0xA008212F (2684887343 decimal)
      memSize: 0x2000 (8192 decimal) memory units
growDirection: down
  memorySpace: N/A
```

The hyperlink for "including the PIL test framework overhead" expands to:

PIL Test Framework Overhead:

The maximum stack usage reported after PIL is the stack usage of the entire PIL application, which includes a small amount of stack used by the PIL test framework. The stack usage reported is therefore a maximum bound on the stack usage of the algorithm under test.

To more accurately determine the stack usage of the algorithm it is possible to use the Link for TASKING CrossView Pro stack profiling feature on an application that is not configured for PIL. This will allow the stack usage to be determined without the stack overhead of the PIL test framework.

Non-PIL Applications

Non-PIL applications (perhaps with stimulus signals coming from target I/O drivers) can be profiled using the CrossView Pro API commands `stackProfileReset` and `stackProfile`.

1. Call `stackProfileReset` to reset the application you are debugging, and write a signature pattern to the stack memory region. Use the following syntax:

   xview`.stackProfileReset`

where *xview* is a `tasking.xviewapi` object. See “Methods for Class tasking.xviewapi” on page 2-20.

2. Call `stackProfile` immediately after resetting to view 0% stack usage profiling results.
3. Execute the application (e.g., `xview.execute('C')`).
4. After the amount of time you want to profile for, stop the application using `xview.halt`
5. Call `stackProfile` to get the profiling results for the execution period.

An example of this procedure is shown following.

```
>> XView_Obj.stackProfileReset
CrossView Pro: A hardware reset occurred.
CrossView Pro: A software reset of the program occurred.
>> XView_Obj.stackProfile
Maximum stack usage since last profile reset:

TriCore User Stack: 0/2048 (0%) words used.
TriCore Interrupt Stack: 0/256 (0%) words used.

>> XView_Obj.execute('C');
CrossView Pro: The target is running.
>> XView_Obj.halt
CrossView Pro: The target stopped executing with cause: "UNKNOWN"
CrossView Pro: Command with sequence number 71 completed.
>> XView_Obj.stackProfile
Maximum stack usage since last profile reset:

TriCore User Stack: 4/2048 (0%) words used.
TriCore Interrupt Stack: 0/256 (0%) words used.
```

Infineon TriCore Stack Depth Analyzer

The Infineon TriCore Stack Depth Analyzer (SDA) tool is a static stack depth analyzer for the TASKING TriCore toolset. This is an alternative to the dynamic stack profiling provided with Link for TASKING.

It can be found at the Infineon TriCore Software Downloads page:

```
http://www.infineon.com/cgi-bin/ifx/portal/ep/channelView.do?channelId=-75077&pageTypeId=17099
```

Bidirectional Traceability Between Code and Model

Context menu items and command-line methods allow you to navigate bidirectionally between Simulink blocks and the corresponding generated source files in the Tasking EDE or the CrossView Pro debugger.

See the demo tasking_demo_objects to try this feature. This is a command line demo that you can run from the Help browser.

To find the generated code for any block in the model, right click on the block and select: **Link for TASKING > See Generated Code in EDE** or **Link for TASKING > See Generated Code in CrossView Pro**.

This opens the source file which contains the generated code for the block, and highlights the Real-Time Workshop tag for that block. The Real-Time Workshop tag is usually found in the block's generated comments preceding the block's code.

There are command-line alternatives to the right-click context menu items — see `tasking_demo_objects` for an example.

To find the block which corresponds to some generated code in the EDE or CrossView Pro:

1. Click to place the cursor at the line of code containing the Real-Time Workshop Tag for the given block. Here is an example:

   ```
   /* Outputs for atomic SubSystem: '<Root>/SS2'
   ```

2. Enter at the MATLAB command prompt:

   ```
   EDE_Obj.hilite_system
   ```

   or

   ```
   XView_Obj.hilite_system
   ```

Enabling Traceability

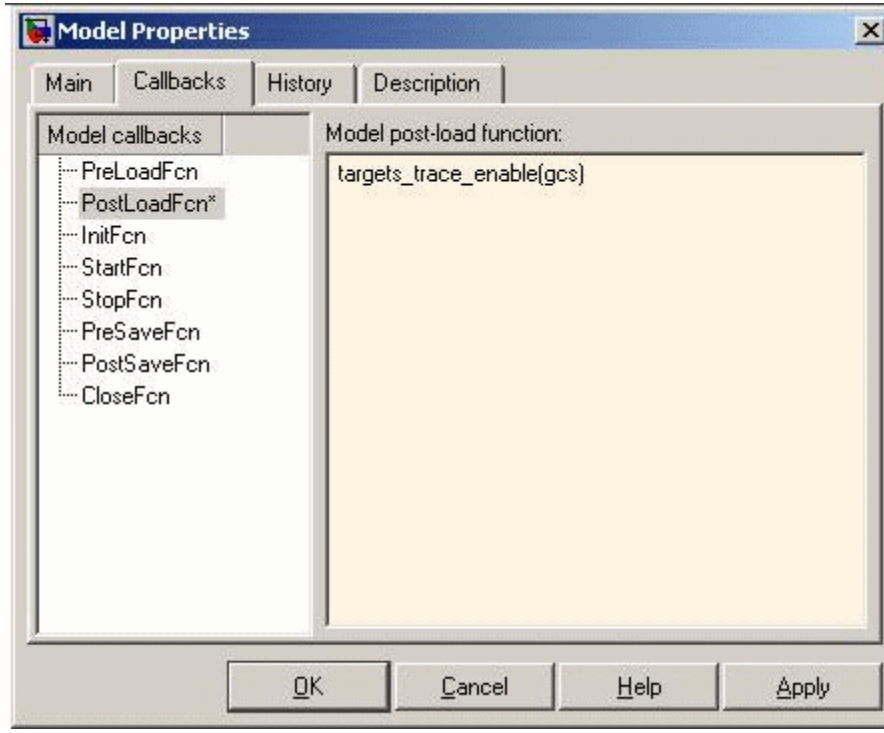
To use the Traceability feature, you must configure your model as follows:

1 Enable the generation of traceability information by adding `targets_trace_enable(gcs)` to the `PostLoadFcn` callback of the model.

   a Select **File > Model Properties > Callbacks**.'

   b Click `PostLoadFcn`.

   c Enter `targets_trace_enable(gcs)`, as shown.



   Click **OK**.

Note `targets_trace_enable` also selects the check box options **Generate HTML report** and **Include hyperlinks to model** under Real-Time Workshop in the Configuration Parameters dialog box.

---

2 The model must use an ERT based Target.

MISRA-C Rule Checking

The TASKING C compiler supports MISRA-C rule checking and can be easily configured to check the code generated by Real-Time Workshop.

You can switch on MISRA-C rule checking in your application and/or library template projects. When you build using these template projects, the TASKING compiler will provide warnings about MISRA-C violations. Link for TASKING returns these warnings to the MATLAB command line for your review.

Link for TASKING provides an example application project template, pre-configured for MISRA-C rule checking, for the TASKING TriCore Toolset. For instructions, see the MISRA-C Rule Checking demo, found under Link for TASKING Demos.

Optimization

Compiler / Linker Optimization Settings

Template projects allow you to fully control the optimization settings used by the compiler and linker.

- See “Template Projects” on page 2-4 for details of using template projects.
- See “PIL Block Parameters” on page 3-12 for information about optimization setting requirements for Processor-in-the-Loop.
- See the TASKING documentation for details of available optimization settings.

Target Memory Placement / Mapping

Template projects allow you to fully control the target memory map used for your application.

- See “Overview of the Project Generator Component” on page 2-2 for a general discussion of how the code generation process and subsequent build process work together, including a memory placement example.
- See “Template Projects” on page 2-4 for details of using template projects. See TASKING documentation for details of memory map settings.

Execution and Stack Profiling

Execution Profiling

Execution profiling metrics from the CrossView Pro instruction set simulator during PIL cosimulation can be used to identify areas of your algorithms that can be further optimized.

See "Execution Profiling" on page 3-18 for details.

Stack Profiling

Stack profiling metrics for PIL cosimulation or real-time applications can be used to optimize the amount of stack memory required for an application.

See "Stack Profiling" on page 3-21 for details.

Target Specific Optimizations

Target Optimized Libraries for Infineon XC166 and TriCore

The following optimized libraries are available for the processors supported by Link for TASKING, and can be used to create optimized Simulink blocks:

- Infineon XC166 DSP Library

  See the Infineon C166 Software Downloads Web page to get the XC166 DSP Library:

  ```
  http://www.infineon.com/cgi-bin/ifx/portal/ep/channelView.do?channelId=-75076&pageTypeId=17099
  ```

  This library is described by Infineon as follows:

  XC166 DSP library is a DSP function library, is C-callable, hand-coded assembly, general purpose signal processing routines:

  - Arithmetic Functions
  - Filters (FIR–, IIR–, Adaptive Filters)
  - Transforms (FFT, IFFT)
  - Matrix Operations
  - Mathematical Operations
  - Statistical Functions

- Infineon TriCore DSP Library (TriLib)

  See the Infineon TriCore Software Downloads page to get the TriLib DSP Library:

  ```
  http://www.infineon.com/cgi-bin/ifx/portal/ep/channelView.do?channelId=-75076&pageTypeId=17099
  ```

  This library is described by Infineon as follows:

TriLib is a DSP Library for TriCore™, containing more than 60 commonly used DSP routines for

- Complex & Vector Arithmetic
- FIR, IIR, Adaptive Filters
- Fast Fourier, Discrete Cosine Transform
- Mathematical, Matrix, Statistical functions

Target Optimized FIR / FFT Blocks for the Infineon TriCore

Example FIR / FFT blocks that call target optimized Infineon TriLib routines are available on MATLAB Central. These blocks can be over a hundred times faster than the regular blocks in the Signal Processing Blockset.

Search MATLAB Central for details.

C Language Extensions / Intrinsics

Depending on your toolset, your TASKING compiler may support C language extensions or intrinsics to help optimize in some of the following areas:

- Data Types (eg. Fractional Arithmetic, Bit Addressable Memory)
- Memory Qualifiers (eg. Near, far address space)
- Data Type Qualifiers (eg. Circular Buffers, Saturated arithmetic)

Please see your TASKING documentation for details. You can use these language extensions in your own Simulink blocks and / or custom code.

Model Advisor

Following the suggestions in the Model Advisor report may result in faster on-target execution. See “Consulting Model Advisor” in the Simulink documentation.

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Tutorials

Tutorial: Using Option Sets

Option sets are preconfigured settings to specify the target configuration for the TASKING tools. You use option sets to apply EDE project settings (e.g., compiler and linker settings, hardware or simulator) that you can then modify if you choose. For example, once you have set up your target preferences for a TriCore configuration, you can use option sets to switch between using an instruction set simulator configuration, two hardware board configurations, or a simulator with some MISRA-C rule checking.

To choose an option set:

1. Select **Start > Simulink > Link for TASKING > Select Preconfigured Target Preference Settings**.

   The TASKING Configuration Selection dialog box appears.

2. Select a target configuration (e.g., `C166`, `TriCore`) from the list in the dialog box, and click **OK**.

   The Option Set Selection dialog box appears.

3. Select an option set. The list items are specific to the configuration you selected; the available option sets are listed in “Option Sets” on page 1-30. Click **OK**.

   Your target preferences are automatically updated according to the option set you select, and command line messages inform you the following target preferences have changed:

   - `EDE_Configuration`

     `Template_Application_Project`: Set to default template application project relating to the option set.

     `Template_Library_Project`: Set to default template library project relating to the option set.

   - `CrossView_Pro_Configuration`

     `Initialization_File`: Set to CrossView Pro (`.st`) initialization file relating to the option set.

Now, when you build any model configured for the same target (e.g., `TriCore`), these project settings are used. To switch to a different option set, repeat the steps.

You can also use option sets to set up an initial configuration when creating new template projects. See “Tutorial: Creating New Template Projects” on page 5-4.

Tutorial: Creating New Template Projects

Note You may want to create a new configuration to use with new template projects. See the next section, "Tutorial: Creating a New Configuration" on page 5-6 for details.

In this tutorial, you create new template projects for a target configuration and set up options such as simulator or hardware implementation, compiler and linker settings, MISRA-C rule checking, or any other project options. Every time you build a model for the selected target configuration, the project options you have set up in the new template projects are used.

To create custom application and library template projects:

1. Select **Start > Simulink > Link for TASKING > Create New Template Projects**.
2. When prompted to select a configuration, select your target (e.g., `TriCore`), and click **OK**.

   Your target preferences for the location of your TASKING installation must be set up for the target configuration you choose (see "Setting Target Preferences" on page 1-9).

   a. Make sure the fields are filled in for this configuration (except the Application and Library Template Projects fields, and CrossView Initialization field, which are autopopulated during the following steps).

   b. If your target preferences are set up correctly, your TASKING EDE launches when you click **OK**.
3. When you are prompted, choose a location for the template projects, and enter the template name.
4. When you are prompted, choose an option set. An *option set* delineates options specific to your target, such as whether you want to use the simulator or hardware. You can use these to set up an initial configuration to modify later. See "Option Sets" on page 1-30 for more information and a list of available option sets.

You now have custom template projects for this new configuration. The EDE project settings associated with the option set are applied to the new template projects. Messages at the command line inform you the following target preferences have been automatically updated:

- EDE_Configuration

  `Template_Application_Project`: Set to new template application project configured by the option set.

  `Template_Library_Project`: Set to new template library project configured by the option set.

- CrossView_Pro_Configuration

  `Initialization_File`: Set to CrossView Pro (`.st`) initialization file configured by the option set.

Note You can always choose a preconfigured option set to return to the default settings (using the **Start** menu option **Select Preconfigured Target Preference Settings**).

Next, modify the compiler settings for these new template projects.

5 To modify the template projects, you need to open them in the TASKING EDE:

a Select **Start > Simulink > Link for TASKING > Open Existing Template Projects**.

b When you are prompted to select a configuration, select the same target for which you created new template projects, and click **OK**.

The template projects should now be open in the EDE.

Note Opening or making changes to template projects causes the regeneration of application and library projects.

---

c Right-click the project in the TASKING EDE, and select **Project Options**. You can now modify the project options (compiler settings, linker settings, etc.).

Note When making any changes to template projects, it is important to remove the project from the project space, to make sure your changes are written to disk. Otherwise the changes may not be applied immediately. To remove a current project from the project space, right-click on it and choose **Remove from Project Space**.

---

d When done, close the template projects in the TASKING EDE.

6 To modify your CrossView Pro configuration (optional) you need to specify a `.ini` file in the `Initialization_File` Target Preference field. See `Initialization` in the section "Target Preference Fields" on page 1-11.

You are now ready to use the configuration.

7 Open any Simulink model that is configured with Link for TASKING (`tasking_demo_fuelsys`, for example).

8 Select **Simulation > Configuration Parameters**. The Configuration Parameters dialog box opens.

9 Select **Link for TASKING** on the left-side panel. When you select your target in the **TASKING Configuration Description** menu, the template projects you have set up are used.

See "Template Projects" on page 2-4 for details about how Link for TASKING uses template projects during the build process.

Tutorial: Creating a New Configuration

You can customize the default Target Preference configurations by choosing from the preconfigured options sets, or by creating new template projects.

However, it may be useful to create a new Target Preference configuration if you want to switch between them in the **TASKING Configuration Description** menu. For example, if your target is TriCore, you could set

up a new configuration called `TriCore_user` to specify hardware settings for your target; then you can easily switch between `TriCore` (the default instruction set simulator configuration) and `TriCore_user` using the **TASKING Configuration Description** menu in your model's Configuration Parameters dialog box.

In this tutorial, you create a new TASKING configuration and save it in the TASKING target preferences. You can then use your new configuration in any Simulink model that is configured with Link for TASKING by selecting it in the **TASKING Configuration Description** menu.

To create a new configuration:

1. From the MATLAB **Start** menu select **Simulink > Link for TASKING > TASKING Target Preferences**.
2. Select `Create new Configuration`, and click **OK**.
3. Expand `Configuration_Options`.
4. Type `Tutorial` in the **Configuration_Description** field.
5. Fill in the rest of the fields for this configuration. See "Setting Target Preferences" on page 1-9 to set these fields properly.
   a. You must specify the location of your toolset, by filling in the path to the `CrossView_Pro_Executable`, the `DOL_File`, and the `EDE_Executable`.
   b. You can set up the template projects and CrossView initialization fields automatically in one of two ways:
      - You can use the **Start** menu option **Select Preconfigured Target Preference Settings**. See "Tutorial: Using Option Sets" on page 5-2 for instructions.
      - You can create new template projects for this configuration. See "Tutorial: Creating New Template Projects" on page 5-4.

      If you are going to use either of these options you can leave the template projects and CrossView initialization fields blank, because they will be filled in automatically when you follow the steps in using option sets or creating new template projects.

Click **OK** to close and save your target preferences.

6 After you save your target preferences, you can use the new `Tutorial` configuration in any model that is configured with Link for TASKING. For example, open any of the Link for TASKING demo models (such as `tasking_demo_fuelsys`).

7 Select **Simulation > Configuration Parameters**. The Configuration Parameters dialog box opens.

8 Select **Link for TASKING** on the left-side panel. Click the **TASKING Configuration Description** menu, and notice that the `Tutorial` configuration now appears in the list.

Tutorial: Configuring an Existing Model for Link for TASKING

In this tutorial, you configure an existing fixed-point model and build it with Link for TASKING.

1. At the MATLAB command prompt, type `rtwdemo_fixptdiv` to open a fixed-point demo model.
2. Switch the model to use Real-Time Workshop Embedded Coder as follows:
   a. Select **Simulation > Configuration Parameters**, and click **Real-Time Workshop**.
   b. Click **Browse** and select `ert.tlc` (first item in the list). Click **OK**.
3. Select **Tools > Link for TASKING > Add Link for TASKING Configuration to Model** to add the Link for TASKING configuration set to the model.
4. Open the Configuration Parameters dialog box again from the **Simulation** menu, and verify that the Link for TASKING configuration set is now added to the model. Select **Link for TASKING** from the left panel:
   a. Set the **Build Action** to `Create and Build Application Project`.
   b. Select the **TASKING Configuration Description** to match your target.
   c. Select the check box option to **Add Build Directory Suffix**, and type `int` in the **Build Directory Suffix** field.
   d. Under the Real-Time Workshop options, select **Interface** and clear the check box for **floating-point numbers** support under **Software environment**, because this model is fixed point. Clearing this option instructs Real-Time Workshop to avoid building the floating-point version of the `rtwlib` library.
   e. Under **Real-Time Workshop**, select **Hardware Implementation**, and select your device type. For example:
      - For C166 platforms, select Infineon C16x, XC16x.
      - For TriCore platforms, select Infineon TriCore.
      - For ARM platforms, select ARM 7/8/9.

- For Renesas M16C, 8051 Compatible, or Freescale DSP563xx (16-bit mode) platforms, select those options.

You are now ready to build the model. Press **Ctrl+B** or select **Tools > Real-Time Workshop > Build Model**.

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Examples

Use this list to find examples in the documentation.

Tutorials

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