Polyspace® Code Prover™

User's Guide

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Polyspace® Code Prover™ User's Guide

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Contents

1 Introduction to Polyspace Products

2 How to Use Polyspace Software

3 Setting Up Project: Basic Steps

4 Setting Up Project : Advanced Steps

5 Setting Up Project: Additional Information

6 Emulating Your Runtime Environment

7 Preparing Source Code for Verification

8 Running a Verification

9 Troubleshooting Verification Problems

10 Reviewing Verification Results

11 Managing Orange Checks

12 Coding Rule Sets and Concepts

13 Checking Coding Rules

14 Software Quality with Polyspace Metrics

15 Configure Model for Code Analysis

16 Model Link for Polyspace Code Prover

17 Configure Code Analysis Options

18 Run Polyspace on Generated Code

19 Using Polyspace Software in the Eclipse IDE

20 Using Polyspace Software in Visual Studio

Glossary

Introduction to Polyspace Products

Polyspace Code Prover Product Description

Prove the absence of run-time errors in software

Polyspace Code Prover proves the absence of overflow, divide-by-zero, out-of-bounds array access, and certain other run-time errors in C and C++ source code. It produces results without requiring program execution, code instrumentation, or test cases. Polyspace Code Prover uses static analysis and abstract interpretation based on formal methods. You can use it on handwritten code, generated code, or a combination of the two. Each operation is color-coded to indicate whether it is free of run-time errors, proven to fail, unreachable, or unproven.

Polyspace Code Prover also displays range information for variables and function return values, and can prove which variables exceed specified range limits. Results can be published to a dashboard to track quality metrics and ensure conformance with software quality objectives. Polyspace Code Prover can be integrated into build systems for automated verification.

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

Key Features

- Proven absence of certain run-time errors in C and C++ code
- Color-coding of run-time errors directly in code
- Calculation of range information for variables and function return values
- Identification of variables that exceed specified range limits
- Quality metrics for tracking conformance with software quality objectives
- Web-based dashboard providing code metrics and quality status
- Guided review-checking process for classifying results and run-time error status
- Graphical display of variable reads and writes

Polyspace Verification

In this section...

Polyspace Verification

Polyspace products verify C, C++, and Ada code by detecting run-time errors before code is compiled and executed.

To verify the source code, you set up verification parameters in a project, run the verification, and review the results. A graphical user interface helps you to efficiently review verification results. The software assigns a color to operations in the source code as follows:

- **Green** – Indicates that the operation is proven to not have certain kinds of error.
- **Red** – Indicates that the operation is proven to have at least one error.
- **Gray** – Indicates unreachable code.
- **Orange** – Indicates that the operation can have an error along some execution paths.

The color-coding helps you to quickly identify errors and find the exact location of an error in the source code. After you fix errors, you can easily run the verification again.

Value of Polyspace Verification

Polyspace verification can help you to:

Enhance Software Reliability

Polyspace software enhances the reliability of your C/C++ applications by proving code correctness and identifying run-time errors. Using advanced verification techniques, Polyspace software performs an exhaustive verification of your source code.

Because Polyspace software verifies all executions of your code, it can identify code that:

- Never has an error
- Always has an error
- Is unreachable
- Might have an error

With this information, you know how much of your code does not contain run-time errors, and you can improve the reliability of your code by fixing errors.

You can also improve the quality of your code by using Polyspace verification software to check that your code complies with established coding standards, such as the MISRA C®, MISRA® C++ or JSF® C++ standards.[1]

Decrease Development Time

Polyspace software reduces development time by automating the verification process and helping you to efficiently review verification results. You can use it at any point in the development process. However, using it during early coding phases allows you to find errors when it is less costly to fix them.

You use Polyspace software to verify source code before compile time. To verify the source code, you set up verification parameters in a project, run the verification, and review the results. This process takes significantly less time than using manual methods or using tools that require you to modify code or run test cases.

Color-coding of results helps you to quickly identify errors. You will spend less time debugging because you can see the exact location of an error in the source code. After you fix errors, you can easily run the verification again.

Polyspace verification software helps you to use your time effectively. Because you know the parts of your code that do not have errors, you can focus on the code with proven (red code) or potential errors (orange code).

Reviewing code that might have errors (orange code) can be time-consuming, but Polyspace software helps you with the review process. You can use filters to focus on certain types of errors or you can allow the software to identify the code that you should review.

1. MISRA and MISRA C are registered trademarks of MISRA Ltd., held on behalf of the MISRA Consortium.

Improve the Development Process

Polyspace software makes it easy to share verification parameters and results, allowing the development team to work together to improve product reliability. Once verification parameters have been set up, developers can reuse them for other files in the same application.

Polyspace verification software supports code verification throughout the development process:

- An individual developer can find and fix run-time errors during the initial coding phase.
- Quality assurance engineers can check overall reliability of an application.
- Managers can monitor application reliability by generating reports from the verification results.

How Polyspace Verification Works

Polyspace software uses *static verification* to prove the absence of run-time errors. Static verification derives the dynamic properties of a program without actually executing it. This differs significantly from other techniques, such as run-time debugging, in that the verification it provides is not based on a given test case or set of test cases. The dynamic properties obtained in the Polyspace verification are true for all executions of the software.

What is Static Verification

Static verification is a broad term, and is applicable to any tool that derives dynamic properties of a program without executing the program. However, most static verification tools only verify the complexity of the software, in a search for constructs that may be potentially erroneous. Polyspace verification provides deep-level verification identifying almost all run-time errors and possible access conflicts with global shared data.

Polyspace verification works by approximating the software under verification, using representative approximations of software operations and data.

For example, consider the following code:

```
for (i=0 ; i<1000 ; ++i)
{    tab[i] = foo(i);
}
```

To check that the variable `i` never overflows the range of `tab`, a traditional approach would be to enumerate each possible value of `i`. One thousand checks would be required.

Using the static verification approach, the variable `i` is modelled by its domain variation. For instance, the model of `i` is that it belongs to the static interval [0..999]. (Depending on the complexity of the data, convex polyhedrons, integer lattices and more elaborate models are also used for this purpose).

By definition, an approximation leads to information loss. For instance, the information that `i` is incremented by one every cycle in the loop is lost. However, the important fact is that this information is not required to ensure that no range error will occur; it is only necessary to prove that the domain variation of `i` is smaller than the range of `tab`. Only one check is required to establish that — and hence the gain in efficiency compared to traditional approaches.

Static code verification has an exact solution. However, this exact solution is not practical, as it would require the enumeration of all possible test cases. As a result, approximation is required for a usable tool.

Exhaustiveness

Nothing is lost in terms of exhaustiveness. The reason is that Polyspace verification works by performing upper approximations. In other words, the computed variation domain of a program variable is a superset of its actual variation domain. As a result, Polyspace verifies run-time error items that require checking.

Related Products

In this section...

Polyspace Products for Verifying Ada Code

For information about Polyspace products that verify Ada code, see the following:

http://www.mathworks.com/products/polyspaceclientada/

http://www.mathworks.com/products/polyspaceserverada/

Polyspace Bug Finder

For information about Polyspace Bug Finder™ , see http://www.mathworks.com/products/polyspace-bug-finder/.

Tool Qualification and Certification

You can use the DO Qualification Kit and IEC Certification Kit products to qualify Polyspace Products for C/C++ for DO and IEC Certification.

To view the artifacts available with these kits, use the Certification Artifacts Explorer. Artifacts included in the kits are not accessible from the MathWorks® web site.

For more information on the IEC Certification Kit, see IEC Certification Kit (for ISO 26262 and IEC 61508).

For more information on the DO Qualification Kit, see DO Qualification Kit (for DO-178).

2

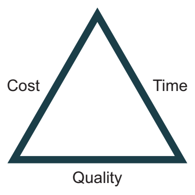
How to Use Polyspace Software

Polyspace Verification and the Software Development Cycle

In this section...
"Software Quality and Productivity" on page 2-2
"Best Practices for Verification Workflow" on page 2-3

Software Quality and Productivity

The goal of most software development teams is to maximize both quality and productivity. However, when developing software, there are three related variables to consider: cost, quality, and time.



Changing the requirements for one of these variables affects the other two.

Generally, the criticality of your application determines the balance between these three variables – your quality model. With classical testing processes, development teams generally try to achieve their quality model by testing all modules in an application until each module meets the required quality level. Unfortunately, this process often ends before quality requirements are met, because the available time or budget has been exhausted.

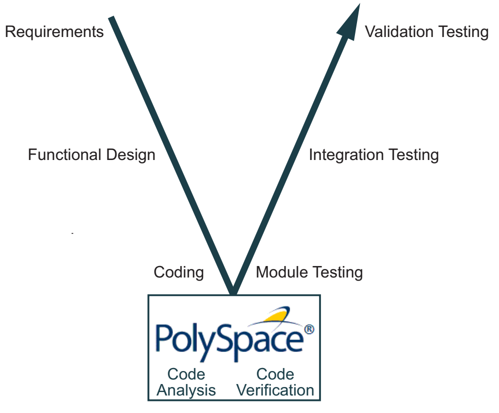
Polyspace verification allows a different process. Polyspace verification can support both productivity improvement and quality improvement at the same time. However, you must balance the aims of these activities.

You should not perform code verification at the end of the development process. To achieve maximum quality and productivity, integrate verification into your development process, considering time and cost restrictions.

This section describes how to integrate Polyspace verification into your software development cycle. It explains both how to use Polyspace verification in your current development process, and how to change your process to get more out of verification.

Best Practices for Verification Workflow

Polyspace verification can be used throughout the software development cycle. However, to maximize both quality and productivity, the most efficient time to use it is early in the development cycle.



Polyspace Verification in the Development Cycle

Typically, verification is conducted in two stages. First, you verify code as it is written, to check coding rules and quickly identify obvious defects. Once the code is stable, you verify it again before module/unit testing, with more stringent verification and review criteria.

Using verification early in the development cycle improves both quality and productivity, because it allows you to find and manage defects soon after the code is written. This saves time because each user is familiar with their own code, and can quickly determine why the code contains defects. In addition, defects are cheaper to fix at this stage, since they can be addressed before the code is integrated into a larger system.

Implement Process for Verification

Overview of the Polyspace Process

Polyspace verification cannot magically produce quality code at the end of the development process. However, if you integrate Polyspace verification into your development process, Polyspace verification helps you to measure the quality of your code, identify issues, and ultimately achieve your own quality goals.

To implement Polyspace verification within your development process, you must perform each of the following steps:

1. Define your quality goals.
2. Define a process to match your quality goals.
3. Apply the process to assess the quality of your code.
4. Improve the process.

Define Process to Meet Your Goals

Once you have defined your quality goals, you must define a process that allows you to meet those goals. Defining the process involves actions both within and outside Polyspace software.

These actions include:

- Communicating coding standards (coding rules) to your development team.
- Setting Polyspace analysis options. For more information, see "Specify Analysis Options".
- Setting review criteria in the Results Manager perspective for consistent review of results. For more information, see "Organize Results Using Review Scopes".

Apply Process to Assess Code Quality

Once you have defined a process that meets your quality goals, it is up to your development and testing teams to apply it consistently to all software components.

This process includes:

1. Running a Polyspace verification on each software component as it is written.
2. Reviewing verification results consistently. See "Assign Review Status to Result".
3. Saving review comments for each component, so they are available for future review. See "Import Review Comments from Previous Verifications".
4. Performing additional verifications on each component, as defined by your quality goals.

Improve Your Verification Process

Once you review initial verification results, you can assess both the overall quality of your code, and how well the process meets your requirements for software quality, development time, and cost restrictions.

Based on these factors, you may want to take actions to modify your process. These actions may include:

- Reassessing your quality goals.
- Changing your development process to produce code that is easier to verify.
- Changing Polyspace analysis options to improve the precision of the verification.
- Changing Polyspace options to change how verification results are reported.

For more information, see "Orange Check Management".

Sample Workflows for Polyspace Verification

In this section...

Overview of Verification Workflows

Polyspace verification supports two goals at the same time:

- Reducing the cost of testing and validation
- Improving software quality

You can use Polyspace verification in different ways depending on your development context and quality model.

This section provides sample workflows that show how to use Polyspace verification in a variety of development contexts.

Software Developers and Testers – Standard Development Process

User Description

This workflow applies to software developers and test groups using a standard development process, where coding rules are not used or followed consistently.

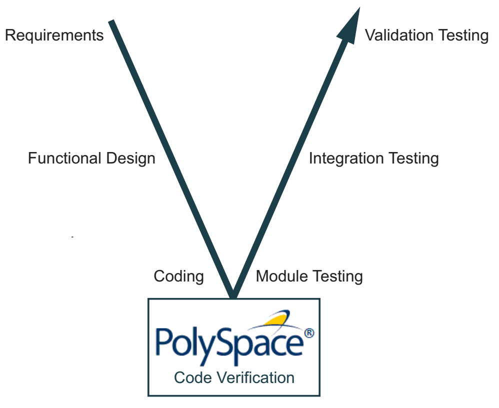
Quality

The main goal of Polyspace verification is to improve productivity while maintaining or improving software quality. Verification helps developers and testers find and fix bugs more quickly than other processes. It also improves software quality by identifying bugs that otherwise might remain in the software.

In this process, the goal is not to completely prove the absence of errors. The goal is to deliver code of equal or better quality that other processes, while optimizing productivity to provide a predictable time frame with minimal delays and costs.

Verification Workflow

This process involves file-by-file verification immediately after coding, and again just before functional testing.



The verification workflow consists of the following steps:

1. The project leader configures a Polyspace project to perform robustness verification, using default Polyspace options.

   Note: This means that verification uses the automatically generated “main” function. This main will call unused procedures and functions with full range parameters.

   ---
2. Each developer performs file-by-file verification as they write code, and reviews verification results.
3. The developer fixes **red** errors and examines **gray** code identified by the verification.
4. Until coding is complete, the developer repeats steps 2 and 3 as required..
5. Once a developer considers a file complete, they perform a final verification.
6. The developer fixes **red** errors, examines **gray** code, and performs a selective orange review.

Note: The goal of the selective orange review is to find as many bugs as possible within a limited period of time.

Using this approach, it is possible that some bugs may remain in unchecked oranges. However, the verification process represents a significant improvement from other testing methods.

Costs and Benefits

When using verification to detect bugs:

- **Red and gray checks** – Reviewing red and gray checks provides a quick method to identify real run-time errors in the code.
- **Orange checks** – Selective orange review provides a method to identify potential run-time errors as quickly as possible. The time required to find one bug varies from 5 minutes to 1 hour, and is typically around 30 minutes. This represents an average of two minutes per orange check review, and a total of 20 orange checks per package in Ada and 60 orange checks per file in C.

Disadvantages to this approach:

- **Number of orange checks –** If you do not use coding rules, your verification results will contain more orange checks.
- **Unreviewed orange checks** – Some bugs may remain in unchecked oranges.

Software Developers and Testers – Rigorous Development Process

User Description

This workflow applies to software developers and test engineers working within development groups. These users are often developing software for embedded systems, and typically use coding rules.

These users typically want to find bugs early in the development cycle using a tool that is fast and iterative.

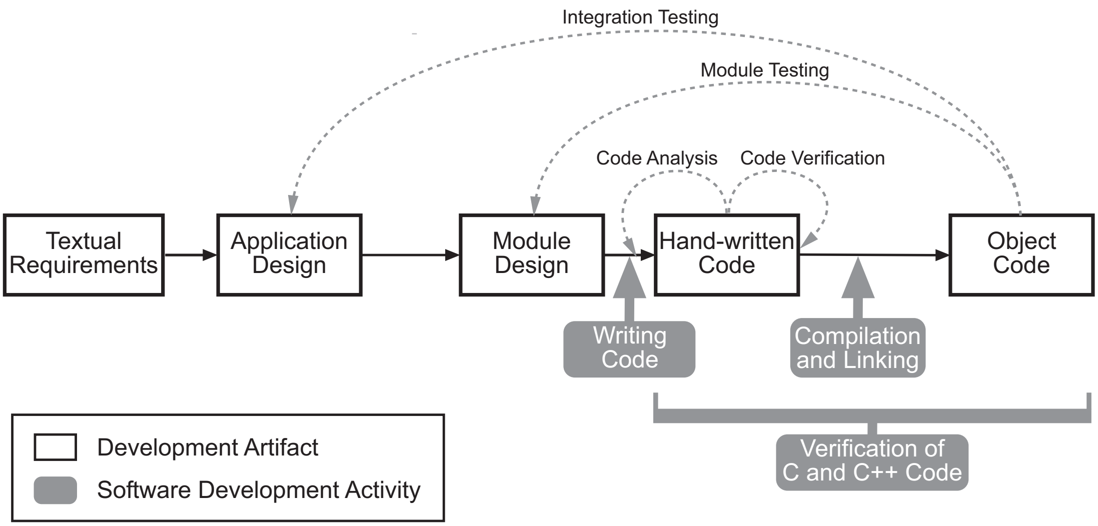
Quality

The goal of Polyspace verification is to improve software quality with equal or increased productivity.

Verification can prove the absence of run-time errors, while helping developers and testers to find and fix defects efficiently.

Verification Workflow

This process involves both code analysis and code verification during the coding phase, and thorough review of verification results before module testing. It may also involve integration analysis before integration testing.



Workflow for Code Verification

Note: Solid arrows in the figure indicate the progression of software development activities.

The verification workflow consists of the following steps:

1 The project leader configures a Polyspace project to perform contextual verification. This involves:

- Using Data Range Specifications (DRS) to define initialization ranges for input data. For example, if a variable "x" is read by functions in the file, and if x can be initialized to any value between 1 and 10, this information should be included in the DRS file.

- Creates a “main” program to model call sequence, instead of using the automatically generated main.
- Sets options to check the properties of some output variables. For example, if a variable “y” is returned by a function in the file and should always be returned with a value in the range 1 to 100, then Polyspace can flag instances where that range of values might be breached.

2. The project leader configures the project to check the required coding rules.
3. Each developer performs file-by-file verification as they write code, and reviews both coding rule violations and verification results.
4. The developer fixes coding rule violations and **red** errors, examines **gray** code, and performs a selective orange review.
5. Until coding is complete, the developer repeats steps 2 and 3 as required.
6. Once a developer considers a file complete, they perform a final verification.
7. The developer or tester performs an exhaustive orange review on the remaining orange checks.

Note: The goal of the exhaustive orange review is to examine orange checks that are not reviewed as part of selective reviews. When you fix coding rule violations, the total number of orange checks is reduced, and the remaining orange checks are likely to reveal problems with the code.

Optionally, an additional verification can be performed during the integration phase. The purpose of this additional verification is to track integration bugs, and review:

- Red and gray integration checks;
- The remaining orange checks with a selective review: *Integration bug tracking*.

Costs and Benefits

With this approach, Polyspace verification typically provides the following benefits:

- Fewer orange checks in the verification results (improved selectivity). The number of orange checks is typically reduced to 3–5 per file, yielding an average of 1 bug. Often, several of the orange checks represent the same bug.
- Fewer gray checks in the verification results.

- Typically, each file requires two verifications before it can be checked-in to the configuration management system.
- The average verification time is about 15 minutes.

Note: If the development process includes data rules that determine the data flow design, the benefits might be greater. Using data rules reduces the potential of verification finding integration bugs.

If performing the optional verification to find integration bugs, you may see the following results. On a typical 50,000 line project:

- A selective orange review may reveal **one integration bug per hour** of code review.
- Selective orange review takes about 6 hours to complete. This is long enough to review orange checks throughout the whole application and represents a step towards an exhaustive orange check review. Spending more time is unlikely to be efficient.
- An exhaustive orange review would take between 4 and 6 days, assuming that 50,000 lines of code contains approximately 400–800 orange checks. Exhaustive orange review is typically recommended only for high-integrity code, where the consequences of a potential error justify the cost of the review.

Quality Engineers – Code Acceptance Criteria

User Description

This workflow applies to quality engineers who work outside of software development groups, and are responsible for independent verification of software quality and adherence to standards.

These users generally receive code late in the development cycle, and may even be verifying code that is written by outside suppliers or other external companies. They are concerned with not just detecting bugs, but measuring quality over time, and developing processes to measure, control, and improve product quality going forward.

Quality

The main goal of Polyspace verification is to control and evaluate the safety of an application.

The criteria used to evaluate code can vary widely depending on the nature of the application. For example:

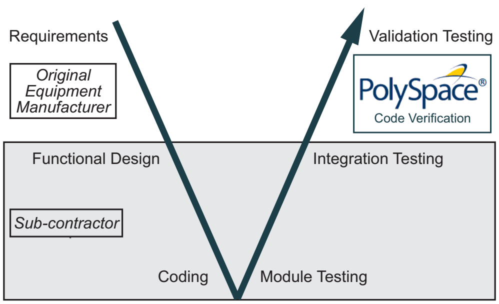
- You may be satisfied with zero red checks.
- In addition to zero red checks, you may want to conduct an exhaustive orange check review.

Typically, these criteria become increasingly stringent as a project advances from early, to intermediate, and eventually to final delivery.

For more information on defining these criteria, see "Customize Software Quality Objectives".

Verification Workflow

This process usually involves both code analysis and code verification before validation phase, and thorough review of verification results based on defined quality goals.



Note: Verification is often performed multiple times, as multiple versions of the software are delivered.

The verification workflow consists of the following steps:

1. Quality engineering group defines clear quality goals for the code to be written, including specific quality levels for each version of the code to be delivered (first, intermediate, or final delivery) For more information, see "Customize Software Quality Objectives".
2. Development group writes code according to established standards.
3. Development group delivers software to the quality engineering group.
4. The project leader configures the Polyspace project to meet the defined quality goals, as described in "Define Process to Meet Your Goals" on page 2-4.

5 Quality engineers perform verification on the code.

6 Quality engineers review **red** errors, **gray** code, and the number of orange checks defined in the process.

Note: The number of orange checks reviewed often depends on the version of software being tested (first, intermediate, or final delivery). This can be defined by quality level (see "Define Broad Requirements for Verification").

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7 Quality engineers create reports documenting the results of the verification, and communicate those results to the supplier.

8 Quality engineers repeat steps 5–7 for each version of the code delivered.

Costs and Benefits

The benefits of code verification at this stage are the same as with other verification processes, but the cost of correcting faults is higher, because verification takes place late in the development cycle.

It is possible to perform an exhaustive orange review at this stage, but the cost of doing so can be high. If you want to review all orange checks at this phase, it is important to use development and verification processes that minimize the number of orange checks. This includes:

- Developing code using strict coding and data rules.
- Providing accurate manual stubs for unresolved function calls.
- Using DRS to provide accurate data ranges for input variables.

Taking these steps will minimize the number of orange checks reported by the verification, and make it more likely that remaining orange checks represent real issues with the software.

Quality Engineers – Certification/Qualification

User Description

This workflow applies to quality engineers who work with applications requiring outside quality certification, such as IEC 61508 certification or DO-178 qualification.

These users must perform a set of activities to meet certification requirements.

You can use the "IEC Certification Kit (for ISO 26262 and IEC 61508)" to help qualify Polyspace products within an IEC 61508, ISO 26262, EN 50128, or other related functional-safety standard certification environment.

You can use the "DO Qualification Kit (for DO-178)" to help qualify Polyspace products within an DO-178 qualification environment.

Model-Based Design Users — Verifying Generated Code

User Description

This workflow applies to users who have adopted model-based design to generate code for embedded application software.

These users generally use Polyspace software in combination with several other MathWorks products, including Simulink®, Embedded Coder® , and Simulink Design Verifier™ products. In many cases, these customers combine application components that are manually written code with those created using generated code.

Quality

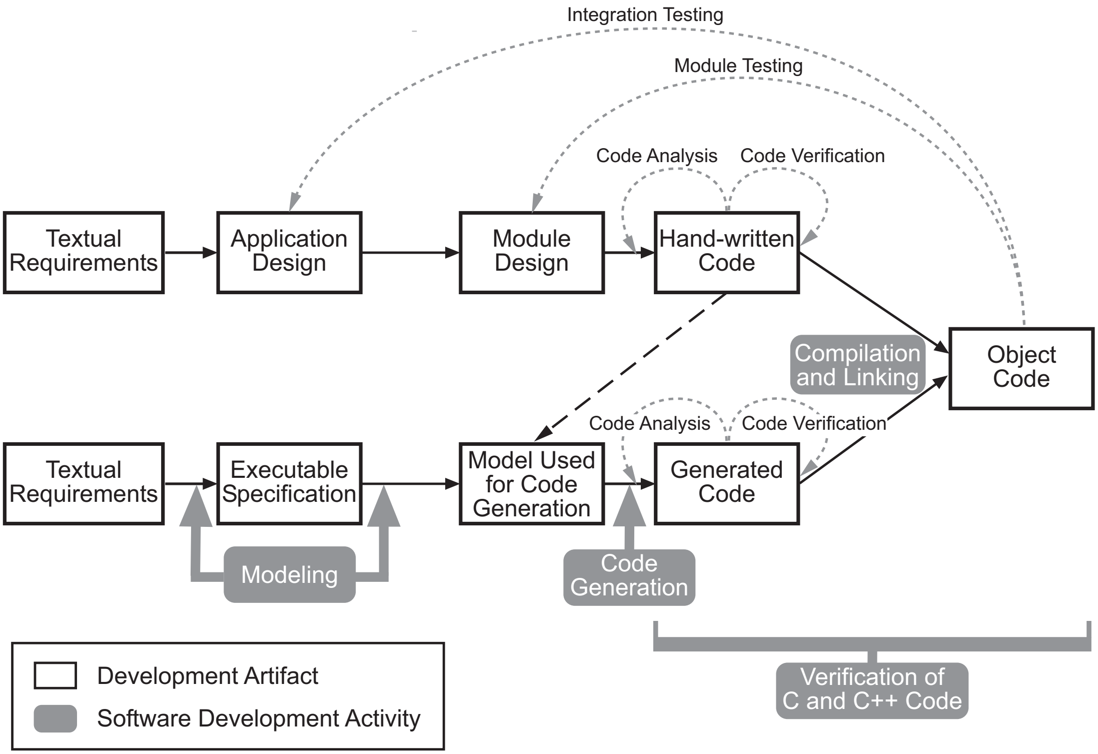
The goal of Polyspace verification is to improve the quality of the software by identifying implementation issues in the code, and proving that the code is both semantically and logically correct.

Polyspace verification allows you to find run-time errors:

- In hand-coded portions within the generated code
- In the model used for production code generation
- In the integration of manually written and generated code

Verification Workflow

The workflow is different for manually written code, generated code, and mixed code. Polyspace products can perform code verification as part of any of these workflows. The following figure shows a suggested verification workflow for manually written and mixed code.



Workflow for Verification of Generated and Mixed Code

Note: Solid arrows in the figure indicate the progression of software development activities.

The verification workflow consists of the following steps:

1. The project leader configures a Polyspace project to meet defined quality goals.
2. Developers manually code sections of the application.
3. Developers or testers perform **Polyspace verification** of manually coded sections within the generated code, and review verification results according to the established quality goals.
4. Developers create Simulink model based on requirements.

5 Developers validate model to prove it is logically correct (using tools such as Simulink Model Advisor, and the Simulink Verification and Validation™ and Simulink Design Verifier products).

6 Developers generate code from the model.

7 Developers or testers perform **Polyspace verification** on the entire software component, including both manually written and generated code.

8 Developers or testers review verification results according to the established quality goals.

Note: Polyspace Code Prover allows you to quickly track issues identified by the verification back to the block in the Simulink model.

Costs and Benefits

Simulink Design Verifier verification can identify errors in textual designs or executable models that are not identified by other methods. The following table shows how errors in textual designs or executable models can appear in the resulting code.

Examples of Common Run-Time Errors

Type of Error	Design or Model Errors	Code Errors
Arithmetic errors	• Incorrect Scaling • Unknown calibrations • Untested data ranges	• Overflows/Underflows • Division by zero • Square root of negative numbers
Memory corruption	• Incorrect array specification in state machines • Incorrect legacy code (look-up tables)	• Out of bound array indexes • Pointer arithmetic
Data truncation	• Unexpected data flow	• Overflows/Underflows • Wrap-around
Logic errors	• Unreachable states • Incorrect Transitions	• Non initialized data • Dead code

Project Managers — Integrating Polyspace Verification with Configuration Management Tools

User Description

This workflow applies to project managers responsible for establishing check-in criteria for code at different development stages.

Quality

The goal of Polyspace verification is to test that code meets established quality criteria before being checked in at each development stage.

Verification Workflow

The verification workflow consists of the following steps:

1. Project manager defines quality goals, including individual quality levels for each stage of the development cycle.
2. Project leader configures a Polyspace project to meet quality goals.
3. Developers or testers run verification at the following stages:
   - Daily check-in — On the files currently under development. Compilation must complete without the permissive option.
   - Pre-unit test check-in — On the files currently under development.
   - Pre-integration test check-in — On the whole project, ensuring that compilation can complete without the permissive option. This stage differs from daily check-in because link errors are highlighted.
   - Pre-build for integration test check-in — On the whole project, with multitasking aspects accounted for as required.
   - Pre-peer review check-in — On the whole project, with multitasking aspects accounted for as required.
4. Developers or testers review verification results for each check-in activity to confirm the code meets the required quality level. For example, the transition criterion could be: “No defect found in 20 minutes of selective orange review”

Setting Up Project: Basic Steps

What is a Project?

In Polyspace software, a project is a named set of parameters for your software project's source files. A project includes:

- Source files
- Include folders
- One or more configurations, specifying a set of analysis options
- One or more modules, each of which include:
  - Source (specific set of source files)
  - Configuration (specific set of analysis options)
  - Results

Use the Project Manager perspective to create and modify a project.

What is a Project Template?

A **Project Template** is a predefined set of analysis options for a specific compilation environment. When creating a new project, you have the option to:

- Use an existing template to automatically set analysis options for your compiler.

  Polyspace software provides predefined templates for common compilers such as `IAR`, `Kiel`, and `VxWorks` `Aonix`, `Rational`, and `Greenhills`. For additional templates, see Polyspace Compiler Templates .
- Set analysis options manually. You can save your options to a custom template and reuse them later. For more information, see "Save Analysis Options as Project Template" .

Create New Project

This example shows how to create a new project in Polyspace Code Prover. Before you create a project, you must know:

- Location of source files
- Location of include files
- Location where verification results will be stored

For these locations, it is convenient to create three subfolders under a common project folder. For instance, under the folder `polyspace_project`, you can create `sources`,`includes` and `results`.

1 Select **File** > **New Project...**.
2 In the Project – Properties dialog box, enter the following information:

   - **Project name**
   - **Location**: Folder where you will store the project file with extension `.psprj`. You can use this file to open an existing project.

     The software assigns a default location to your project. You can change this default on the **Project and Results Folder** tab in the Polyspace Preferences dialog box.
   - **Project language**

   If you want to use a template, select the **Use template** check box. Then, click **Next**.
3 Select the template for your compiler. If your compiler does not appear in the list of predefined templates, select **Baseline**. You can then start with a generic template. Click **Next**.
4 Add source files and include folders to your project.

   - Navigate to the location where you stored your source files. Select the source files for your project. Click **Add Source Files**.
   - The software automatically adds the standard include files to your project. To use custom include files, navigate to the folder containing your include files. Click **Add Include Folders**.
5 Click **Finish**.

   The new project opens in the **Project Browser**.

6. Save the project. Select **File** > **Save** or enter **Ctrl+S**.

Related Examples

- "Add Source Files and Include Folders"

More About

- "What is a Project?"

Add Source Files and Include Folders

This example shows how to add source files and include folders to an existing project.

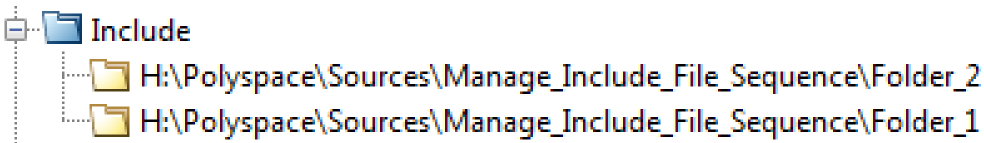
Add Sources and Includes

1. In the **Project Browser**, right-click your project or the **Source** or **Include** folder in your project.
2. Select **Add Source**.
3. Add source files to your project.
   - Navigate to the location where you stored your source files. Select each source file. Click **Add Source Files**.
   - To add all files in a folder and its subfolders, select the option **Add recursively**. Select the folder. Click **Add Source Files**.
   - To add all files in a folder but not in its subfolders, clear the option **Add recursively**. Select the first file in the folder. Press the **Shift** key while selecting the last file. Click **Add Source Files**.
   - To add certain files in a folder, press the **Ctrl** key while selecting the files. Click **Add Source Files**.
4. Add include folders to your project. The software adds standard include files to your project. However, you must explicitly add folders containing your custom include files.
   - Navigate to the folder containing your include files. Select the folder and click **Add Include Folders**.
   - If you do not want to add subfolders of the folder, clear **Add recursively**. Select the folder and click **Add Include Folders**.
5. Click **Finish**.
6. Before running a verification, you must copy the source files to a module.
   a. Select the source files that you want to copy. To select multiple files together, press the **Ctrl** key while selecting the files.
   b. Right-click your selection.
   c. Select **Copy to** > **Module_*n***. *n* is the module number.

Manage Include File Sequence

You can change the order of include folders to manage the sequence in which include files are compiled. When multiple include files by the same name exist in different folders, it is convenient to change the order of include folders instead of reorganizing the contents of your folders. For a particular include file name, the software includes the file in the first include folder under ***`Project_Name`*** > **Include**.

In the following figure, `Folder_1` and `Folder_2` contain the same include file `include.h`. If your source code includes this header file, during compilation, `Folder_2/include.h` is included in preference to `Folder_1/include.h`.



To change the order of include folders:

1. In the **Project Browser**, expand the **Include** folder.
2. Select the include folder that you want to move.
3. To move the folder, click either  or  on the Project Browser toolbar.

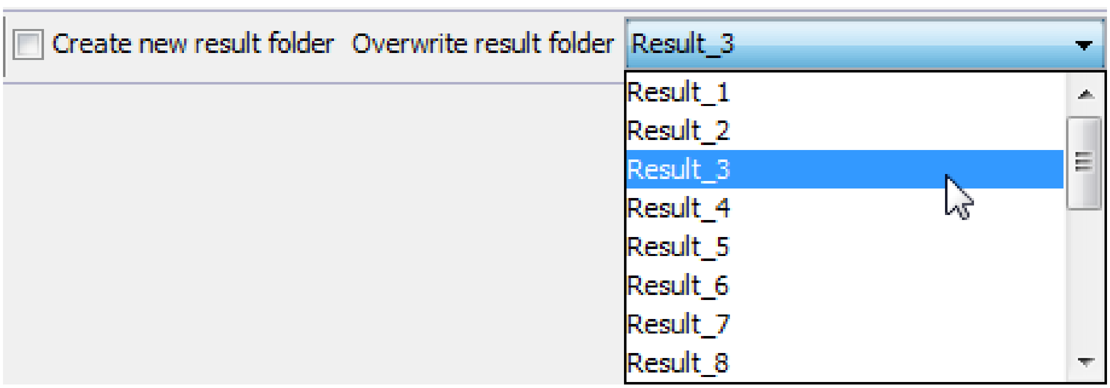
Related Examples

- "Specify Results Folder"
- "Create New Project"

Specify Results Folder

This example shows how to specify a results folder. By default, the software creates a new results folder for each analysis. Before starting an analysis, you can choose to overwrite an existing results folder. For example, if you stopped an analysis before completion and want to restart it, you can overwrite a results folder.

- To create a new folder, in the Project Manager toolbar, select the **Create new result folder** box.
  - By default, the new folder is created in `Project_folder` / `Module_name`. `Project_folder` is the project location you specified when creating a new project.
  - You can also create a parent folder for storing your results. Select **Tools** > **Preferences** and enter the parent folder location on the **Project and Results Folder** tab. If you enter a parent folder location, any new result folder will be created under this parent folder.
- To overwrite an existing folder that is open in the **Project Browser**, clear the **Create new result folder** box. In the **Overwrite result folder** drop-down list, select the folder that you want to use.



- To overwrite an existing folder not open in the **Project Browser**, right-click the **Result** node. Select **Choose a Result folder**. Select the folder where you want your results stored.
- To specify a results folder from the command line, use the `-results-dir` option, followed by the full path to the folder inside `"  "`.

When you start the verification, the software saves the results in the specified folder.

See Also

"-results-dir"

Related Examples

- "Customize Results Folder Location and Name"

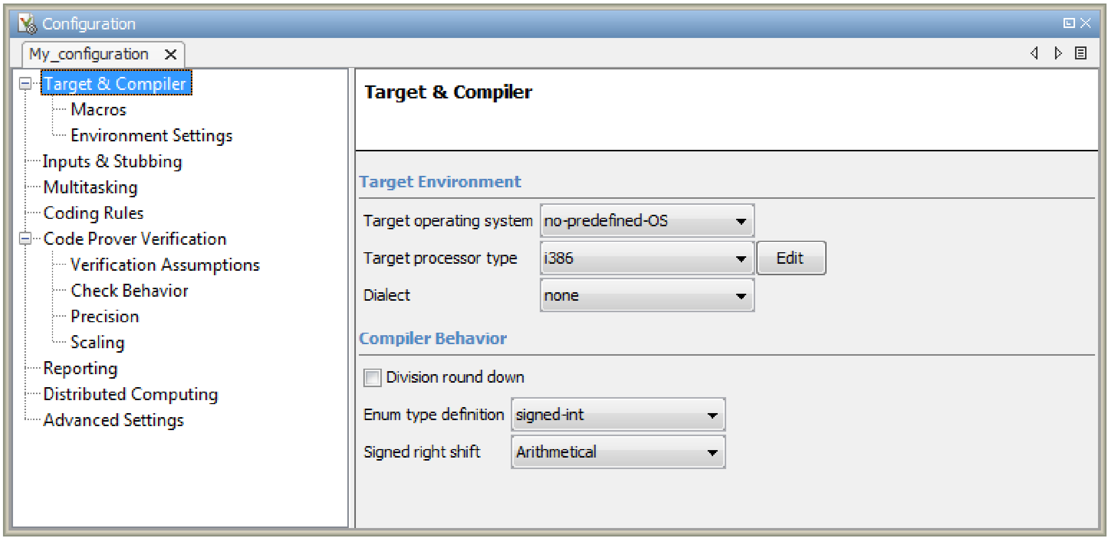
Specify Analysis Options

You can either retain the default analysis options used by the software or change them to your requirements.

In this section...

Specify Options in User Interface

In the Polyspace Project Manager perspective, use the **Configuration** pane.



For instance:

- To specify the target processor, select **Target & Compiler** in the **Configuration** tree view. Select your processor from the **Target processor type** drop-down list.
- To specify verification precision, select under the **Code Prover Verification** node, select **Precision**. Select a number for **Precision level**.

Specify Options from DOS and UNIX Command Line

At the DOS or UNIX® command-line, append analysis options to the `polyspace-code-prover-nodesktop` command. For instance:

- To specify the target processor, use the `-target` option. For instance, to specify the `m68k` processor for your source file `file.c`, use the command:

  ```
  polyspace-code-prover-nodesktop -sources "file.c" -lang c -target m68k
  ```
- To specify verification precision, use the `-O` option. For instance, to set precision level to 2 for your source file `file.c`, use the command:

  ```
  polyspace-code-prover-nodesktop -sources "file.c" -lang c -O2
  ```

Specify Options from MATLAB Command Line

At the MATLAB® command-line, enter analysis options and their values as string arguments to the `polyspaceCodeProver` function. For instance:

- To specify the target processor, use the `-target` option. For instance, to specify the `m68k` processor for your source file `file.c`, enter:

  ```
  polyspaceCodeProver('-sources','file.c','-lang','c','-target','m68k')
  ```
- To specify verification precision, use the `-O` option. For instance, to set precision level to 2 for your source file `file.c`, enter:

  ```
  polyspaceCodeProver('-sources','file.c','-lang','c','-O2')
  ```

See Also

“polyspaceCodeProver”

Related Examples

- “Save Analysis Options as Project Template”

More About

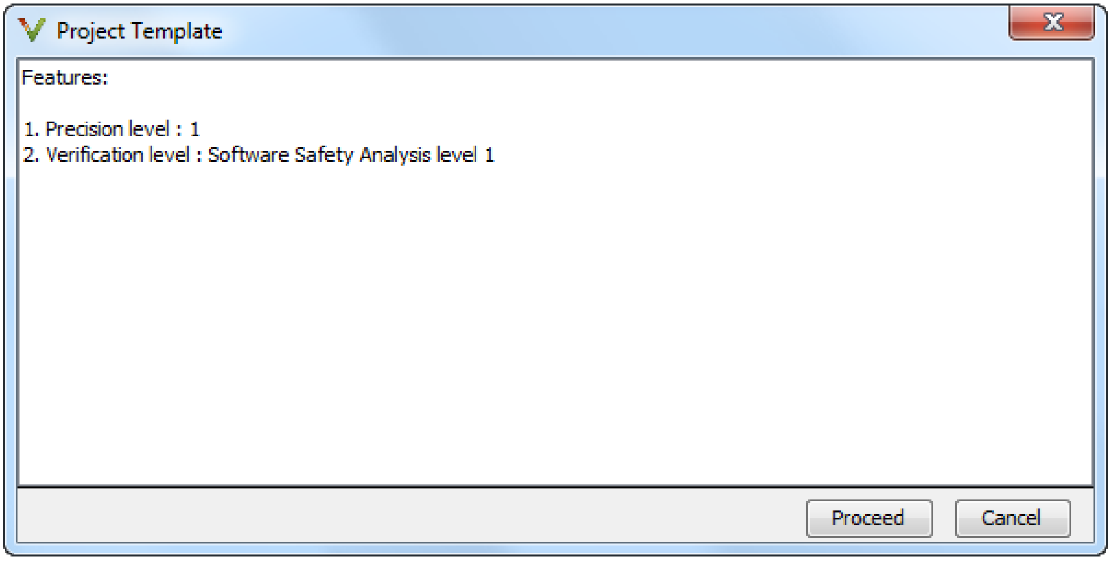
- “Analysis Options for C Code”
- “Analysis Options for C++ Code”

Save Analysis Options as Project Template

This example shows how to save analysis options for use in other projects. Once you have configured analysis options for a project, you can save the configuration as a **Project Template**. You can use this saved configuration to automatically set up analysis options for other projects.

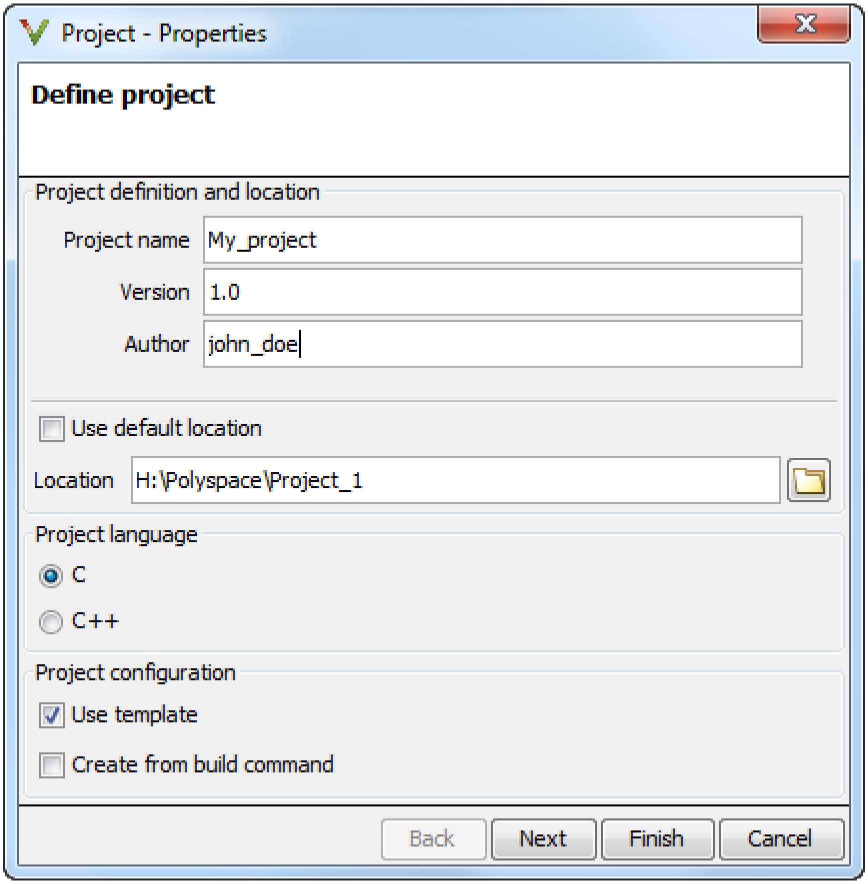
- To create a **Project Template** from an open project:

  1. Right-click the configuration that you want to use, and then select **Save As Template**.
  2. Enter a description for the template, then click **Proceed**. Save your Template file.



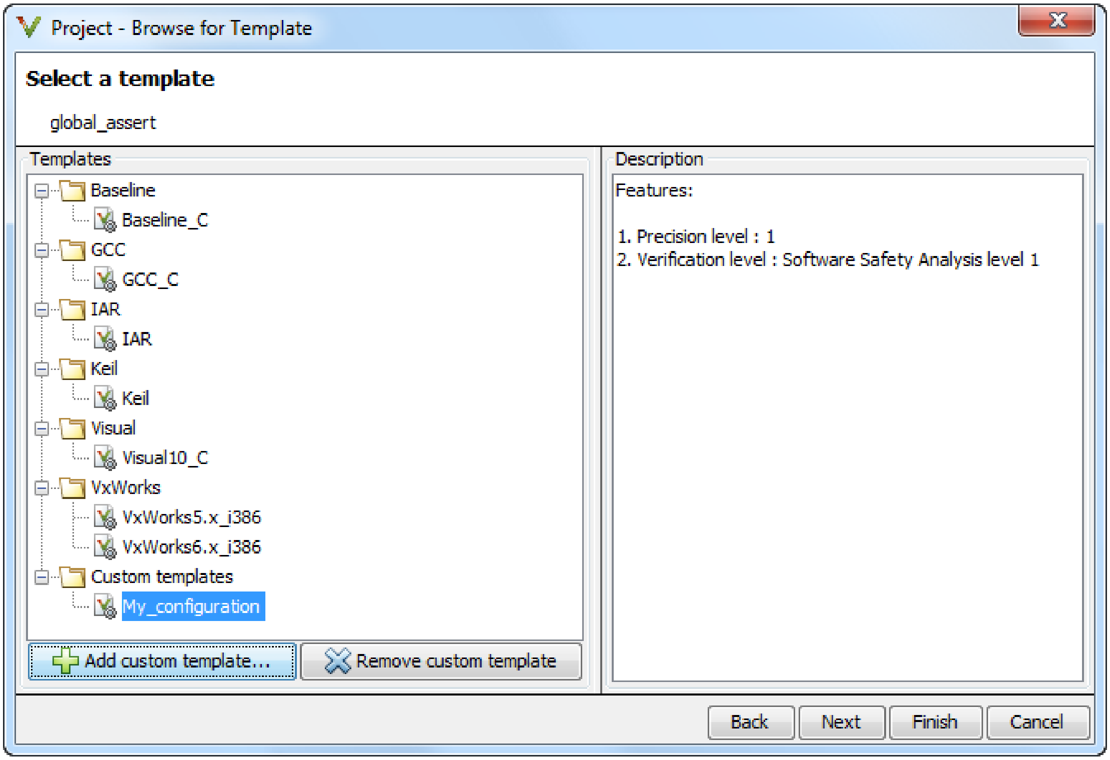
- When you create a new project, to use a saved template:

  1. Under **Project configuration**, check the **Use template** box. Click **Next**.



2 Select 

. Navigate to the template that you saved earlier, and then click **Open**. The new template appears in the **Custom templates** folder on the **Templates** browser. Select the template for use.



Related Examples

- "Specify Analysis Options"

More About

- "What is a Project Template?"
- "Analysis Options for C Code"
- "Analysis Options for C++ Code"

Specify External Text Editor

This example shows how to change the default text editor for opening source files from the Polyspace interface. By default, if you open your source file from the user interface, it opens on a **Code Editor** tab. If you prefer editing your source files in an external editor, you can change this default behavior.

1. Select **Tools** > **Preferences**.
2. On the Polyspace Preferences dialog box, select the **Editors** tab.
3. From the **Text editor** drop-down list, select **External**.
4. In the **Text editor** field, specify the path to your text editor. For example:

   `C:\Program Files\Windows NT\Accessories\wordpad.exe`
5. To make sure that your source code opens at the correct line and column in your text editor, specify command-line arguments for the editor using Polyspace macros, `$FILE`, `$LINE` and `$COLUMN`. Once you specify the arguments, when you right-click a check on the **Results Summary** pane and select **Open Source File**, your source code opens at the location of the check.

   Polyspace has already specified the command-line arguments for the following editors:

   - `Emacs`
   - `Notepad++` — Windows® only
   - `UltraEdit`
   - `VisualStudio`
   - `WordPad` — Windows only
   - `gVim`

   If you are using one of these editors, select it from the **Arguments** drop-down list. If you are using another text editor, select `Custom` from the drop-down list, and enter the command-line options in the field provided.
6. To revert back to the built-in editor, on the **Editors** tab, from the **Text editor** drop-down list, select **Built In**.

For console-based text editors, you must create a terminal. For example, to specify `vi`:

1. In the **Text Editor** field, enter `/usr/bin/xterm`.

2 From the **Arguments** drop-down list, select `Custom`.

3 In the field to the right, enter `-e /usr/bin/vi $FILE`.

Change Default Font Size

This example shows how to change the default font size in the Polyspace user interface.

1 Select **Tools** > **Preferences**.
2 On the **Miscellaneous** tab:

   - To increase the font size of labels on the user interface, select a value for **GUI font size**.

     For example, to increase the default size by 1 point, select `+1`.
   - To increase the font size of the code on the **Source** pane and the **Code Editor** pane, select a value for **Source code font size**.
3 Click **OK**.

When you restart Polyspace, you see the increased font size.

4

Setting Up Project : Advanced Steps

Create Projects Automatically from Your Build System

In this section...

If you use build automation scripts to build your source code, you can automatically setup a Polyspace project from your scripts. The automatic project setup runs your automation scripts to determine:

- Source files.
- Includes.
- **Target & Compiler** options.

Note: In the Polyspace interface, it is possible that the created project will not show implicit defines or includes. The configuration tool does include them. However, they are not visible.

Create Project in User Interface

1. Select **File** > **New Project**.
2. On the Project – Properties dialog box, under **Project Configuration**, select **Create from build command**.
3. On the next window, enter the following information:

Field	Description
Specify command used for building your source files	If you use an IDE such as Visual Studio® or Eclipse™ to build your project, specify the full path to your IDE executable or navigate to it using the button. For a tutorial using Visual Studio, see "Trace Visual Studio Build". **Example:** `"C:\Program Files (x86)\Microsoft Visual Studio 10.0\Common7\IDE\VCExpress.exe"`

Field	Description
	If you use command-line tools to build your project, specify the appropriate command. **Example:** • `"C:\cygwin64\usr\bin\make.exe"` • `make -B -f` *`makefileName`*
Specify working directory for running build command	Specify the folder from which you run your build automation script. If you specify the full path to your executable in the previous field, this field is redundant. Specify any folder.
Add advanced configuration options	Specify additional options for advanced tasks such as incremental build. For the full list of options, see the `-options value` argument for `polyspaceConfigure`.

4 Click 

.

- If you entered your build command, Polyspace runs the command and sets up a project.
- If you entered the path to an executable, the executable runs. Build your source code and close the executable. Polyspace traces your build and sets up a project.

  For example, in Visual Studio 2010, use **Tools** > **Rebuild Solution** to build your source code. Then close Visual Studio.

5 If you updated your build command, you can recreate the Polyspace project from the updated command. To recreate an existing project, on the **Project Browser**, right-click the project name and select **Update Project**.

Note: If your build process requires user interaction, you cannot run the build command from the Polyspace user interface and do an automatic project setup.

Create Project from DOS and UNIX Command Line

Use the `polyspace-configure` command to trace your build automation scripts. You can use the trace information to:

- Create a Polyspace project. You can then open the project in the user interface.

  Example: If you use the command `make targetName buildOptions` to build your source code, use the following command to create a Polyspace project `myProject.psprj` from your makefile:

  ```
  polyspace-configure -prog myProject make -B targetName buildOptions
  ```

- Create an options file. You can then use the options file to run verification on your source code from the command-line.

  Example: If you use the command `make targetName buildOptions` to build your source code, use the following commands to create an options file `myOptions` from your makefile:

  ```
  polyspace-configure -no-project -output-options-file myOptions ...
            make -B targetName buildOptions
  ```

  Use the options file to run verification:

  ```
  polyspace-code-prover-nodesktop -options-file myOptions
  ```

For more information on advanced options for `polyspace-configure`, see the `-options value` argument for `polyspaceConfigure`.

Create Project from MATLAB Command Line

Use the `polyspaceConfigure` command to trace your build automation scripts. You can use the trace information to:

- Create a Polyspace project. You can then open the project in the user interface.

  Example: If you use the command `make targetName buildOptions` to build your source code, use the following command to create a Polyspace project `myProject.psprj` from your makefile:

  ```
  polyspaceConfigure  -prog myProject ...
             make -B targetName buildOptions
  ```

- Create an options file. You can then use the options file to run verification on your source code from the command-line.

  Example: If you use the command `make targetName buildOptions` to build your source code, use the following commands to create an options file `myOptions` from your makefile:

  ```
  polyspaceConfigure  -no-project -output-options-file myOptions ...
            make -B targetName buildOptions
  ```

  Use the options file to run verification:

  ```
  polyspaceCodeProver -options-file myOptions
  ```

For more information, see `polyspaceConfigure`.

Related Examples

- "Trace Visual Studio Build"

More About

- "Requirements for Project Creation from Build Systems"
- "Your Compiler Is Not Supported"

Requirements for Project Creation from Build Systems

For `polyspace-configure` to correctly trace your build and gather all your source files:

- Your compiler must be called locally for a clean build.
- Your compiler configuration must be available to Polyspace. The compilers currently supported are:
  - Visual C++® compiler
  - `gcc`
  - `clang`
  - `MinGW` compiler
  - `IAR` compiler

If your compiler does not meet these requirements, try the following:

- If your compiler performs only an incremental build, use appropriate options to build all your source files. For example, if you use `gmake`, append the `-B` option to force a clean build.
- If your compiler configuration is not available to Polyspace:
  - Write a compiler configuration file in a specific format. For more information, see "Your Compiler Is Not Supported".
  - Contact MathWorks Technical Support. For more information, see "Obtain System Information for Technical Support".
- If you use a compiler cache such as `ccache` or a distributed build system such as `distmake`, `polyspace-configure` cannot trace your build. You must deactivate them.
- If you use Cygwin™ to build your source code, `polyspace-configure` cannot trace your build. Use MinGW to build your source and have `polyspace-configure` trace your build, or do the following:

  1. Build your source code using the process that you usually follow. Copy the commands that executed during the build.

     For instance, on `make` systems, use the flag `-B` to build your entire source and `-n` to view the commands. For more information, see make options.

2 Enter the commands in a Windows batch file. A batch file is a file that can contain one or more commands. It has a `.bat` extension. For more information, see batch files.

3 Run the batch file to make sure your build commands work.

If your batch file is called `myBuild.bat`, at a DOS command prompt, enter:

```
cmd.exe /C myBuild.bat
```

4 Run `polyspace-configure` on the batch file.

If you ran the command in the previous step, at a DOS command prompt, enter:

```
polyspace-configure cmd.exe /C myBuild.bat
```

See Also

"polyspaceConfigure"

Related Examples

- "Create Projects Automatically from Your Build System"

Your Compiler Is Not Supported

For `polyspaceConfigure` to correctly trace your build and gather your source files, your compiler configuration must be available to Polyspace. For information on supported compilers, see “Requirements for Project Creation from Build Systems”. If your compiler is not supported, you can write your own compiler configuration file to enable support.

1 Copy one of the existing configuration files from *matlabroot*\polyspace\configure\compiler_configuration\.
2 Save the file as *my_compiler*.xml. *my_compiler* can be any name that helps you identify the file.

   To edit the file, save it outside the installation folder. After you have finished editing, you must copy the file back to *matlabroot*\polyspace\configure\compiler_configuration\.
3 Edit the contents of the file to represent your compiler. Replace the entries between the XML elements with appropriate content.

   The following table lists the XML elements in the file with a description of what the content within the element represents.

XML Element	Content Description	Content Example for GNU® C Compiler
<compiler_names><name> ... </name><compiler_names>	Name of the compiler executable. This executable transforms your `.c` files into object files. You can add several binary names, each in a separate <name>...</name> element. `polyspaceConfigure` checks for each of the provided names and uses the compiler name	• `gcc` • `gpp`

XML Element	Content Description	Content Example for GNU® C Compiler
	for which it finds a match. You must not specify the linker binary inside the `<name>...</name>` elements.	
`<include_options><opt> ... </opt></include_options>`	The option that you use with your compiler to specify include folders.	`-I`
`<system_include_options><opt> ... </opt></system_include_options>`	The option that you use with your compiler to specify system headers.	`-isystem`
`<preinclude_options><opt> ... </opt></preinclude_options>`	The option that you use with your compiler to force inclusion of a file in the compiled object.	`-include`
`<define_options><opt> ... </opt></define_options>`	The option that you use with your compiler to predefine a macro.	`-D`
`<undefine_options><opt> ... </opt></undefine_options>`	The option that you use with your compiler to undo any previous definition of a macro.	`-U`
`<semantic_options><opt> ... </opt></semantic_options>`	The options that you use to modify the compiler behavior. These options specify the language settings to which the code must conform.	• `-ansi` • `-std=C90` • `-std=c++11` • `-fun signed-char`

XML Element	Content Description	Content Example for GNU® C Compiler
`<dialect> ... </dialect>`	The options that specify the Polyspace dialect used by your compiler. For the complete list of dialects, on the **Configuration** pane, select **Target & Compiler**.	`gnu4.7`
`<preprocess_options_list><opt> ... </opt></preprocess_options_list>`	The options that specify how your compiler generates a preprocessed file.	`-E`
`<src_extensions><ext> ... </ext></src_extensions>`	The file extensions for source files.	• `c` • `cpp` • `c++`
`<obj_extensions><ext> ... </ext></obj_extensions>`	The file extensions for object files.	
`<precompiled_header_extensions> ... </precompiled_header_extensions>`	The file extensions for precompiled headers (if available).	

4 After saving the edited XML file to `matlabroot\polyspace\configure\compiler_configuration\`, create a project automatically using your build command. For more information, see:

- "Create Project in User Interface"
- "Create Project from DOS and UNIX Command Line"
- "Create Project from MATLAB Command Line"

Create Multiple Modules

This example shows how to create multiple modules in a Polyspace Code Prover project. With each of these modules, you can analyze a specific set of source files using a specific set of analysis options. When you create a module, the software creates a project configuration with default option values. You can modify these values. In addition, you can create multiple configurations in each module, allowing you to change analysis options each time you run an analysis.

1. In the **Project Browser**, select your project.
2. On the **Project Browser** toolbar, click .

   You see a second module, `Module_2`, in the **Project Browser** tree.
3. In the project **Source** folder, right-click the files that you want to add to the module. From the context menu, select **Copy to** > **Module_2**.

   The software displays these files in the **Source** folder of `Module_2`.

   If you have twenty or more modules in your project, when you select **Copy to**, the Select Modules dialog box opens. From the module list, choose the required modules. Then click **Select**.

Note: You can also drag source files from a project into the Source folder of a module.

Related Examples

- "Create Multiple Analysis Option Configurations"

Create Multiple Analysis Option Configurations

This example shows how to create and use multiple configurations in your Polyspace project. Each of these configurations specifies a specific set of analysis options. Using multiple configurations allows you to analyze a set of source files multiple times using different analysis options for each run.

1 In the **Project Browser**, select a module.
2 Right-click the **Configuration** folder in the module. From the context menu, select **Create New Configuration**.

   - On the **Project Browser**, the software displays a new configuration `project_name_1`. To rename the configuration, double-click it.
   - On the **Configuration** pane, the new configuration appears as an additional tab.

3 On the **Configuration** pane, specify the analysis options for the new configuration.
4 To use this new configuration for the verification, right-click the configuration. Select **Set as Default**.

   The default configuration appears blue. When you run a new verification, it uses the default configuration.

5 To see the configuration you used for a certain result, right-click the result on the **Project Browser**. Select **Open Configuration**.

   If you are viewing the results in the Results Manager, to see the configuration you used, select **Window** > **Show/Hide View** > **Settings**.

6 To copy a configuration to another module, right-click the configuration. Select **Copy Configuration to** > ***`Module_name`***.

Related Examples

- "Create Multiple Modules"

More About

- "Analysis Options for C Code"

Customize Results Folder Location and Name

By default, the software saves results in `Module_#` subfolders within the project folder. However, through the Polyspace Preferences dialog box, you can define a parent folder for your results:

1. From the Polyspace toolbar, select **Tools** > **Preferences**.
2. On the **Project and Results Folder** tab, select the **Create new result folder** check box.
3. In the **Parent results folder location** field, specify the location that you want.

   Note: If you do not specify a parent results folder, the software uses the active module folder as the parent folder.

   ---
4. If you require a subfolder, select the **Add a subfolder using the project name** check box. This subfolder takes the name of the project.
5. If required, specify additional formatting options for the folder name . The options allow you to incorporate the following information into the name of the results folder:
   - **Result folder prefix** — A string that you define. Default is `Result`.
   - **Project variable** — Project, module, and configuration.
   - **Date format** — Date of analysis
   - **Time format** — Time of analysis
   - **Counter** — Count value that automatically increments by one for each new results folder

The software now creates a new results folders with the file name *`ResultFolderPrefix_ProjectVariable_DateFormat_TimeFormat_Counter`*.

Define Broad Requirements for Verification

This example shows how to define your broad requirements before you begin a Polyspace Code Prover verification, and then implement them in your verification process.

1 Prepare a set of quality levels for your application. A quality level chart can be like this:

Software Quality Levels

Criteria	Software Quality Levels			
	QL1	QL2	QL3	QL4
Document static information	X	X	X	X
Enforce MISRA C coding rules in `SQO-subset1`	X	X	X	X
Review all red checks	X	X	X	X
Review all gray checks	X	X	X	X
Review critical orange checks		X	X	X
Review all orange checks			X	X
Enforce MISRA C coding rules in `SQO-subset2`			X	X
Analyze dataflow			X	X

2 Depending on the quality level that you want to implement, choose your verification options. The options appear on the **Configuration** pane in the Project Manager perspective.

For instance, if you want to implement level QL1, under **Coding Rules**, select `SQO-subset1` for **Check MISRA C:2004**.

3 Depending on the quality level that you want to implement, plan your review process for the verification results. Your review process involves options in the Result Manager perspective.

For instance, if you want to implement level QL1, on the **Results Summary** pane, filter only red and gray checks.

Related Examples

- "Define Specific Requirements for Verification"
- "Organize Results Using Filters and Groups"

Define Specific Requirements for Verification

This example shows how to define specific requirements before you begin a Polyspace Code Prover verification, and then implement them in your verification process.

Specify Code Constructs

1. Prepare a list of constructs that you want to retain in your code or remove from it.
2. On the **Configuration** pane, specify the verification options corresponding to your requirements.

   For instance, you can have the following requirements and choose the corresponding options.

Requirement	Option
Detect overflows only on signed integer computations.	Under **Check Behavior**, for **Detect overflows**, select `signed`.
Allow a pointer to one structure field to point to another field of the same structure.	Under **Check Behavior**, select **Enable pointer arithmetic across fields**.
Do not allow global variables to be initialized by default.	Under **Inputs & Stubbing**, select **Ignore default initialization of global variables**.

Specify Coding Rules

1. Prepare a list of coding rules for your code.
2. On the **Configuration** pane, under the **Coding Rules** node, specify your coding rules.

Requirement	Example
Select predefined rule subsets.	“Activate Coding Rules Checker”
Create your own subset from existing rules.	“Select Specific MISRA or JSF Coding Rules”
Create your own coding rules.	“Create Custom Coding Rules”

Specify Results to Review

1. Prepare a list of files or list of checks that you want to review.
2. After you run your verification, apply appropriate filters to focus your review to those files or checks. For more information, see “Organize Results Using Filters and Groups”.

Related Examples

- “Define Broad Requirements for Verification”
- “Specify Analysis Options”
- “Save Analysis Options as Project Template”

Provide Context for C Code Verification

This example shows how to provide context for your C code verification. If you use default options and do not provide a `main` function, Polyspace Code Prover:

- Considers that global variables and function inputs are full range.
- Generates a `main` that calls uncalled functions in arbitrary order.

In addition, if you do not define a function but declare and call it in your code, Polyspace stubs the function.

You can use analysis options on the **Configuration** pane to change this default behavior and provide more context about your code.

Control Variable Range

Use the following options. The options appear under the **Code Prover Verification** node.

Option	Purpose
“Variables to initialize (C)”	Specify the global variables that Polyspace must consider as initialized despite no explicit initialization in the code.
“Variable/function range setup (C/C++)”	Specify range for global variables.

Control Function Call Sequence

Use the following options. The options appear under the **Code Prover Verification** node.

Option	Purpose
“Initialization functions (C)”	Specify the functions that the generated `main` must call first.
“Functions to call (C)”	Specify the functions that the generated `main` must call later.

Control Stubbing Behavior

Use the following options. The options appear under the **Inputs & Stubbing** node.

Option	Purpose
“No automatic stubbing (C/C++)”	Specify that verification must stop if a function is not defined in the source files.
“Functions to stub (C)”	Specify the functions that Polyspace must stub.

Related Examples

- “Provide Context for C++ Code Verification”
- “Specify Analysis Options”
- “Save Analysis Options as Project Template”

Provide Context for C++ Code Verification

This example shows how to provide context to your C++ code verification. If you use default options and do not provide a `main` function, Polyspace Code Prover:

- Considers that global variables and function inputs are full range.
- Generates a `main` that calls uncalled class methods and other functions in arbitrary order.

In addition, if you do not define a function or method but declare and call it in your code, Polyspace stubs the function.

You can use analysis options on the **Configuration** pane to change this default behavior and provide more context about your code.

Control Variable Range

Use the following options. The options appear under the **Code Prover Verification** node.

Option	Purpose
"Variables to initialize (C++)"	Specify the global variables that Polyspace must consider as initialized despite no explicit initialization in the code.
"Variable/function range setup (C/C++)"	Specify range for global variables.

Control Function Call Sequence

1 Use the following options to call class methods. The options appear under the **Code Prover Verification** node.

Option	Purpose
"Class (C++)"	Specify classes whose methods the generated `main` must call.
"Functions to call within the specified classes (C++)"	Specify methods that the generated `main` must call.
"Analyze class contents only (C++)"	Specify that the generated `main` must call class methods only.

Option	Purpose
"Skip member initialization check (C++)"	Specify that the generated `main` must not check whether each class constructor initializes all class members.

2 Use the following options to call functions that are not class methods. The options appear under the **Code Prover Verification** node.

Option	Purpose
"Initialization functions (C++)"	Specify the functions that the generated `main` must call first.
"Functions to call (C++)"	Specify the functions that the generated `main` must call later.

Control Stubbing Behavior

Use the following options. The options appear under the **Inputs & Stubbing** node.

Option	Purpose
"No automatic stubbing (C/C++)"	Specify that verification must stop if a function is not defined in the source files.
"No STL stubs (C++)"	Specify that the verification must not use Polyspace implementations of the standard template library.
"Functions to stub (C)"	Specify the functions that Polyspace must stub.

Related Examples

- "Provide Context for C Code Verification"
- "Specify Analysis Options"
- "Save Analysis Options as Project Template"

Setting Up Project: Additional Information

Create Projects Using Visual Studio Information

In this section...

Use Visual Studio Project

You can directly create a Polyspace project from a Visual Studio project file with extension `.vcproj`. The Visual Studio import retrieves the following information from a Visual Studio project:

- **Source** files
- **Include** folders
- Some **Target & Compiler** options
- **Preprocessor Macros**

Note: For Visual Studio 2010 or Visual Studio 2012, you cannot directly import your project.

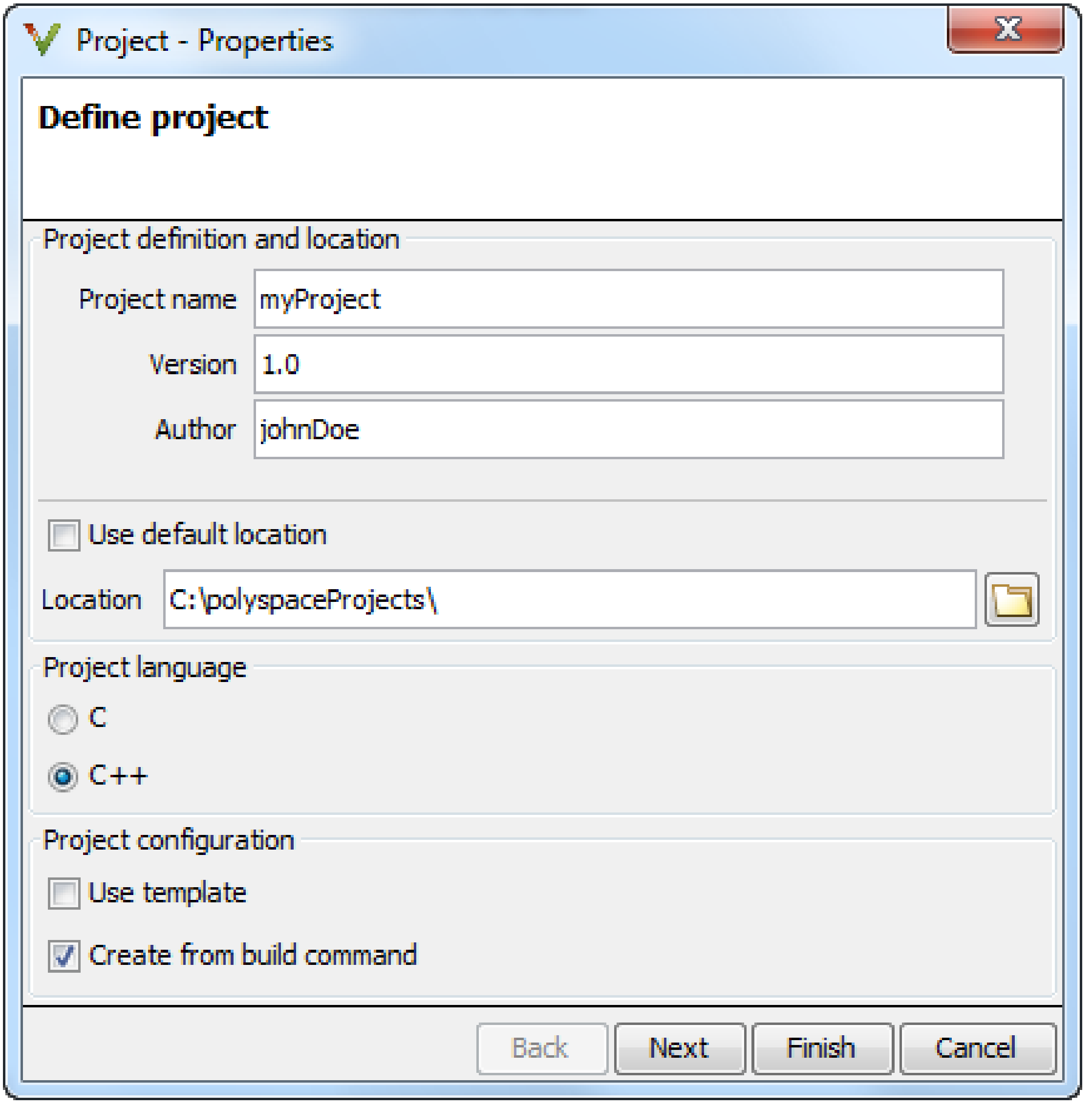
---

1. In the Project Manager perspective, select **File** > **Import Visual Studio Project**.
2. In the Import Visual Studio dialog box, specify the **Visual Studio project** that you want to use.
3. You can:
   - **Create new Polyspace project**: Enter full path to a new Polyspace project.
   - **Update existing Polyspace project**: The dropdown list contains all projects currently open in the **Project Browser**. Select the project you want to update.
4. Click **Import**.

Trace Visual Studio Build

To create a Polyspace project, you can trace your Visual Studio build. For Polyspace to correctly trace your Visual Studio build, you must install both `x86` and `x64` versions of the Visual C++ Redistributable for Visual Studio 2012 from this address.

1 In the Polyspace Project Manager, select **File** > **New Project**.
2 In the Project – Properties window, enter your project information.
   a Choose **C++** as **Project Language**.
   b Under **Project Configuration**, select **Create from build command** and click **Next**.



3 In the field **Specify command used for building your source files**, enter the full path to the Visual Studio executable. For instance, "`C:\Program Files (x86)\Microsoft Visual Studio 10.0\Common7\IDE\VCExpress.exe`".

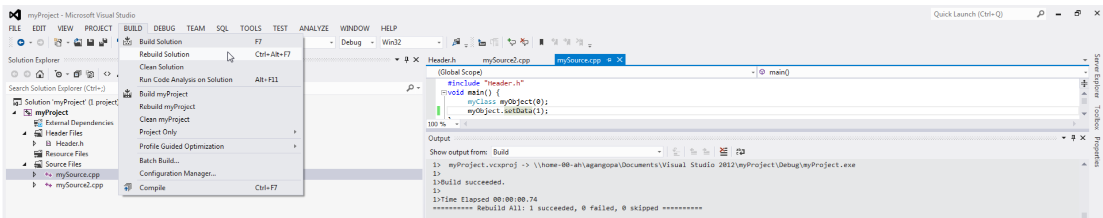
4 In the field **Specify working directory for running build command**, enter `C:\`. Click 

.

This action opens the Visual Studio environment.

5 In the Visual Studio environment, create and build a Visual Studio project.

If you already have a Visual Studio project, open the existing project and build a clean solution. To build a clean solution in Visual Studio 2012, select **BUILD** > **Rebuild Solution**.



6 After the project builds, close Visual Studio.

Polyspace traces your Visual Studio build and creates a Polyspace project.

The Polyspace project contains the source files from your Visual Studio build and the relevant **Target & Compiler** options.

7 If you update your Visual Studio project, to update the corresponding Polyspace project, on the **Project Browser**, right-click the project name and select **Update Project**.

Related Examples

- “Visual Studio Verification”

More About

- “Cannot create project from Visual Studio build”

Cannot create project from Visual Studio build

If you are trying to import a Visual Studio 2010 or Visual Studio 2012 project and `polyspace-configure` does not work properly, do the following:

1. Stop the `MSBuild.exe` process.
2. Set the environment variable `MSBUILDDISABLENODEREUSE` to 1.
3. Specify `MSBuild.exe` with the `/nodereuse:false` option.
4. Restart the Polyspace configuration tool:

```
polyspace-configure.exe -lang cpp <MSVS path>/msbuild sample.sln
```

Storage of Polyspace Preferences

The software stores the settings that you specify through the Polyspace Preferences dialog box in the following file:

- Windows: `$Drive\Users\$User\AppData\Roaming\MathWorks \MATLAB \$Release\Polyspace\polyspace.prf`
- Linux®: `/home/$User/.matlab/$Release/Polyspace/polyspace.prf`

Here, `$Drive` is the drive where the operating system files are located such as `C:`, `$User` is the username such as `johndoe` and `$Release` is the release number such as `2014b`.

The following file stores the location of all installed Polyspace products across various releases:

- Windows: `$Drive\Users\$User\AppData\Roaming\MathWorks \MATLAB \AppData\Roaming\MathWorks\MATLAB \polyspace_shared \polyspace_products.prf`
- Linux : `/home/$User/.matlab/polyspace_shared/polyspace_products.prf`

Emulating Your Runtime Environment

Set Up a Target

In this section...

Target & Compiler Overview

Many applications are designed to run on specific target CPUs and operating systems. The type of CPU determines many data characteristics, such as data sizes and addressing. These factors can determine whether errors occur, for example, overflows.

Since some run-time errors are dependent on the target CPU and operating system, you must specify the type of CPU and operating system used in the target environment before running a verification.

Specify Target and Compiler

Before verification, you can specify the target environment and compiler behavior for your application.

For example, to specify the target environment for your application:

1 On the **Configuration** pane, select **Target & Compiler**.

2 For **Target operating system**, select the operating system on which your application is designed to run.

3 For **Target processor type**, select the processor on which your application is designed to run.

   For detailed specification of each predefined target processor, see “Target processor type (C)” or “Target processor type (C++)”.

Modify Predefined Target Processor Attributes

If your processor is not listed under **Target processor type**, you can select a similar processor and modify its characteristics to match your processor. For the settings that you can modify for each target, see the values listed in `[]` on “Target processor type (C)” or “Target processor type (C++)”.

1 On the **Configuration** pane, select **Target & Compiler**.

2 For **Target processor type**, select the target processor that you want to use.

3 To the right of the **Target processor type** field, click **Edit**.

4 Modify the attributes as required.

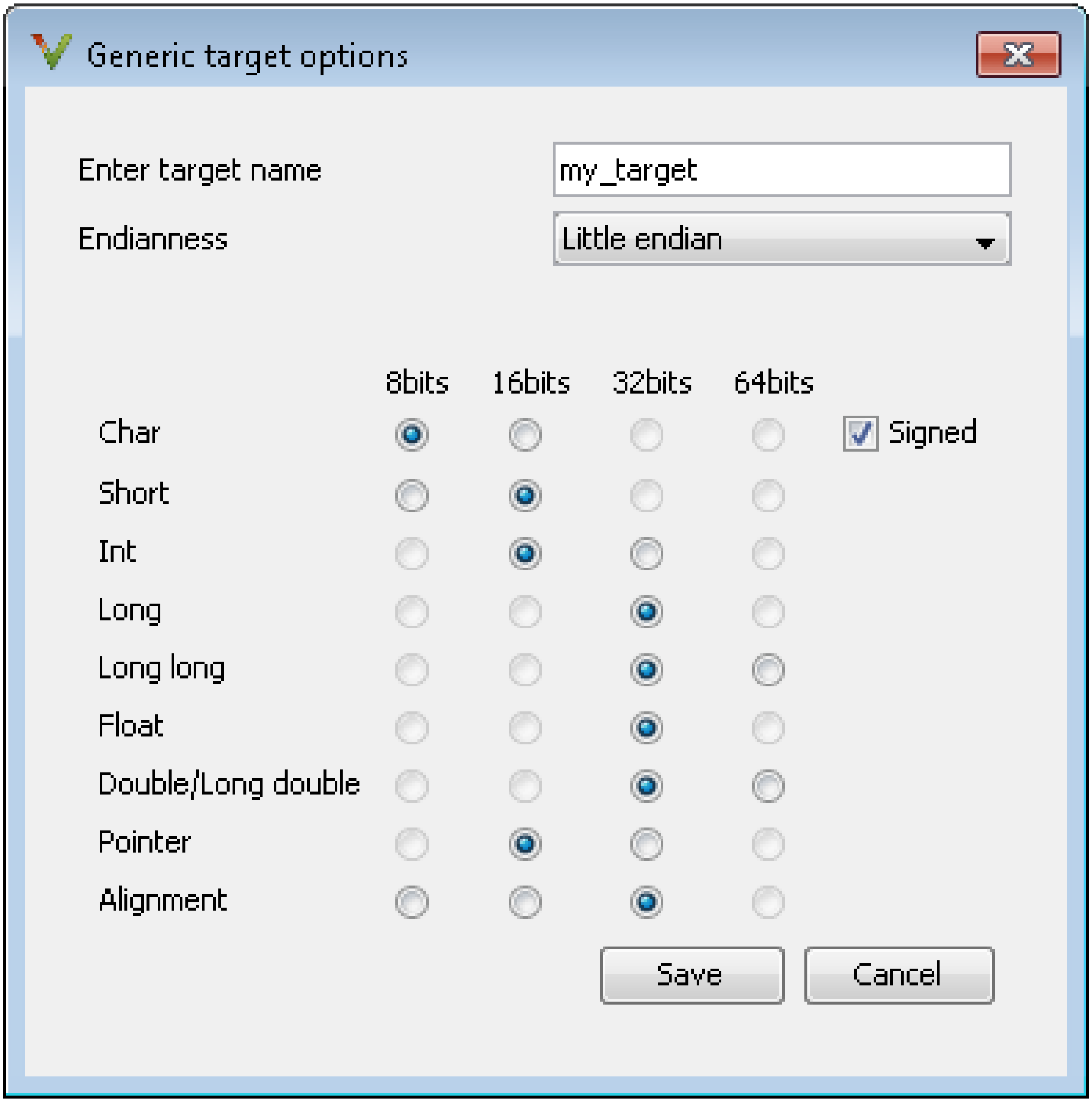
Define Generic Target Processors

If your application is designed for a custom target processor, you can specify its attributes.

1 On the **Configuration** pane, select **Target & Compiler**.

2 For **Target processor type**, select `mcpu... (Advanced)`.

   The Generic target options dialog box opens.



3 Enter a target name, for example, `my_target`.

4 Specify the parameters for your target, such as the size of basic types, and alignment with arrays and structures.

For example, when the alignment of basic types within an array or structure is 8, the storage assigned to arrays and structures is determined by the size of the individual data objects (without fields and end padding).

Common Generic Targets

The following tables describe the characteristics of common generic targets.

ST7 (Hiware C compiler : HiCross for ST7)

ST7	char	short	int	long	long long	float	double	long double	ptr	char is	endian
size	8	16	16	32	32	32	32	32	16/32	unsigned	Big
alignmen	8	16/8	16/8	32/16/8	32/16/8	32/16/8	32/16/8	32/16/8	32/16/8	N/A	N/A

ST9 (GNU C compiler : gcc9 for ST9)

ST9	char	short	int	long	long long	float	double	long double	ptr	char is	endian
size	8	16	16	32	32	32	64	64	16/64	unsigned	Big
alignmen	8	8	8	8	8	8	8	8	8	N/A	N/A

Hitachi H8/300, H8/300L

Hitachi H8/300, H8/300L	char	short	int	long	long long	float	double	long double	ptr	char is	endian
size	8	16	16/32	32	64	32	654	64	16	unsigned	Big
alignmen	8	16	16	16	16	16	16	16	16	N/A	N/A

Hitachi H8/300H, H8S, H8C, H8/Tiny

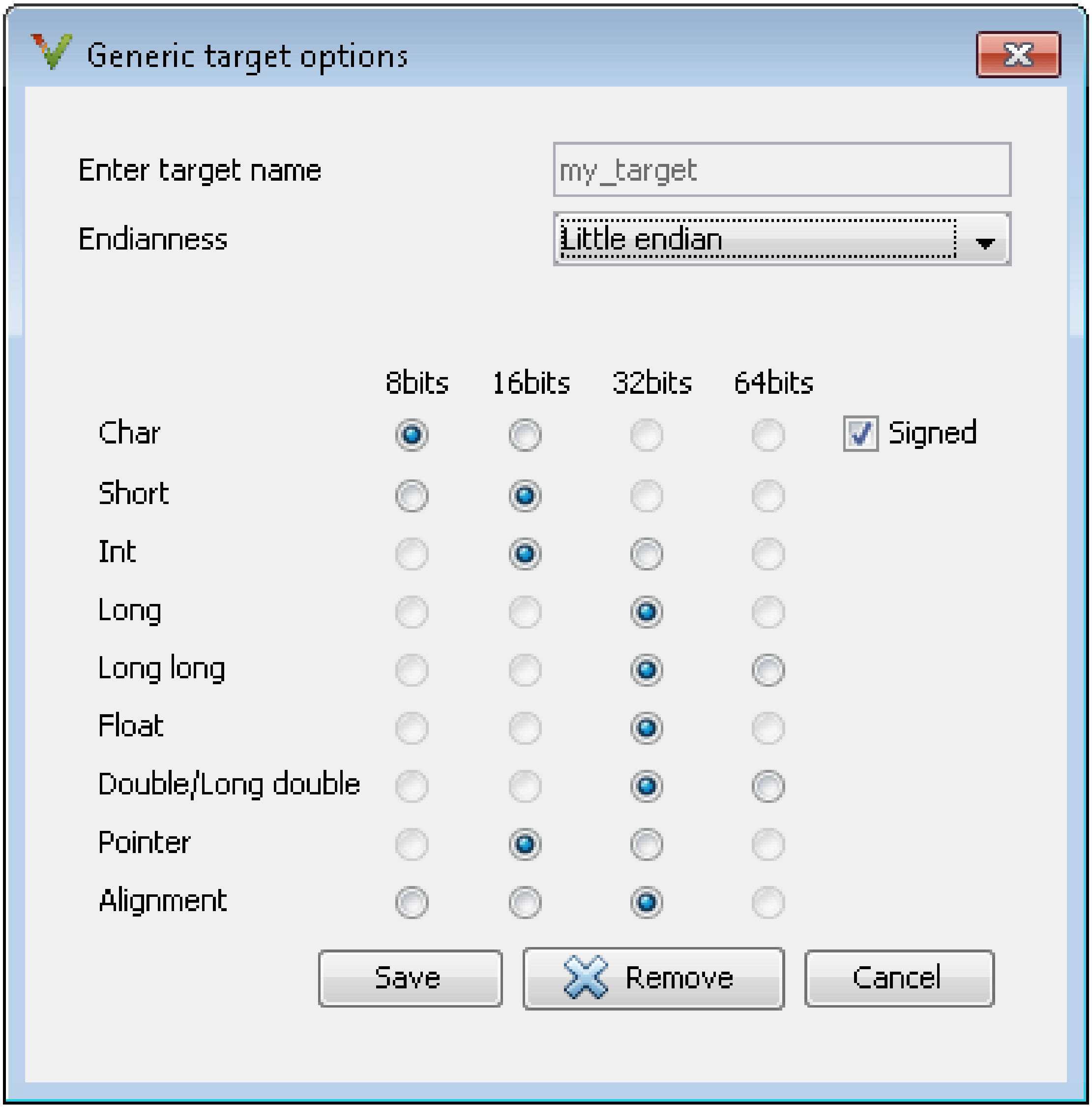
Hitachi H8/300H, H8S, H8C, H8/Tiny	char	short	int	long	long long	float	double	long double	ptr	char is	endian
size	8	16	16/ 32	32	64	32	64	64	32	unsigned	Big

Hitachi H8/300H, H8S, H8C, H8/Tiny	char	short	int	long	long long	float	double	long double	ptr	char is	endian
alignmen	8	16	32/ 16	32/16	32/16	32/16	32/16	32/16	32/16	N/A	N/A

View or Modify Existing Generic Targets

To view or modify generic targets that you previously created:

1. On the **Configuration** pane, select **Target & Compiler**.
2. For **Target processor type**, select your target, for example, `MyTarget`.
3. Click **Edit**. The Generic target options dialog box opens, displaying your target attributes.



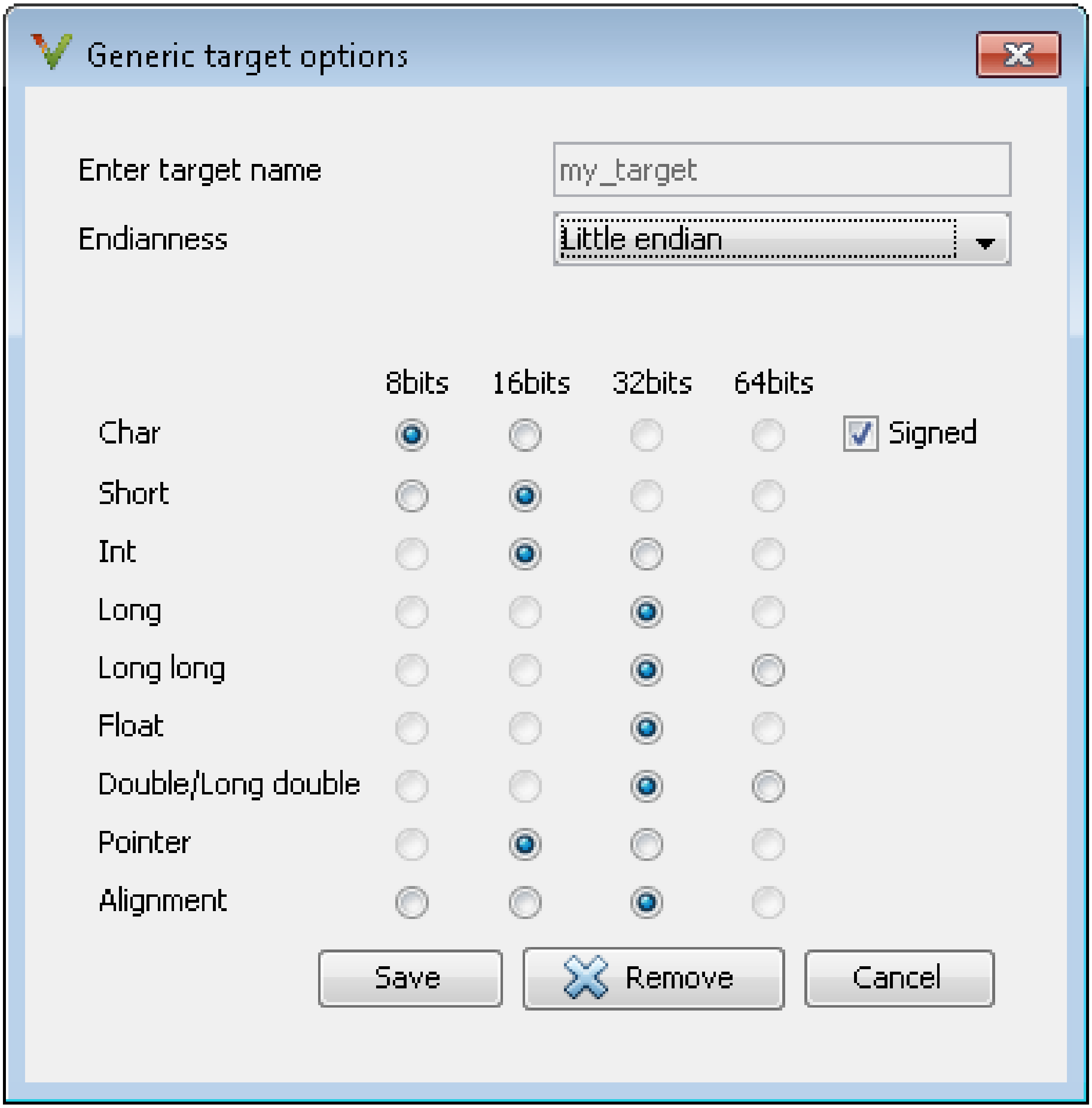
4 If required, specify new attributes for your target. Then click **Save**.

5 Otherwise, click **Cancel**.

Delete Generic Target

To delete a generic target:

1. On the **Configuration** pane, select **Target & Compiler**.
2. For **Target processor type**, select the target that you want to remove, for example, `my_target`.



3 Click **Remove**. The software removes the target from the list.

Compile Operating System Dependent Code

- "Predefined Compilation Flags for C Code" on page 6-10
- "Predefined Compilation Flags for C++ Code" on page 6-12
- "My Target Application Runs on Linux" on page 6-16
- "My Target Application Runs on Solaris" on page 6-16
- "My Target Application Runs on Vxworks" on page 6-17
- "My Target Application Does Not Run on Linux, VxWorks, or Solaris" on page 6-17

Predefined Compilation Flags for C Code

If you choose a value for **Target operation system**, before verification, Polyspace automatically:

- Defines certain compilation flags.
- Includes certain header files.

Target operating system	Compilation flags	—include file and content
no-predefined-OS	-D__STDC__	
Visual	-D__STDC__	-include *<product_dir>*/cinclude/pst-visual.h
VxWorks	-D__STDC__ -DANSI_PROTOTYPES -DSTATIC= -DCONST=const -D__GNUC__=2 -Dunix -D__unix -D__unix__ -Dsparc -D__sparc -D__sparc__ -Dsun -D__sun -D__sun__ -D__svr4__	-include *<product_dir>*/cinclude/pst-vxworks.h

Target operating system	Compilation flags	—include file and content
	-D__SVR4	
Linux	-D__STDC__ -D__GNUC__=2 -D__GNUC_MINOR__=6 -D__GNUC__=2 -D__GNUC_MINOR__=6 -D__ELF__ -Dunix -D__unix -D__unix__ -Dlinux -D__linux -D__linux__ -Di386 -D__i386 -D__i386__ -Di686 -D__i686 -D__i686__ -Dpentiumpro -D__pentiumpro -D__pentiumpro__	<*product_dir*>/cinclude/pst-linux.h

Target operating system	Compilation flags	—include file and content
Solaris	-D__STDC__ -D__GNUC__=2 -D__GNUC_MINOR__=8 -D__GNUC__=2 -D__GNUC_MINOR__=8 - D__GCC_NEW_VARARGS__ -Dunix -D__unix -D__unix__ -Dsparc -D__sparc -D__sparc__ -Dsun -D__sun -D__sun__ -D__svr4__ -D__SVR4	No -include file mentioned

Note: The use of the `-OS-target` option is equivalent to the following approaches:

- Setting the same `-D` flags manually
- Using the `-include` option on a copied and modified pst-*OS-target*.h file

Predefined Compilation Flags for C++ Code

The following table shown for each `–OS-target`, the list of compilation flags defined by default, including pre-include header file (see also `–include`):

Target operating system	Compilation flags	-include file	Minimum set of options
Linux	- D__SIZE_TYPE__=unsigned -D__PTRDIFF_TYPE__=int	<product_dir>/ cinclude/ pst-linux.h	polyspace-[desktop-]cpp - OS-target Linux \

Target operating system	Compilation flags	-include file	Minimum set of options
	-D__inline__=inline -D__signed__=signed - D__gnuc_va_list=va_list -D__STL_CLASS_PARTIAL_ SPECIALIZATION -D__GNU_SOURCE -D__STDC__ -D__ELF__ -Dunix -D__unix -D__unix__ -Dlinux -D__linux -D__linux__ -Di386 -D__i386 -D__i386__ -Di686 -D__i686 -D__i686__ -Dpentiumpro -D__pentiumpro -D__pentiumpro__		-I <polyspace_install>/ include/ include-linux \ -I <product_dir>/include/ include-linux/next Where the Polyspace product has been installed in the folder <polyspace_install>

Target operating system	Compilation flags	-include file	Minimum set of options
VxWorks	- D__SIZE_TYPE__=unsigned -D__PTRDIFF_TYPE__=int -D__inline__=inline -D__signed__=signed - D__gnuc_va_list=va_list -D__STL_CLASS_PARTIAL_ SPECIALIZATION -DANSI_PROTOTYPES -DSTATIC= -DCONST=const -D__STDC -D__GNU_SOURCE -Dunix -D__unix -D__unux__ -Dsparc -D__sparc -D__sparc__ -Dsun -D__sun -D__sun__ -D__svr4 -D__SVR4	<product_dir>/ cinclude/ pstvxworks. h	polyspace-[desktop-]cpp \ -OS-target vxworks \ -I /your_path_to/ Vxworks_include_folders

Target operating system	Compilation flags	-include file	Minimum set of options
Visual	-D__SIZE_TYPE__=unsigned -D__PTRDIFF_TYPE__=int -D__STRICT_ANSI__ -D__inline__=inline -D__signed__=signed -D__gnuc_va_list=va_list -D_POSIX_SOURCE -D__STL_CLASS_PARTIAL_SPECIALIZATION	<product_dir>/cinclude/pstvisual. h	

Solaris	-D__SIZE_TYPE__=unsigned
	-D__PTRDIFF_TYPE__=int
	-D__inline__=inline
	-D__signed__=signed
	-D__gnuc_va_list=va_list
	-D__STL_CLASS_PARTIAL_SPECIALIZATION
	-D__GNU_SOURCE
	-D__STDC
	-D__GCC_NEW_VARARGS__
	-Dunix
	-D__unix
	-D__unux__
	-Dsparc
	-D__sparc
	-D__sparc__
	-Dsun
	-D__sun
	-D__sun__
	-D__svr4
	-D__SVR4
			If Polyspace runs on a Linux machine:
			`polyspace-[desktop-]cpp \`
			`-OS-target Solaris \`
			`-I /your_path_to_solaris_include`
			If Polyspace runs on a Solaris machine:
			`polyspace-code-prover-nodesktop -lang cpp\`
			`-OS-target Solaris \`
			`-I /usr/include`

Target operating system	Compilation flags	-include file	Minimum set of options

no-predefined-OS	-D__SIZE_TYPE__=unsigned
	-D__PTRDIFF_TYPE__=int
	-D__STRICT_ANSI__
	-D__inline__=inline
	-D__signed__=signed
	-D__gnuc_va_list=va_list
	-D_POSIX_SOURCE
	-D__STL_CLASS_PARTIAL_SPECIALIZATION
			`polyspace-[desktop-]cpp \`
			`-OS-target no-predefined-OS \`
			`-I /your_path_to/MyTarget_include_folders`

Note: This list of compiler flags is written in every log file.

My Target Application Runs on Linux

The minimum set of options is as follows:

```
polyspace-code-prover-nodesktop \
 -OS-target Linux \
 -I MATLAB_Install/polyspace/verifier/cxx/include/include-libc \

 ...
```

If your target application runs on Linux but you are starting your verification from Windows, the minimum set of options is as follows:

```
polyspace-code-prover-nodesktop \
 -OS-target Linux \
 -I MATLAB_Install\polyspace\verifier\cxx\include\include-libc \

 ...
```

MATLAB_Install is your MATLAB installation folder.

My Target Application Runs on Solaris

If Polyspace software runs on a Linux machine:

```
polyspace-code-prover-nodesktop \
 -OS-target Solaris \
 -I /your_path_to_solaris_include
```

My Target Application Runs on Vxworks

If Polyspace software runs on either a Solaris™ or a Linux machine:

```
polyspace-code-prover-nodesktop \
 -OS-target vxworks \
 -I /your_path_to/Vxworks_include_folders
```

My Target Application Does Not Run on Linux, VxWorks, or Solaris

If Polyspace software does not run on a Linux machine:

```
polyspace-code-prover-nodesktop \
 -OS-target no-predefined-OS \
 -I /your_path_to/MyTarget_include_folders
```

Address Alignment

Polyspace software handles address alignment by calculating `sizeof` and alignments. This approach takes into account 3 constraints implied by the ANSI standard which ensure that:

- Global `sizeof` and `offsetof` fields are optimum, that is, as short as possible.
- The alignment of addressable units is respected.
- Global alignment is respected.

Consider the example:

```
struct foo {char a; int b;}
```

- Each field must be aligned; that is, the starting offset of a field must be a multiple of its own size[2]
- So in the example, `char a` begins at offset 0 and its size is 8 bits. `int b` cannot begin at 8 (the end of the previous field) because the starting offset must be a multiple of its own size (32 bits). Consequently, `int b` begins at offset=32. The size of the `struct foo` before global alignment is therefore 64 bits.

2. except in the cases of “double” and “long” on some targets.

- The global alignment of a structure is the maximum of the individual alignments of each of its fields;
- In the example, `global_alignment = max (alignment char a, alignment int b) = max (8, 32) = 32`
- The size of a struct must be a multiple of its global alignment. In our case, b begins at 32 and is 32 long, and the size of the struct (64) is a multiple of the `global_alignment` (32), so `sizeof` is not adjusted.

Ignore or Replace Keywords Before Compilation

You can ignore noncompliant keywords, for example, `far` or `0x`, which precede an absolute address. The template `myTpl.pl` allows you to ignore these keywords.

1 Save the template as `C:\Polyspace\myTpl.pl`.

Content of myTpl.pl

```
#!/usr/bin/perl

##############################################################
# Post Processing template script
#
##############################################################
# Usage from Project Manager GUI:
#
# 1) Linux: /usr/bin/perl PostProcessingTemplate.pl
# 2) Windows: MATLAB_Install\sys\perl\win32\bin\perl.exe <pathtoscript>\
PostProcessingTemplate.pl
#
##############################################################

$version = 0.1;

$INFILE = STDIN;
$OUTFILE = STDOUT;

while (<$INFILE>)
{

 # Remove far keyword
 s/far//;
```

```
 # Remove "@ 0xFE1" address constructs
 s/\@\s0x[A-F0-9]*//g;

 # Remove "@0xFE1" address constructs
 # s/\@0x[A-F0-9]*//g;

 # Remove "@ ((unsigned)&LATD*8)+2" type constructs
 s/\@\s\(\(unsigned\)\&[A-Z0-9]+\*8\)\+\d//g;

 # Convert current line to lower case
# $_ =~ tr/A-Z/a-z/;

 # Print the current processed line
 print $OUTFILE $_;
}
```

For reference, see a summary of Perl regular expressions.

Perl Regular Expressions

```
#########################################################
# Metacharacter What it matches
#########################################################
# Single Characters
# . Any character except newline
# [a-z0-9] Any single character in the set
# [^a-z0-9] Any character not in set
# \d A digit same as
# \D A non digit same as [^0-9]
# \w An Alphanumeric (word) character
# \W Non Alphanumeric (non-word) character
#
# Whitespace Characters
# \s Whitespace character
# \S Non-whitespace character
# \n newline
# \r return
# \t tab
# \f formfeed
# \b backspace
#
```

```
# Anchored Characters
# \B word boundary when no inside []
# \B non-word boundary
# ^ Matches to beginning of line
# $ Matches to end of line
#
# Repeated Characters
# x? 0 or 1 occurrence of x
# x* 0 or more x's
# x+ 1 or more x's
# x{m,n} Matches at least m x's and no more than n x's
# abc All of abc respectively
# to|be|great One of "to", "be" or "great"
#
# Remembered Characters
# (string) Used for back referencing see below
# \1 or $1 First set of parentheses
# \2 or $2 First second of parentheses
# \3 or $3 First third of parentheses
##########################################################
# Back referencing
#
# e.g. swap first two words around on a line
# red cat -> cat red
# s/(\w+) (\w+)/$2 $1/;
#
##########################################################
```

2. On the **Configuration** pane, select **Environment Settings**.
3. To the right of **Command/script to apply to preprocessed files**, click .
4. Use the Open File dialog box to navigate to `C:\Polyspace`.
5. In the **File name** field, enter `myTpl.pl`.
6. Click **Open**. You see `C:\Polyspace\myTpl.pl` in the **Command/script to apply to preprocessed files** field.

For more information, see "`-post-preprocessing-command`".

Language Extensions

The software allows a verification to accept a subset of common C language constructs and extended keywords, as defined by the C99 standard or supported by many compilers.

By default, the following constructs are accepted:

- Designated initializers (labeling initialized elements)
- Compound literals (structs or arrays as values)
- Boolean type (`_Bool`)
- Statement expressions (statements and declarations inside expressions)
- `typeof` constructs
- Case ranges
- Empty structures
- Cast to union
- Local labels (`__label__`)
- Hexadecimal floating-point constants
- Extended keywords, operators, and identifiers (`_Pragma`, `__func__`, `__const__`, `__asm__`)

The software ignores the following extended keywords:

- `near`
- `far`
- `restrict`
- `_attribute_(X)`
- `rom`

Verify Keil or IAR Dialects

Typical embedded control applications frequently read and write port data, set timer registers and read input captures. To deal with this without using assembly language, some microprocessor compilers have specified special data types like `sfrand sbit`. Typical declarations are:

```
sfr A0 = 0x80;
sfr A1 = 0x81;
sfr ADCUP = 0xDE;
sbit EI = 0x80;
```

These declarations reside in header files such as `regxx.h` for the basic `80Cxxx` micro processor. The definition of `sfr` in these header files customizes the compiler to the target processor.

When accessing a register or a port, using `sfr` data is then simple, but is not part of standard ANSI C:

```
int status,P0;

void main (void) {
  ADCUP = 0x08; /* Write data to register */
  A1 = 0xFF; /* Write data to Port */
  status = P0; /* Read data from Port */
  EI = 1; /* Set a bit (enable all interrupts) */
}
```

You can verify this type of code using the **Dialect** (`-dialect`) option . This option allows the software to support the Keil or IAR C language extensions even if some structures, keywords, and syntax are not ANSI standard. The following tables summarize what is supported when verifying code that is associated with the Keil or IAR dialects.

The following table summarizes the supported Keil C language extensions:

Example: `-dialect keil -sfr-types sfr=8`

Type/Language	Description	Example	Restrictions

Type `bit`	• An expression to type bit gives values in range [0,1].
	• Converting an expression in the type, gives 1 if it is not equal to 0, else 0. This behavior is similar to c ++ bool type.
		`bit x = 0, y = 1,`
		` z = 2;`
		`assert(x == 0);`
		`assert(y == 1);`
		`assert(z == 1);`
		`assert(sizeof(bit)`
		` == sizeof(int));`
			pointers to bits and arrays of bits are not allowed

Type `sfr`	• The -sfr-types option defines unsigned types **name** and size in bits.
	• The behavior of a variable follows a variable of type integral.
		`sfr x = 0xf0; //`
		`declaration of`
		`variable x at`
		`address 0xF0`
		`sfr16 y = 0x4EEF;`
		
		For this example, options need to be:
		
		`-dialect keil`
			sfr and sbit types are only allowed in declarations of external global variables.

Type/Language	Description	Example	Restrictions
	• A variable which overlaps another one (in term of address) will be considered as volatile.	`-sfr-types sfr=8,  \` `    sfr16=16`	

Type `sbit`	• Each read/write access of a variable is replaced by an access of the corresponding sfr variable access.
	• Only external global variables can be mapped with a sbit variable.
	• Allowed expressions are integer variables, cells of array of int and struct/union integral fields.
	• a variable can also be declared as extern bit in an another file.
		`sfr x = 0xF0;`
		`sbit x1 = x ^ 1; // 1st bit of x`
		`sbit x2 = 0xF0 ^ 2; // 2nd bit of x`
		`sbit x3 = 0xF3; // 3rd bit of x`
		`sbit y0 = t[3] ^ 1;`
		
		`/* file1.c */`
		`sbit x = P0 ^ 1;`
		`/* file2.c */`
		`extern bit x;`
		`x = 1; // set the 1st bit of P0 to 1`	

Absolute variable location	Allowed constants are integers, strings and identifiers.	`int var _at_ 0xF0`
		`int x @ 0xFE ;`
		`static const`
		`int y @ 0xA0 = 3;`
			Absolute variable locations are ignored (even if declared with a #pragma location).

Interrupt functions	A warnings in the log file is displayed when an interrupt function has been found: "interrupt handler detected : <name>" or "task entry point detected : <name>"	`void foo1 (void)`
		`interrupt XX = YY`
		`using 99 {…}`
		`void foo2 (void) _`
		`task_ 99 _priority_`
		`2 {…}`
			Entry points and interrupts are not taken into account as `-entry-points`.

Keywords removed during preprocessing	The software removes certain Keil keywords during preprocessing.	`alien`, `bdata`, `far`, `idata`, `ebdata`, `huge`, `sdata`	

Type/Language	Description	Example	Restrictions
	If you use any of these keywords as a variable name, you see a compilation error. To avoid the compilation error, do one of the following: • In the user interface, enter `__PST_KEIL_NO_KEYW` for **Preprocessor definitions**. • On the command-line, use the flag `-D __PST_KEIL_NO_KEYW`		

The following table summarize the IAR dialect:

Example: `-dialect iar -sfr-types sfr=8`

Type/Language	Description	Example	Restrictions

Type `bit`	• An expression to type bit gives values in range [0,1].
	• Converting an expression in the type, gives 1 if it is not equal to 0, else 0. This behavior is similar to c ++ bool type.
	• If initialized with values 0 or 1, a variable of type bit is a simple variable (like a c++ bool).
	• A variable of type bit is a register bit
		`union {`
		`  int v;`
		`  struct {`
		`    int z;`
		`  } y;`
		`} s;`
		
		`void f(void) {`
		`  bit y1 = s.y.z . 2;`
		`  bit x4 = x.4;`
		`  bit x5 = 0xF0 . 5;`
		`  y1 = 1;`
		` // 2nd bit of s.y.z`
		` // is set to 1`
		`};`
			pointers to bits and arrays of bits are not allowed

Type/Language	Description	Example	Restrictions
	variable (mapped with a bit or a sfr type)		

Type `sfr`	• The -sfr-types option defines unsigned types name and size.
	• The behavior of a variable follows a variable of type integral.
	• A variable which overlaps another one (in term of address) will be considered as volatile.
		`sfr x = 0xf0; //`
		`declaration of`
		`variable x at`
		`address 0xF0`
			sfr and sbit types are only allowed in declarations of external global variables.

Individual `bit` access	• Individual bit can be accessed without using sbit/bit variables. • Type is allowed for integer variables, cells of integer array, and struct/union integral fields.	`int x[3], y;` `x[2].2 = x[0].3 + y.1;`	

Absolute variable location	Allowed constants are integers, strings and identifiers.	`int var @ 0xF0;`
		`int xx @ 0xFE ;`
		`static const int y \`
		` @0xA0 = 3;`
			Absolute variable locations are ignored (even if declared with a #pragma location).

Interrupt functions	• A warning is displayed in the log file when an interrupt function has been found: "interrupt handler detected : funcname"	`interrupt [1] \`
		` using [99] void \`
		` foo1(void) { ... };`
		
		`monitor [3] void \`
		` foo2(void) { ... };`
			Entry points and interrupts are not taken into account as `-entry-points`.

Type/Language	Description	Example	Restrictions
	• A monitor function is a function that disables interrupts while it is executing, and then restores the previous interrupt state at function exit.		
Keywords removed during preprocessing	The software removes certain IAR keywords during preprocessing. If you use any of these keywords as a variable name, you see a compilation error. To avoid the compilation error, do one of the following: • In the user interface, enter `__PST_IAR_NO_KEYWO` for **Preprocessor definitions**. • On the command-line, use the flag `-D __PST_IAR_NO_KEYWO`	`saddr, reentrant, reentrant_idata, non_banked, plm, bdata, idata, pdata, code, data, xdata, xhuge, interrupt, __interrupt` and `__intrinsic`	
Unnamed struct/ union	• Fields of unions/ structs with no tag and no name can be accessed without naming their parent struct. • On a conflict between a field of an anonymous struct with other identifiers:	`union { int x; };` `union { int y; struct { int z; }; } @ 0xF0;`	

Type/Language	Description	Example	Restrictions
	• with a variable name, field name is hidden • with a field of another anonymous struct at different scope, closer scope is chosen • with a field of another anonymous struct at same scope: an error "anonymous struct field name <name> conflict“ is displayed in the log file.		
`no_init` attribute	• a global variable declared with this attribute is handled like an external variable. • It is handled like a type qualifier.	`no_init int x;` `no_init union { int y; } @ 0xFE;`	#pragma no_init has no effect

The option `-sfr-types` defines the size of a `sfr` type for the Keil or IAR dialect.

The syntax for an `sfr` element in the list is `type-name=typesize`.

For example:

```
-sfr-types sfr=8,sfr16=16
```

defines two `sfr` types: `sfr` with a size of 8 bits, and `sfr16` with a size of 16-bits. A value type-name must be given only once. 8, 16 and 32 are the only supported values for `type-size`.

Note: As soon as an `sfr` type is used in the code, you must specify its name and size, even if it is the keyword `sfr`.

Note: Many IAR and Keil compilers currently exist that are associated to specific targets. It is difficult to maintain a complete list of those supported.

Gather Compilation Options Efficiently

The code is often tuned for the target (see "Verify Keil or IAR Dialects" on page 6-21). Instead of applying minor changes to the code, create a single `polyspace.h` file that contains all target specific functions and options. The `-include` option can then be used to force the inclusion of the `polyspace.h` file in all source files under verification.

Where there are missing prototypes or conflicts in variable definition, writing the expected definition or prototype within such a header file will yield several advantages.

Direct benefits:

- The error detection is much faster since it will be detected during compilation rather than in the link or subsequent phases.
- The position of the error will be identified more precisely.
- There will be no need to modify original source files.

Indirect benefits:

- The file is automatically included as the very first file in the original `.c` files.
- The file can contain much more powerful macro definitions than simple -D options.
- The file is reusable for other projects developed under the same environment.

Example

This is an example of a file that can be used with the `-include` option.

```
// The file may include (say) a standard include file implicitly
// included by the cross compiler

#include <stdlib.h>
#include "another_file.h"
```

```
// Generic definitions, reusable from one project to another
#define far
#define at(x)

// A prototype may be positioned here to aid in the solution of
// a link phase conflict between
// declaration and definition. This will allow detection of the
// same error at compilation time instead of at link time.
// Leads to:
// - earlier detection
// - precise localisation of conflict at compilation time
void f(int);

// The same also applies to variables.
extern int x;

// Standard library stubs can be avoided,
// and OS standard prototypes redefined.

#define POLYSPACE_NO_STANDARD_STUBS // use this flag to prevent the
              //automatic stubbing of std functions
#define __polyspace_no_sscanf
#define __polyspace_no_fgetc
void sscanf(int, char, char, char, char, char);
void fgetc(void);
```

Supported C++ 2011 Standards

Standard	Description	Supported
C++2011-N2118	Rvalue references	Yes
C++2011-N2439	Rvalue references for *this	Yes
C++2011-N1610	Initialization of class objects by rvalues	Yes
C++2011-N2756	Non-static data member initializers	Yes
C++2011-N2242	Variadic templates	Yes
C++2011-N2555	Extending variadic template template parameters	Yes
C++2011-N2672	Initializer lists	Yes
C++2011-N1720	Static assertions	Yes
C++2011-N1984	auto-typed variables	Yes
C++2011-N1737	Multi-declarator auto	Yes
C++2011-N2546	Removal of auto as a storage-class specifier	Yes
C++2011-N2541	New function declarator syntax	Yes
C++2011-N2927	New wording for C++0x lambdas	Yes
C++2011-N2343	Declared type of an expression	Yes
C++2011-N3276	decltype and call expressions	Yes

Standard	Description	Supported
C++2011-N1757	Right angle brackets	Yes
C++2011-DR226	Default template arguments for function templates	Yes
C++2011-DR339	Solving the SFINAE problem for expressions	Yes
C++2011-N2258	Template aliases	Yes
C++2011-N1987	Extern templates	Yes
C++2011-N2431	Null pointer constant	Yes
C++2011-N2347	Strongly-typed enums	Yes
C++2011-N2764	Forward declarations for enums	Yes
C++2011-N2761	Generalized attributes	Yes
C++2011-N2235	Generalized constant expressions	Yes
C++2011-N2341	Alignment support	Yes
C++2011-N1986	Delegating constructors	Yes
C++2011-N2540	Inheriting constructors	Yes
C++2011-N2437	Explicit conversion operators	Yes
C++2011-N2249	New character types	Yes
C++2011-N2442	Unicode string literals	Yes

Standard	Description	Supported
C++2011-N2442	Raw string literals	Yes
C++2011-N2170	Universal character name literals	No
C++2011-N2765	User-defined literals	Yes
C++2011-N2342	Standard Layout Types	Not applicable[1]
C++2011-N2346	Defaulted and deleted functions	Yes
C++2011-N1791	Extended friend declarations	No
C++2011-N2253	Extending sizeof	Yes
C++2011-N2535	Inline namespaces	Yes
C++2011-N2544	Unrestricted unions	Yes
C++2011-N2657	Local and unnamed types as template arguments	Yes
C++2011-N2930	Range-based for	Yes
C++2011-N2928	Explicit virtual overrides	Yes
C++2011-N3050	Allowing move constructors to throw [noexcept]	Yes
C++2011-N3053	Defining move special member functions	Yes
C++2011-N2239	Concurrency - Sequence points	Not applicable[1]
C++2011-N2427	Concurrency - Atomic operations	No

Standard	Description	Supported
C++2011-N2748	Concurrency - Strong Compare and Exchange	No
C++2011-N2752	Concurrency - Bidirectional Fences	No
C++2011-N2429	Concurrency - Memory model	Not applicable[1]
C++2011-N2664	Concurrency - Data-dependency ordering: atomics and memory model	No
C++2011-N2179	Concurrency - Propagating exceptions	No
C++2011-N2440	Concurrency - Abandoning a process and at_quick_exit	Yes
C++2011-N2547	Concurrency - Allow atomics use in signal handlers	No
C++2011-N2659	Concurrency - Thread-local storage	No
C++2011-N2660	Concurrency - Dynamic initialization and destruction with concurrency	No
C++2011-N2340	__func__ predefined identifier	Yes
C++2011-N1653	C99 preprocessor	Yes
C++2011-N1811	long long	Yes
C++2011-N1988	Extended integral types	Not applicable[1]

[1] This C++11 requirement is not a factor in a Polyspace verification.

See Also

"C++11 Extensions (C++)"

Verify C Application Without a "Main"

In this section...

Main Generator Overview

Polyspace verification requires that your code must have a `main` function. You can do one of the following:

- Provide a `main` function in your code.
- Specify that Polyspace must generate a `main`.

Before verification, you can specify one of the following options:

Option	Description
Verify whole application	The verification stops if the software does not detect a `main`.
Verify module (default)	Before verification, Polyspace checks your code for a `main`. • If your source files contain a `main` function, the verification uses that `main`. • If your source files do not contain a `main` function, the verification generates a `main` using the options that you specify.

Automatically Generate a Main

To automatically generate a main, on the **Configuration > Code Prover Verification** pane, click **Verify module**.

Note: If a main exists in your code, then the verification uses this main and disregards the **Verify module** options.

For cyclic program code generated from a Simulink model, the generated main:

1. Initializes calibration variables identified by the `-variables-written-before-loop` option.
2. Calls initialization functions specified by the `-functions-called-before-loop` option.
3. Initializes input variables identified by the `-variables-written-in-loop` option. This initialization of variables is performed for each cycle.
4. Calls cyclic functions specified by the `-functions-called-in-loop` option.
5. Calls termination functions specified by the option `-functions-called-after-loop`.

For other code, the generated main:

1. Initializes variables identified by the `-main-generator-writes-variables` option.
2. Calls initialization functions specified by the `-functions-called-before-main` option.
3. Calls functions specified by the `-main-generator-calls` option. The order and the number of times that the functions are called is not specified.

Main for Generated Code

The following example shows how to use the main generator options to generate a main for a cyclic program, such as code generated from a Simulink model.

```
init parameters  // -variables-written-before-loop
init_fct()    // -functions-called-before-loop

volatile int random = 0;
while(random){          // Start main loop
  init inputs                 // -variables-written-in-loop
  step_fct()          // -functions-called-in-loop
}
terminate_fct()  // -functions-called-after-loop
```

Manually Generate a Main

Manually generating a main is often preferable to an automatically generated main, because it allows you to provide a more accurate model of the calling sequence to be generated.

To manually define the main:

1. Identify the API functions and extract their declarations.
2. Create a main containing declarations of a volatile variable for each type that is mentioned in the function prototypes.
3. Create a loop with a volatile end condition.
4. Inside this loop, create a switch block with a volatile condition.
5. For each API function, create a case branch that calls the function using the volatile variable parameters you created.

Consider the following example. Suppose that the API functions are:

```
int func1(void *ptr, int x);
void func2(int x, int y);
```

You should create the following main:

```
void main()
{
volatile int random; /* We need an integer variable as a function
parameter */
volatile void * volatile ptr; /* We need a void pointer as a function
parameter */
while (random) {
 switch (random) {
 case 1:
  random = func1(ptr, random); break; /* One API function call */
 default:
  func2(random, random); /* Another API function call */
 }
}
```

Specify Call Sequence

Polyspace software verifies functions on the basis that the functions can be called in any order. Consider a scenario where a function `f` is listed before a function `g`. If actions in `f` must be executed before `g` is called, writing a main which calls `f` and `g` in the required order will produce a higher selectivity.

Colored Source Code Example

With default settings, a Polyspace verification will not identify defects in the following example.

```
static char x;
static int y;

void f(void)
{
y = 300;
}

void g(void)
{
x = y; // red or green OVFL?
}
```

However, if you know the call sequence, you can create a main that calls the functions in the desired order:

```
void main(void)
{
f()
g()
}
```

If `f` is called first, the assignment `x = y;` generates a red check as assigning 300 to a `char` is incorrect. The assignment statement would be green if `g` were called before `f`.

Main Generator Assumptions

When using the automatic main generator to verify a specific function, the objective is to find problems with the function. To do this, the generated main makes assumptions about parameters so that you can focus on run-time errors (red, gray and orange) that are related to the function.

The main generator makes assumptions about the arguments of called functions to reduce the number of orange checks in the results. Therefore, when you see an orange check in your results, it is likely to be due to the function, not the main.

However, green checks are computed with the same assumptions. Therefore, you should be cautious of green checks involving the main, especially when conducting unit-by-unit verification.

Polyspace C++ Class Analyzer

In this section...

Why Provide a Class Analyzer

One aim of object-oriented languages such as C++ is reusability. A class or a class family is reusable if it is free of defects for all possible uses of the class. The class can be considered free of defects if run-time errors have been removed and the class passes functional tests. The foremost objective when developing code in such a language is to identify and remove as many run-time errors as possible.

Polyspace class analyzer is a tool for removing run-time errors at compilation time. The software will simulate alluses of a class by:

1. Creating objects using all constructors (default if none exist).
2. Calling all methods (public, static, and protected) of previous objects in every order.
3. Calling all methods of the class between time zero and infinity.
4. Calling every destructor of previous objects (if they exist).

How the Class Analyzer Works

Polyspace Class Analyzer verifies applications class by class, even if these classes are only partially developed.

The **benefits** of this process include error detection at a very early stage, even if the class is not fully developed, without test cases to write. The process is very simple: provide the class name and the software will verify its robustness.

- Polyspace software generates a “pseudo” main.
- It calls each constructor of the class.
- It then calls each public function from the constructors.
- Each parameter is initialized with full range (i.e., with a random value).
- External variables are assigned random values.

Note: Only prototypes of objects (classes, methods, variables, etc.) are required to verify a given class. Missing code is automatically stubbed.

Sources Verified

The sources associated with the verification normally concern public and protected methods of the class. However, sources can also come from inherited classes (fathers) or be the sources of other classes that are used by the class under investigation (friend, etc.).

Architecture of Generated Main

Polyspace software generates the call to each constructor and method of the class. Each method will be analyzed with all constructors. Each parameter is initialized to random. Note that even if you can get an idea of the architecture of the generated main in the Results Manager perspective, the main is not real. You cannot reuse or compile it.

Consider an example class `MathUtils`. This class contains one constructor, one destructor and seven public methods. The architecture of the generated main is as follows:

```
Generating call to constructor: MathUtils:: MathUtils ()
While (random) {
 If (random) Generating call to function: MathUtils::Pointer_Arithmetic()
 If (random) Generating call to function: MathUtils::Close_To_Zero()
```

```
 If (random) Generating call to function: MathUtils::MathUtils()
 If (random) Generating call to function: MathUtils::Recursion_2(int *)
 If (random) Generating call to function: MathUtils::Recursion(int *)
 If (random) Generating call to function: MathUtils::Non_Infinite_Loop()
 If (random) Generating call to function: MathUtils::Recursion_caller()
}
Generating call to destructor: MathUtils::~MathUtils()
```

Note: If a class contains more than one constructor, they are called before the "while" statement in an "if then else" statement. This architecture ensures that the verification will evaluate each function method with every constructor.

Class Verification Log File

During a class verification, the list of methods used for the main appears in the log file during the normalization phase of the C++ verification.

You can view the details of what is analyzed in the log file. Consider an example class `MathUtils` with an associated log file:

```
...
* Generating the Main ...
Generating call to function: MathUtils::Pointer_Arithmetic()
Generating call to function: MathUtils::Close_To_Zero()
Generating call to function: MathUtils::MathUtils()
Generating call to function: MathUtils::Recursion_2(int *)
Generating call to function: MathUtils::Recursion(int *)
Generating call to function: MathUtils::Non_Infinite_Loop()
Generating call to function: MathUtils::~MathUtils()
Generating call to function: MathUtils::Recursion_caller()
```

If a main is defined in the files being analyzed, you receive a warning:

```
…
* Warning: a main procedure already exists but will be ignored.
```

Characteristics of Class and Log File Messages

The log file may contain some error messages concerning the class to be analyzed. These messages appear when characteristics of a class are not respected.

- It is not possible to analyze a class that does not exist in the given sources. The verification will halt with the following message:

```
------------------------------------------------------------
@User Program Error: Argument of option -class-analyzer
must be defined : <name>.
Please correct the program and restart the verifier.
------------------------------------------------------------
```

- It is not possible to analyze a class that only contains declarations without code. The verification will halt with the following message:

```
------------------------------------------------------------
@User Program Error: Argument of option -class-analyzer
must contain at least one function : <name>.
Please correct the program and restart the verifier.
------------------------------------------------------------
```

Behavior of Global Variables and Members

Global Variables

During a class verification, global variables are not considered to be following ANSI Standard anymore if they are defined but not initialized. Remember that ANSI Standard considers, by default, that global variables are initialized to zero.

In a class verification, global variables do not follow standard behaviors:

- Defined variables are initialized to random and then follow the data flow of the code to be analyzed.
- Initialized variables are used with the specified initialized values and then follow the data flow of the code to be analyzed.
- External variables are assigned definitions and initialized to random values.

An example below demonstrates the behaviors of two global variables:

```

extern int fround(float fx);

// global variables
int globvar1;
int globvar2 = 100;

class Location
{
private:
```

```
11  void calculate_new(void);
12  int x;
13
14 public:
15  // constructor 1
16  Location(int intx = 0) { x = intx; };
17  // constructor 2
18  Location(float fx) { x = fround(fx); };
19
20  void setx(int intx) { x = intx; calculate_new(); };
21  void fsetx(float fx) {
22   int tx = fround(fx);
23   if (tx / globvar1 != 0) // ZDV check is orange
24   {
25    tx = tx / globvar2; // ZDV check is green
26    setx(tx);
27   }
28  };
29 };
```

In the above example, `globvar1` is defined but not initialized (see line 5), so the check ZDV is orange at line 23. In the same example, `globvar2` is initialized to 100 (see line 6), so the ZDV check is green at line 25.

Data Members of Other Classes

During the verification of a specific class, variable members of other classes, even members of parent classes, are considered to be initialized. They exhibit the following behaviors:

1. They may not be considered to be initialized if the constructor of the class is not defined. They are assigned to full range, and then they follow the data flow of the code to be analyzed.
2. They are considered to be initialized to the value defined in the constructor if the constructor of the class is defined in the class and is provided for the verification. If the `-class-only` option is applied, the software behaves as though the definition of the constructor is missing (see item 1 above).
3. They may be checked as run-time errors if and only if the constructor is defined but does not initialize the member under consideration.

The example below displays the results of a verification of the class `MyClass`. It demonstrates the behavior of a variable member of the class `OtherClass` that was provided without the definition of its constructor. The variable member of `OtherClass` is initialized to random; the check is orange at line 7 and there are possible overflows at line 17 because the range of the return value `wx` is “full range” in the type definition.

```
class OtherClass
{
protected:
 int x;
public:
 OtherClass (int intx);     // code is missing
 int getMember(void) {return x;};  // NIV is warning
};
class MyClass
{
 OtherClass m_loc;
public:
 MyClass(int intx) : m_loc(0) {};
 void show(void) {
  int wx, wl;
  wx = m_loc.getMember();
  wl = wx*wx + 2;   // Possible overflows because OtherClass
         // member is assigned to full range
 };
};
```

Methods and Class Specifics

Template

A template class cannot be verified on its own. Polyspace software will only consider a specific instance of a template to be a class that can be analyzed.

Consider `template<class T, class Z> class A { }`.

If we want to analyze template class A with two class parameters T and Z, we have to define a typedef to create an instance of the template with specified specializations for T and Z. In the example below, T represents an `int` and Z a `double`:

```
template class A<int, double>;   // Explicit specialisation
typedef class A<int, double> my_template;
```

`my_template` is used as a parameter of the `-class-analyzer` option in order to analyze this instance of template A.

Abstract Classes

In the real world, an instance of an abstract class cannot be created, so it cannot be analyzed. However, it is easy to establish a verification by removing the pure declarations. For example, this can be accomplished via an abstract class definition change:

`void abstract_func () = 0; by void abstract_func ();`

If an abstract class is provided for verification, the software will make the change automatically and the virtual pure function (`abstract_func` in the example above) will then be ignored during the verification of the abstract class.

This means that no call will be made from the generated main, so the function is completely ignored. Moreover, if the function is called by another one, the pure virtual function will be stubbed and an orange check will be placed on the call with the message "call of virtual function [f] may be pure."

Static Classes

If a class defines a static methods, it is called in the generated main as a classical one.

Inherited Classes

When a function is not defined in a derived class, even if it is visible because it is inherited from a father's class, it is not called in the generated main. In the example below, the class `Point` is derived from the class `Location`:

```
class Location
{
protected:
 int x;
 int y;
 Location (int intx, int inty);
public:
 int getx(void) {return x;};
 int gety(void) {return y;};
};
class Point : public Location
{
protected:
 bool visible;
public :
 Point(int intx, int inty) : Location (intx, inty)
```

```
 {
 visible = false;
 };
 void show(void) { visible = true;};
 void hide(void) { visible = false;};
 bool isvisible(void) {return visible;};
};
```

Although the two methods `Location::getx` and `Location::gety` are visible for derived classes, the generated main does not include these methods when analyzing the class `Point`.

Inherited members are considered to be volatile if they are not explicitly initialized in the father's constructors. In the example above, the two members `Location::x` and `Location::y` will be considered volatile. If we analyze the above example in its current state, the method `Location:: Location(constructor)` will be stubbed.

Simple Class

Consider the following class:

`Stack.h`

```
#define MAXARRAY 100

class stack
{
  int array[MAXARRAY];
  long toparray;

public:
  int top (void);
  bool isempty (void);
  bool push (int newval);
  void pop (void);
  stack ();
};
```

`stack.cpp`

```
#include "stack.h"

stack::stack ()
{
```

```
5  toparray = -1;
6  for (int i = 0 ; i < MAXARRAY; i++)
7  array[i] = 0;
8 }
9
10 int stack::top (void)
11 {
12  int i = toparray;
13  return (array[i]);
14 }
15
16 bool stack::isempty (void)
17 {
18  if (toparray >= 0)
19   return false;
20  else
21   return true;
22 }
23
24 bool stack::push (int newvalue)
25 {
26  if (toparray < MAXARRAY)
27  {
28   array[++toparray] = newvalue;
29   return true;
30  }
31
32  return false;
33 }
34
35 void stack::pop (void)
36 {
37  if (toparray >= 0)
38   toparray--;
39 }
```

The class analyzer calls the constructor and then all methods in any order many times.

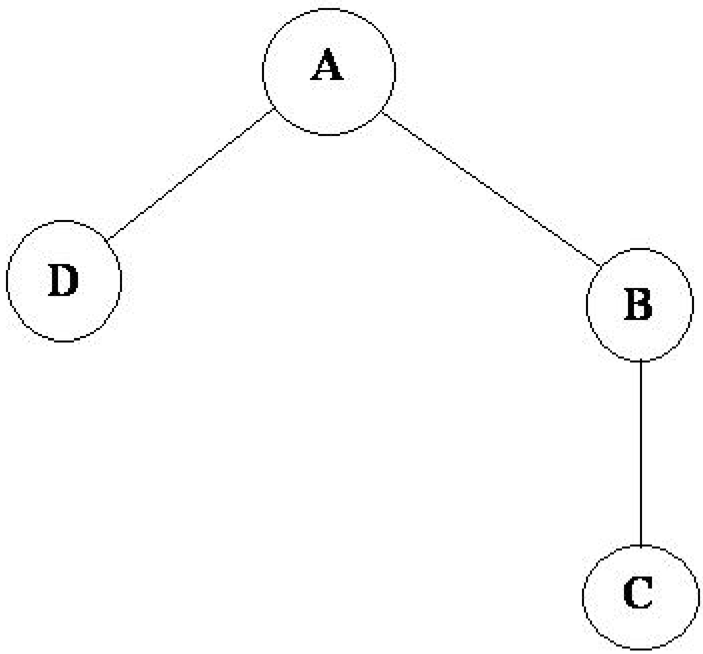
The verification of this class highlights two problems:

- The `stack::push` method may write after the last element of the array, resulting in the OBAI orange check at line 28.
- If called before `push`, the `stack::top` method will access element -1, resulting in the OBAI and NIV checks at line 13.

Fixing these problems will eliminate run-time errors in this class.

Simple Inheritance

Consider the following classes:



A is the base class of B and D.

B is the base class of C.

In a case such a this, Polyspace software allows you to run the following verifications:

1. You can analyze class A just by providing its code to the software. This corresponds to the previous “Simple Class” section in this chapter.
2. You can analyze class B class by providing its code and the class A declaration. In this case, A code will be stubbed automatically by the software.

3 You can analyze class B class by providing B and A codes (declaration and definition). This is a “first level of integration” verification. The class analyzer will not call A methods. In this case, the objective is to find bugs only in the class B code.

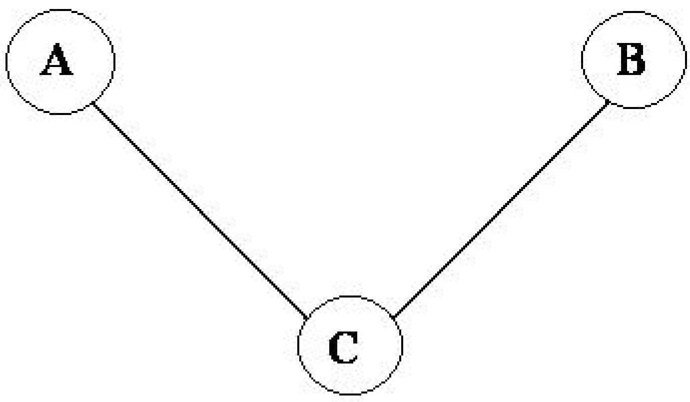
4 You can analyze class C by providing the C code, the B class declaration and the A class declaration. In this case, A and B codes will be stubbed automatically.

5 You can analyze class C by providing the A, B and C code for an integration verification. The class analyzer will call all the C methods but not inherited methods from B and A. The objective is to find only defects in class C.

In these cases, there is no need to provide D class code for analyzing A, B and C classes as long as they do not use the class (e.g., member type) or need it (e.g., inherit).

Multiple Inheritance

Consider the following classes:



A and B are base classes of C.

In this case, Polyspace software allows you to run the following verifications:

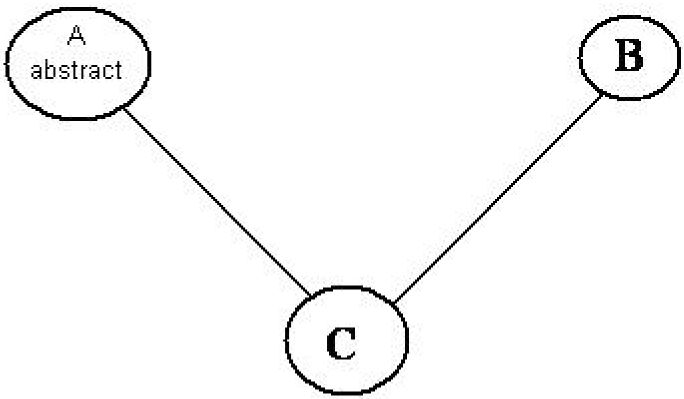
1 You can analyze classes A and B separately just by providing their codes to the software. This corresponds to the previous “Simple Class” section in this chapter.

2 You can analyze class C by providing its code with A and B declarations. A and B methods will be stubbed automatically.

3 You can analyze class C by providing A, B and C codes for an integration verification. The class analyzer will call all the C methods but not inherited methods from A and B. The objective is to find bugs only in class C.

Abstract Classes

Consider the following classes:



A is an abstract class

B is a simple class.

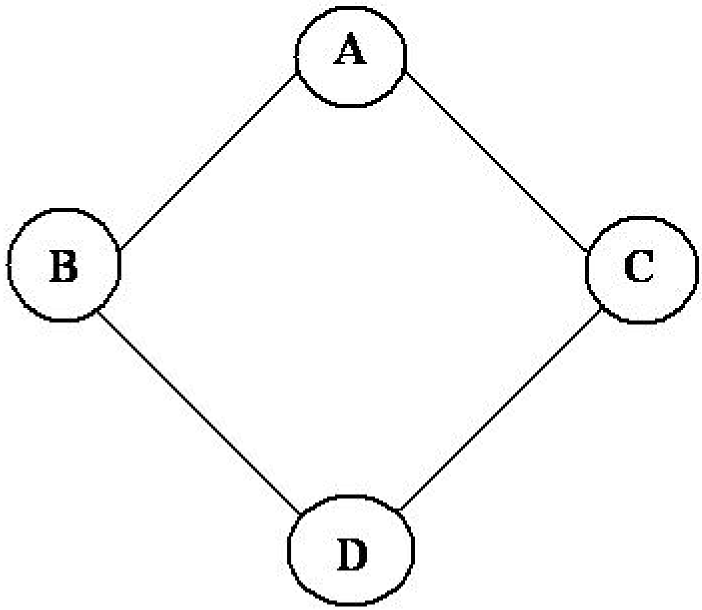
A and B are base classes of C.

C is not an abstract class.

As it is not possible to create an object of class A, this class cannot be analyzed separately from other classes. Therefore, you are not allowed to specify class A to the Polyspace class analyzer. Of course, class C can be analyzed in the same way as in the previous section "Multiple Inheritance."

Virtual Inheritance

Consider the following classes:



B and C classes virtually inherit the A class

B and C are base classes of D.

A, B, C and D can be analyzed in the same way as described in the previous section "Abstract Classes."

Virtual inheritance has no impact on the way of using the class analyzer.

Other Types of Classes

Template Class

A template class can not be analyzed directly. But a class instantiating a template can be analyzed by Polyspace software.

Note: If only the template declaration is provided, missing functions' definitions will automatically be stubbed.

Example

```
template<class T > class A {
public:
 T i;
 T geti() {return i;}
 A() : i(1) {}
};
```

You have to define a `typedef` to create a specialization of the template:

```
template class A<int>;      // Explicit specialization
typedef class A<int> my_template;  // complete instance of the template
```

and use option `-class-analyzer my_template`.

The software will analyze a single instance of the template.

Class Integration

Consider a `C` class that inherits from `A` and `B` classes and has object members of `AA` and `BB` classes.

A class integration verification consists of verifying class `C` and providing the codes for `A`, `B`, `AA` and `BB`. If some definitions are missing, the software will automatically stub them.

Data Range Specifications

Polyspace proves that your code does not contain certain run-time errors for all verification conditions. For example, if you do not have a `main` and a function is not called anywhere in the code, the verification considers that the function inputs are set to full range. Therefore, most operations on these inputs produce an overflow.

However, you can provide more context to your verification. Using Data Range Specifications, you can constrain variable ranges and verify your code for these ranges. This can substantially reduce the number of unproven results.

You can constrain the following kinds of variables:

- Global variables.
- Inputs for functions called by the generated `main`.
- Return values for stubbed functions.

Related Examples

- “Create Data Range Specification Template”
- “Specify Data Ranges Using Existing Template”
- “Specify Data Ranges Using Text Files”
- “Perform Efficient Module Testing with DRS”
- “Reduce Oranges with DRS”

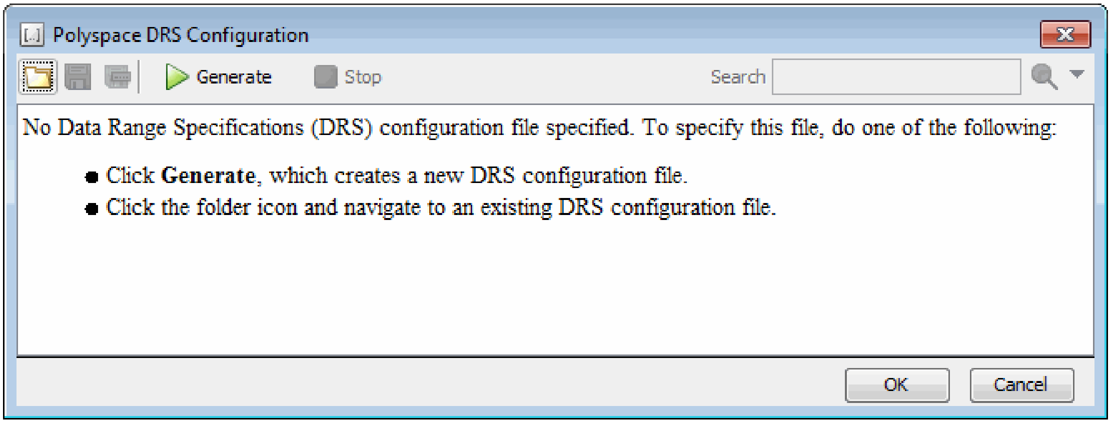
Create Data Range Specification Template

Polyspace can analyze the files in your project and generate a template listing global variables, user-defined functions, and stubbed functions. You can modify this template to constrain variable ranges. For more information, see "Data Range Specifications".

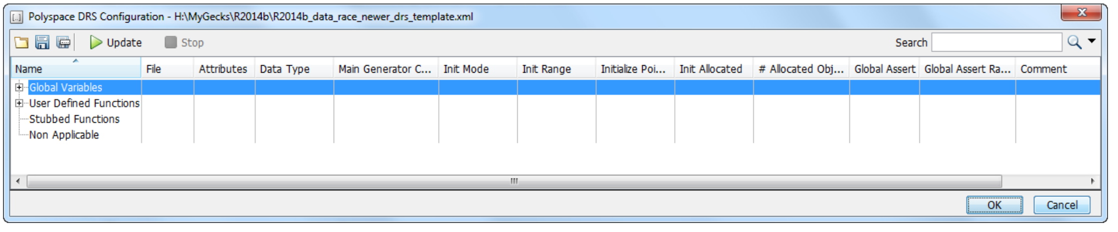
To constrain variable ranges using this template:

1. On the **Configuration** pane, select **Inputs & Stubbing**.
2. To the right of **Variable/function range setup**, click the **Edit** button.

   The Polyspace DRS Configuration dialog box opens.



3. Click **Generate**. The software compiles the project and generates a DRS template.



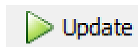
Note: If the option `-unit-by-unit` is enabled:

- The generated file represents the union of DRS values generated for each unit.
- The DRS file generation functionality is not supported for C++.

4 Specify ranges for global variables, user-defined function inputs, and return values of stubbed functions. For more information, see “DRS Configuration Settings” on page 6-66.

5 To save your DRS template, click  (`Save DRS`).

To save your DRS template to a location that you specify, click  (`Save DRS as`).

6 If you change your source code, click  to generate an updated DRS template. As a result of the source code changes, the updated template might contain entries that no longer apply to your code. You can remove these entries from the file. See “Remove Non Applicable Entries from DRS Template” on page 6-57.

7 Click **OK** to close the Polyspace DRS Configuration dialog box. The **Variable/function range setup** field now contains the name of the DRS template. The software uses this DRS template the next time you start a verification.

8 Select **File** > **Save** to save your project settings.

Related Examples

- “Specify Data Ranges Using Existing Template”
- “Edit Existing DRS Template”

Specify Data Ranges Using Existing Template

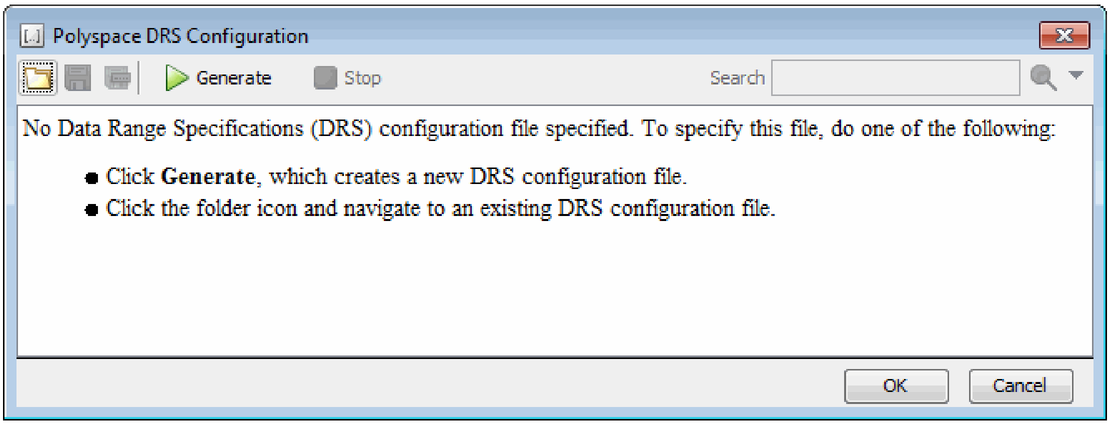
Once you have created a DRS template for a project, you can reuse the ranges for subsequent verifications. For more information, see “Data Range Specifications”.

To specify an existing DRS template for your project:

1 On the **Configuration** pane, select **Inputs & Stubbing**.

2 To the right of **Variable/function range setup**, click the **Edit** button.

The Polyspace DRS Configuration dialog box opens.



3 Click .

4 In the Load a DRS file window, navigate to the folder that contains the required DRS template, and select the file. Then click **Open**. The Load a DRS file dialog box closes.

5 In the Polyspace DRS Configuration dialog box, click **OK**.

6 Select **File** > **Save** to save your project settings, including the DRS template location.

The software uses the specified DRS template the next time you start a verification.

Related Examples

- “Create Data Range Specification Template”
- “Edit Existing DRS Template”

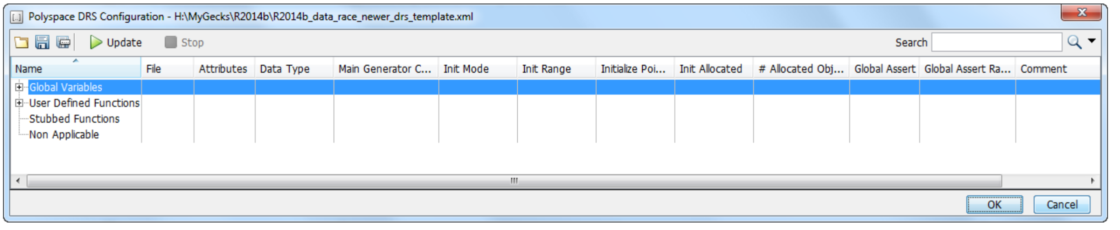
Edit Existing DRS Template

Once you have created a DRS template for your project, you can edit the template using the Polyspace DRS Configuration dialog box. For more information, see “Data Range Specifications”.

To edit an existing DRS template:

1. On the **Configuration** pane, select **Inputs & Stubbing**.
2. To the right of **Variable/function range setup**, click the **Edit** button.

   The Polyspace DRS Configuration dialog box opens.

3. Specify ranges for global variables, user-defined function inputs, and return values of stubbed functions.
4. To save your DRS template, click .
5. Click **OK**, which closes the Polyspace DRS Configuration dialog box.

Related Examples

- “Create Data Range Specification Template”
- “Remove Non Applicable Entries from DRS Template”

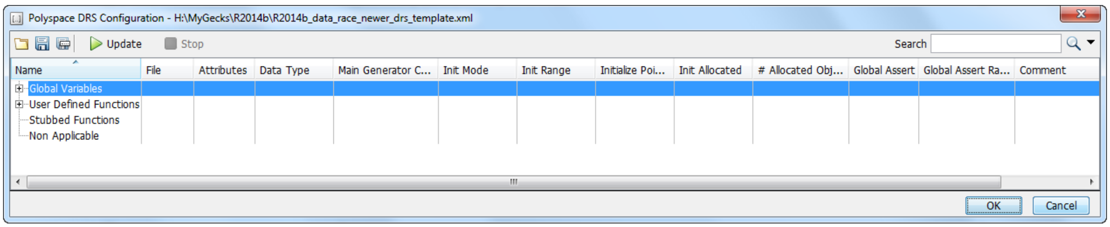
Remove Non Applicable Entries from DRS Template

If you change your source code, you must update your DRS template.

1 On the **Configuration** pane, select **Inputs & Stubbing**.

2 To the right of **Variable/function range setup**, click the **Edit** button.

The Polyspace DRS Configuration dialog box opens.



3 Click 

.

The software updates the template, placing DRS entries that no longer apply to your code under the **Non Applicable** node.

4 Remove entries that do not apply.

  a Right-click **Non Applicable**.

  b From the context menu, select **Remove This Node**.

5 Remove entries corresponding to a subnode.

  - Right-click the subnode, for example, **Non_Infinite_loop()**.
  - From the context menu, select **Remove This Node**.

Related Examples

- "Create Data Range Specification Template"
- "Edit Existing DRS Template"

Specify Data Ranges Using Text Files

For precise verification, you must provide a list of global variables, function inputs and return values of stubbed functions along with their ranges.

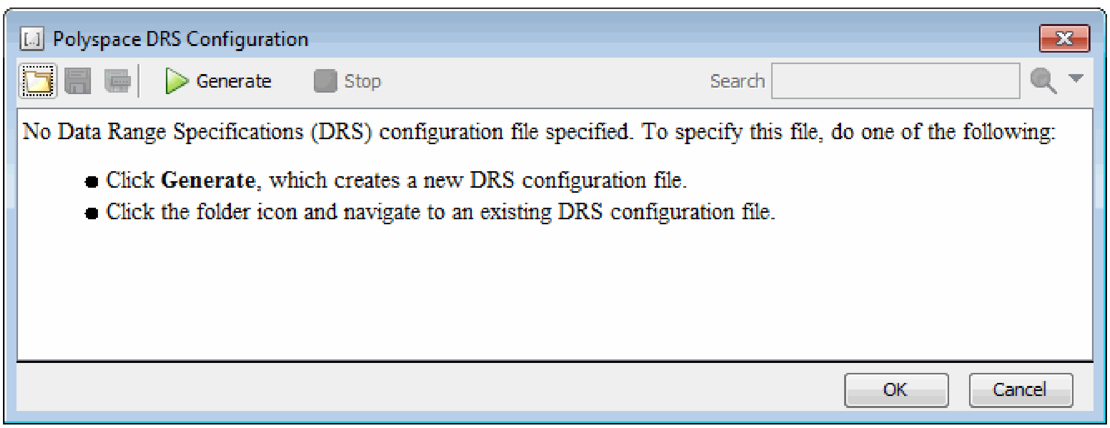
You can specify these ranges using:

- The Polyspace DRS Configuration dialog box. For more information, see “Create Data Range Specification Template” on page 6-53.
- A text file that contains a list of variables and their ranges.

To specify data ranges using a text file:

1. Create a text file containing the list of global variables (or functions) and their associated data ranges, as described in “DRS Text File Format” on page 6-59.
2. Open your project in the **Project Browser**.
3. On the **Configuration** pane, select **Inputs & Stubbing**.
4. To the right of **Variable/function range setup**, click the **Edit** button.

   The Polyspace DRS Configuration dialog box opens.



5. Click .
6. Navigate to the folder that contains the text file, and select the file. Then click **Open**.
7. In the Polyspace DRS Configuration dialog box, click **OK**.

8 Select **File** > **Save** to save your project settings, including the DRS file location.

When you run a verification, the software automatically merges the data ranges in the text file with a DRS template for the project and saves the information in the file `drs-template.xml`, located in your results folder.

DRS Text File Format

The DRS file contains a list of global variables and associated data ranges. The point during verification at which the range is applied to a variable is controlled by the mode keyword: `init`, `permanent`, or `globalassert`.

The DRS file must have the following format:

```
variable_name min_value max_value <init|permanent|globalassert>
```

```
function_name.return min_value max_value permanent
```

- *`variable_name`* — The name of the global variable.
- *`min_value`* — The minimum value for the variable.
- *`max_value`* — The maximum value for the variable.
- `init` — The variable is assigned to the specified range only at initialization, and keeps it until first write.
- `permanent` — The variable is permanently assigned to the specified range. If the variable is assigned outside this range during the program, no warning is provided. Use the `globalassert` mode if you need a warning.
- `globalassert` — After each assignment, an assert check is performed, controlling the specified range. The assert check is also performed at global initialization.
- *`function_name`* — The name of the stub function.

Tips for Creating DRS Text Files

- You can use the keywords "`min`" and "`max`" to denote the minimum and maximum values of the variable type. For example, for the type long, min and max correspond to -2^31 and 2^31-1 respectively.
- You can use hexadecimal values. For example, `x 0x12 0x100 init`.
- Supported column separators are tab, comma, space, or semicolon.

- To insert comments, use shell style "#".
- `init` is the only mode supported for user-defined function arguments.
- `permanent` is the only mode supported for stub function output.
- Function names may be C or C++ functions with blanks or commas. For example, `f(int, int)`.
- Function names can be specified in the short form ("`f`") as long as no ambiguity exists.
- The function returns either an integral (including enum and bool) or floating point type. If the function returns an integral type and you specify the range as a floating point `[v0.x, v1.y]`, the software applies the integral interval `[(int)v0-1, (int)v1+1]`.

Example DRS Text File

In the following example, the global variables are named `x`, `y`, `z`, `w`, and `v`.

```
x  12  100    init
y  0   10000  permanent
z  0   1      globalassert
w  min max    permanent
v  0   max    globalassert
arrayOfInt  -10  20  init
s1.id       0    max init
array.c2    min  1   init
car.speed   0    350 permanent
bar.return  -100 100 permanent

# x is defined between [12;100] at initialization
# y is permanently defined between [0,10000] even any assignment
# z is checked in the range [0;1] after each assignment
# w is volatile and full range on its declaration type
# v is positive and checked after each assignment.
# All cells arrayOfInt are defined between [-10;20] at initialization
# s1.id is defined between [0;2^31-1] at initialisation.
# All cells array[i].c2 are defined between [-2^31;1] at initialization
# Speed of Struct car is permanently defined between 0 and 350 Km/h
# function bar returns -100..100
```

Perform Efficient Module Testing with DRS

DRS allows you to perform efficient static testing of modules. This is accomplished by adding design level information missing in the source-code.

A module can be seen as a black box having the following characteristics:

- Input data are consumed
- Output data are produced
- Constant calibrations are used during black box execution influencing intermediate results and output data.

Using the DRS feature, you can define:

- The nominal range for input data
- The expected range for output data
- The generic specified range for calibrations

These definitions then allow Polyspace software to perform a single static verification that performs two simultaneous tasks:

- answering questions about robustness and reliability
- checking that the outputs are within the expected range, which is a result of applying black-box tests to a module

In this context, you assign DRS keywords according to the type of data (inputs, outputs, or calibrations).

Type of Data	DRS Mode	Effect on Results	Why?	Oranges	Selectivity
Inputs (entries)	`permanent`	**Reduces** the number of oranges, (compared with a standard Polyspace verification)	Input data that were full range are set to a smaller range.	↓	↑
Outputs	`globalassert`	**Increases** the number of oranges, (compared with a standard Polyspace verification)	More verification is introduced into the code, resulting in both more orange checks and more green checks.	↑	→

Type of Data	DRS Mode	Effect on Results	Why?	Oranges	Selectivity
Calibration	`init`	**Increases** the number of oranges, (compared with a standard Polyspace verification)	Data that were constant are set to a wider range.	↑	↓

Reduce Oranges with DRS

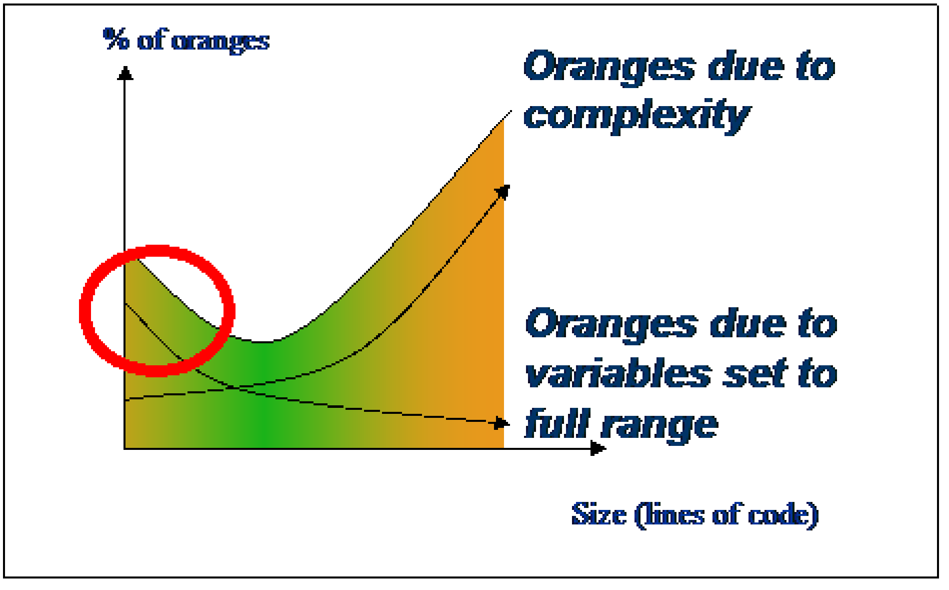
When performing robustness (worst case) verification, data inputs are set to their full range. Therefore, every operation on these inputs, even a simple `one_input + 10` can produce an overflow, as the range of `one_input` varies between the minimum and the maximum of the type.

If you use DRS to restrict the range of `one_input` to the real functional constraints found in its specification, design document, or models, you can reduce the number of orange checks reported for the variable. For example, if you specify that `one_input` can vary between `0` and `10`, Polyspace software knows that:

- `one_input + 100` never overflows
- The results of this operation is always between `100` and `110`

This not only eliminates the local overflow orange check, but also results in more accuracy in the data. This accuracy is then propagated through the rest of the code.

Using DRS removes the oranges located in the red circle below.



Why Is DRS Most Effective on Module Testing?

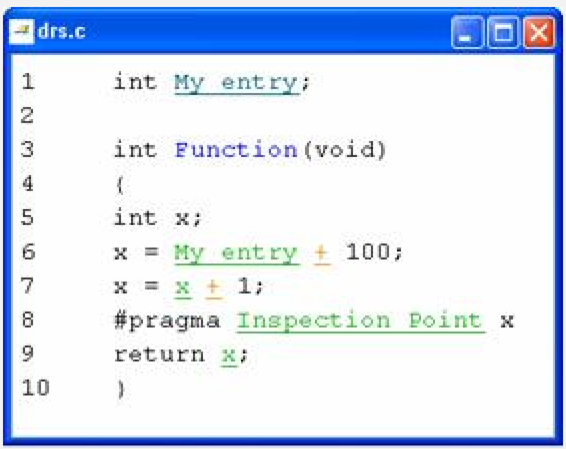
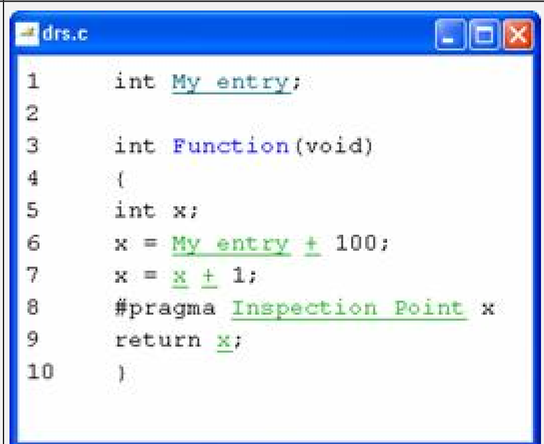
Removing oranges caused by full-range (worst-case) data can drastically reduce the total number of orange checks, especially when used on verifications of small files or modules. However, the number of orange checks caused by code complexity is not effected by DRS. For more information on oranges caused by code complexity, see "Subdivide Code".

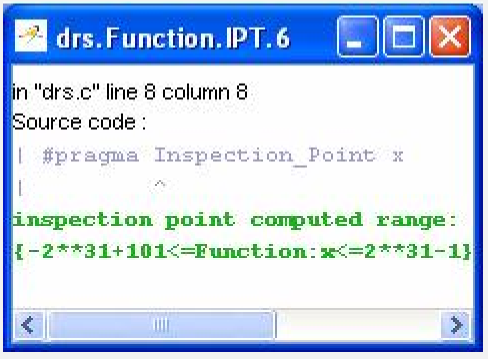
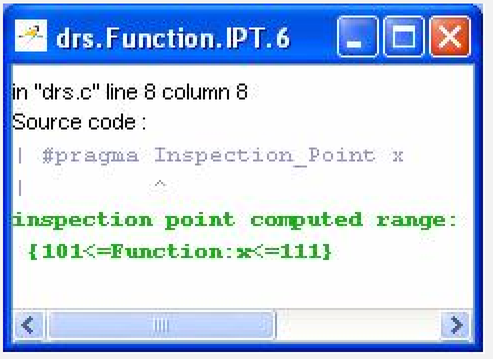
This section describes how DRS reduces oranges on files or modules only.

Example

The following example illustrates how DRS can reduce oranges. Suppose that in the real world, the input "`My_entry`" can vary between `0` and `10`.

Polyspace verification produces the following results: one with DRS and one without.

<table>
<tr><th>Without DRS</th><th>With DRS — 2 Oranges Removed + Return Statement More Accurate</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>• With "My_entry" being full range, the addition "+" is orange,
• the result "x" is equal to all values between [min+100 max]
• Due to previous computations, x+1 can here overflow too, making the addition "+"orange.</td><td>• With "My_entry" being bounded to [0,10], the addition "+" is green
• the result "x" is equal to [100,110]
• Due to previous computations, x+1 can NOT overflow here, making the addition "+" green again.</td></tr>
</table>

Without DRS	With DRS — 2 Oranges Removed + Return Statement More Accurate
And the returned result is between [min+101 max]	And the returned result is between [101,111]
	

DRS Configuration Settings

The Polyspace DRS Configuration dialog box allows you to specify data ranges for global variables, user-defined functions, and stub functions in your project.

Column	Settings
Name	Displays the list of variables and functions in your Project for which you can specify data ranges. This Column displays three expandable menu items: • **Globals** – Displays a list of global variables in the Project. • **User defined functions** – Displays a list of user-defined functions in the Project. Expand a function name to see a list of the input arguments for which you can specify a data range. • **Stubbed functions** – Displays a list of stub functions in the Project. Expand a function name to see a list of the return values for which you can specify a data range.
File	Displays the name of the source file containing the variable or function.
Attributes	Displays information about the variable or function. For example, static variables display `static`.
Data Type	Displays the variable type.
Main Generator Called	Applicable only for user-defined functions. Specifies whether the main generator calls the function: • **`MAIN GENERATOR`** – Main generator may call this function, depending on the value of the `-functions-called-in-loop` (C) or `-main-generator-calls` (C++) parameter. • **`NO`** – Main generator will not call this function. • **`YES`** – Main generator will call this function.
Init Mode	Specifies how the software assigns a range to the variable:

Column	Settings
	• **`MAIN GENERATOR`** – Variable range is assigned depending on the settings of the main generator options `-variables-written-before-loop` and `-no-def-init-glob`. (For C++, the options are `-main-generator-writes-variables`, and `-no-def-init-glob`.) • **`IGNORE`** – Variable is not assigned to any range, even if a range is specified. • **`INIT`** – Variable is assigned to the specified range only at initialization, and keeps the range until first write. • **`PERMANENT`** – Variable is permanently assigned to the specified range. If the variable is assigned outside this range during the program, no warning is provided. Use the `globalassert` mode if you need a warning. User-defined functions support only `INIT` mode. Stub functions support only `PERMANENT` mode. For C verifications, global pointers support `MAIN GENERATOR`, `IGNORE`, or `INIT` mode. • **`MAIN GENERATOR`** – Pointer follows the options of the main generator. • **`IGNORE`** – Pointer is not initialized • **`INIT`** – Specify if the pointer is NULL, and how the pointed object is allocated (**Initialize Pointer** and **Init Allocated** options).

Column	Settings
Init Range	Specifies the minimum and maximum values for the variable. You can use the keywords `min` and `max` to denote the minimum and maximum values of the variable type. For example, for the type long, `min` and `max` correspond to -2^31 and 2^31-1 respectively. You can also use hexadecimal values. For example: `0x12..0x100` For `enum` variables, you cannot specify ranges directly using the enumerator constants. Instead use the values represented by the constants. For `enum` variables, you can also use the keywords `enum_min` and `enum_max` to denote the minimum and maximum values that the variable can take. For example, for an `enum` variable of the type defined below, `enum_min` is 0 and `enum_max` is 5: `enum week{ sunday, monday=0, tuesday, wednesday, thursday, friday, s`
Initialize Pointer	Applicable only to pointers. Enabled only when you specify **Init Mode**:`INIT`. Specifies whether the pointer should be NULL: • **`May-be NULL`** – The pointer could potentially be a NULL pointer (or not). • **`Not Null`** – The pointer is never initialized as a null pointer. • **`Null`** – The pointer is initialized as NULL. **Note:** Not applicable for C++ projects.

Column	Settings
Init Allocated	Applicable only to pointers. Enabled only when you specify **Init Mode**:`INIT`. Specifies how the pointed object is allocated: • **`MAIN GENERATOR`** – The pointed object is allocated by the main generator. • **`None`** – Pointed object is not written. • **`SINGLE`** – Write the pointed object or the first element of an array. (This setting is useful for stubbed function parameters.) • **`MULTI`** – All objects (or array elements) are initialized. See Pointer Examples. **Note:** Not applicable for C++ projects.
# Allocated Objects	Applicable only to pointers. Specifies how many objects are pointed to by the pointer (the pointed object is considered as an array). **Note:** The Init Allocated parameter specifies how many allocated objects are actually initialized. See Pointer Examples. **Note:** Not applicable for C++ projects.
Global Assert	Specifies whether to perform an assert check on the variable at global initialization, and after each assignment.
Global Assert Range	Specifies the minimum and maximum values for the range you want to check.
Comment	Remarks that you enter, for example, justification for your DRS values.

Pointer Examples

For pointer p, **# Allocated objects** = `1`, and **Init Allocated** = `Single`:

```
void f(int *p) {
```

```
  int x;
  x = p[0]; // green IDP, green NIV
  x = p[1]; // red IDP: out of bounds
}
```

Note: Pointer `p` may point to any element inside the array.

For pointer p (a pointer to int), **# Allocated objects** = `3`, and **Init Allocated** = `MULTI`:

```
void f(int *p) {
  int x;
  x = p[0]; // green IDP, green NIV
  x = p[1]; // orange IDP, green NIV
  x = p[2]; // orange IDP, green NIV
  x = p[3]; // red IDP: out of bounds
}
```

Variable Scope

DRS supports variables with external linkages, const variables, extern variables, and defined variables.

Note: If you set a data range on a `const` global variable that is used in another variable declaration (for example as an array size) the variable using the global variable ranged, is not ranged itself.

The following table summarizes possible uses:

	init	**permanent**	**globalassert**	**comments**
Integer	Ok	Ok	Ok	`char`, `short`, `int`, `enum`, `long` and `long long` If you define a range in floating point form, rounding is applied.
Real	Ok	Ok	Ok	`float`, `double` and `long double` If you define a range in floating point form, rounding is applied.
Volatile	No effect	Ok	Full range	Only for `int` and `real`
Structure field	Ok	Ok	Ok	Only for `int` and `real` fields, including arrays or structures of `int` or `real` fields (see below)

	init	permanent	globalassert	comments
Structure field in array	Ok	No effect	No effect	Only when leaves are `int` or `real`. Moreover the syntax is the following: <array_name>.<field_name>
Array	Ok	Ok	Ok	Only for `int` and `real` fields, including structures or arrays of integer or real fields (see below)
Pointer	Ok (for C) No effect for C++	No effect	No effect	For C, you can specify how the main generator initializes the pointed variable, and how the pointed object is written.
Union field	Ok	No effect	Ok	See "DRS Support for Union Members" on page 6-73.
Complete structure	No effect	No effect	No effect	
Array cell	No effect	No effect	No effect	Example: array[0], array[10] …
User-defined function arguments	Ok	No effect	No effect	Main generator calls the function with arguments in the specified range

	init	permanent	globalassert	comments
Stubbed function return	No effect	Ok	No effect	Stubbed function returning integer or floating point

Every variable (or function) and associated data range will be written in the log file during the compile phase of verification. If Polyspace software does not support the variable, a warning message is displayed.

Note: If you use DRS to set a data range on a const global variable that is used in another variable declaration (for example as an array size), the variable that uses the global variable you ranged is not ranged itself.

DRS Support for Structures

DRS can initialize arrays of structures, structures of arrays, etc., as the long as the last field is explicit (structures of arrays of integers, for example).

However, DRS cannot initialize a structure itself — you can only initialize the fields. For example, "`s.x 20 40 init`" is valid, but "`s 20 40 init`" is not (because Polyspace software cannot determine what fields to initialize).

DRS Support for Union Members

In init mode, the software applies the last range in DRS to the union members at the given offset.

In globalassert mode, the software checks every globalassert in DRS for a given offset within the union at every assignment to the union variable at that offset.

For example:

```
union position {
 int sunroof;
  int window;
  int locks;
} positionData;
```

DRS:

```
positionData.sunroof 0 100 globalassert
positionData.window -100 0 globalassert
positionData.locks  -1  1 globalassert
```

An assignment to `positionData.locks` (or other members) will perform assertion checking on the ranges 0 to 100, -100 to 0, and -1 to 1.

XML Format of DRS File

Syntax Description — XML Elements

The DRS file contains the following XML elements:

- `<global>` element — Declares the global scope, and is the root element of the XML file.
- `<file>` element — Declares a file scope. Must be enclosed in the `<global>` element. May enclose any variable or function declaration. Static variables must be enclosed in a file element to avoid conflicts.
- `<scalar>` element— Declares an integer or a floating point variable. May be enclosed in any recognized element, but cannot enclose any element. Sets init/permanent/ global asserts on variables.
- `<pointer>` element — Declares a pointer variable. May enclose any other variable declarations (including itself), to define the pointed objects. Specifies what value is written into pointer (NULL or not), how many objects are allocated and how the pointed objects are initialized.
- `<array>` element — Declares an array variable. May enclose any other variable definition (including itself), to define the members of the array.
- `<struct>` element — Declares a structure variable or object (instance of class). May enclose any other variable definition (including itself), to define the fields of the structure.
- `<function>` element — Declares a function or class method scope. May enclose any variable definition, to define the arguments and the return value of the function. Arguments should be named *`arg1, arg2, …argn`* and the return value should be called *`return`*.

The following notes apply to specific fields in each XML element:

- **(*)** — Fields used only by the GUI. These fields are not mandatory for verification to accept the ranges. The field line contains the line number where the variable is declared in the source code, `complete_type` contains a string with the complete variable type, and `base_type` is used by the GUI to compute the min and max values. The field comment is used to add information about any node.
- **(**)** — The field name is mandatory for scope elements `<file>` and `<function>` (except for function pointers). For other elements, the name must be specified when declaring a root symbol or a `struct` field.

- **(***)** — If more than one attribute applies to the variable, the attributes must be separated by a space. Only the static attribute is mandatory, to avoid conflicts between static variables having the same name. An attribute can be defined multiple times without impact.
- **(****)** — This element is used only by the GUI, to determine which `init` modes are allowed for the current element (according to its type). The value works as a mask, where the following values are added to specify which modes are allowed:
  - **1**: The mode "`NO`" is allowed.
  - **2** : The mode "`INIT`" is allowed.
  - **4**: The mode "`PERMANENT`" is allowed.
  - **8**: The mode "`MAIN_GENERATOR`" is allowed.

  For example, the value "**10**" means that modes "`INIT`" and "`MAIN_GENERATOR`" are allowed. To see how this value is computed, refer to "Valid Modes and Default Values" on page 6-79.
- **(*****)** — A sub-element of a pointer (i.e. a pointed object) will be taken into account only if `init_pointed` is equal to SINGLE or MULTI.

<file> Element

Field	Syntax
`name`	*`filepath_or_filename`*
`comment`	*`string`*

<scalar> Element

Field	Syntax
`name` (**)	*`name`*
`line` (*)	*`line`*

`base_type` (*)	`intx`
	`uintx`
	`floatx`

`Attributes` (***)	`volatile`
	`extern`
	`static`
	`const`

Field	Syntax
complete_type (*)	*type*
init_mode	MAIN_GENERATOR IGNORE INIT PERMANENT disabled unsupported
init_modes_allowed (*)	*single value* (****)
init_range	*range* disabled unsupported
global_ assert	YES NO disabled unsupported
assert_range	*range* disabled unsupported
comment(*)	*string*

<pointer> Element

Field	Syntax
Name (**)	*name*
line (*)	*line*
Attributes (***)	volatile extern static const
complete_type (*)	*type*
init_mode	MAIN_GENERATOR IGNORE INIT PERMANENT

Field	Syntax
	disabled unsupported
init_modes_allowed (*)	*single value* (****)
initialize_ pointer	May be: NULL Not NULL NULL
number_ allocated	*single value* disabled unsupported
init_pointed	MAIN_GENERATOR NONE SINGLE MULTI disabled
comment	*string*

<array> and <struct> Elements

Field	Syntax
Name (**)	*name*
line (*)	*line*
complete_type (*)	*type*
attributes (***)	volatile extern static const
comment	*string*

<function> Element

Field	Syntax
Name (**)	*name*
line (*)	*line*

Field	Syntax

`main_generator_called`	`MAIN_GENERATOR`
	`YES`
	`NO`
	`disabled`

`attributes` (***)	`static`
	`extern`
	`unused`

`comment`	*`string`*

Valid Modes and Default Values

Scope	Type		Init modes	Gassert mode	Initialize pointer	Init allocated	Default
Global variables	Base type	Unqualified/ static/ const scalar	MAIN_ GENERATOR IGNORE INIT PERMANENT	YES NO			Main generator dependant
		Volatile scalar	PERMANENT	disabled			PERMANENT min..max
		Extern scalar	INIT PERMANENT	YES NO			INIT min..max
	Struct	Struct field	Refer to field type				
	Array	Array element	Refer to element type				
Global variables	Pointer	Unqualified/ static/ const scalar	MAIN_ GENERATOR IGNORE INIT		May be NULL Not NULL NULL	NONE SINGLE MULTI	Main generator dependant
		Volatile pointer	un-supported		un-supported	un-supported	
		Extern pointer	IGNORE INIT		May be NULL Not NULL	NONE SINGLE MULTI	INIT May be NULL max MULTI

Scope	Type		Init modes	Gassert mode	Initialize pointer	Init allocated	Default
					NULL		
		Pointed volatile scalar	un-supported	un-supported			
		Pointed extern scalar	INIT	un-supported			INIT min..max
		Pointed other scalars	MAIN_ GENERATOR INIT	un-supported			MAIN_ GENERATOR dependant
		Pointed pointer	MAIN_ GENERATOR INIT/	un-supported	May be NULL Not NULL NULL	NONE SINGLE MULTI	MAIN_ GENERATOR dependant
		Pointed function	un-supported	un-supported			
Function parameters	Userdef function	Scalar parameters	MAIN_ GENERATOR INIT	un-supported			INIT min..max
		Pointer parameters	MAIN_ GENERATOR INIT	un-supported	May be NULL Not NULL NULL	NONE SINGLE MULTI	INIT May be NULL max MULTI
		Other parameters	Refer to parameter type				
	Stubbed function	Scalar parameter	disabled	un-supported			
		Pointer parameters	disabled		disabled	NONE SINGLE MULTI	MULTI
		Pointed parameters	PERMANENT	un-supported			PERMANENT min..max

Scope	Type		Init modes	Gassert mode	Initialize pointer	Init allocated	Default
		Pointed const parameters	disabled	un-supported			
Function return	Userdef function	Return	disabled	un-supported	disabled	disabled	
	Stubbed function	Scalar return	PERMANENT	un-supported			PERMANENT min..max
		Pointer return	PERMANENT	un-supported	May be NULL Not NULL NULL	NONE SINGLE MULTI	PERMANENT May be NULL max MULTI

7

Preparing Source Code for Verification

Stubbing Overview

A function stub is a piece of code that models a function whose body is not provided during verification.

Stubs need not model the details of functions. Depending on your requirements, you can:

- Provide the function argument types and return types.
- Provide a bound on the function arguments and return values.
- Provide other details about how the function relates to the rest of the code.

Stubbing allows you to verify code before functions are developed. The more closely your stub models the actual function, the more precise the verification results will be.

Unless you specify the option **Inputs & Stubbing** > **No automatic stubbing**, Polyspace automatically stubs undefined functions.

When to Provide Function Stubs

By default, Polyspace software automatically stubs undefined functions. Stub functions manually when:

- You note that the automatic stubs do not represent your function arguments and return values. For instance, the automatic stubs can return a broader range of values than you want.
- You want your source code to be complete. If you specify the option **No automatic stubbing**, verification stops if a function is not defined. This behavior allows you to detect undefined functions.
- You want to reduce unproven code. Sometimes, automatic stubs do not provide sufficient information to allow Polyspace to prove presence or absence of run-time errors.
- Your function modifies global variables. Automatic stubs cannot model this behavior.

Manual stubs

If a function `func` represents:

- A timing constraint such as a timer set/reset, a task activation, a delay, or a counter of ticks between two precise locations in the code, stub `func` with an empty action

  ```
  void func(void) {
  }
  ```
  Polyspace takes into account scheduling and interleaving of concurrent execution. Therefore, do not stub functions that set or reset a timer. Declare the variable representing time as volatile.

- An I/O access, such as to a hardware port, a sensor, a read/write of a file, a read of an EEPROM, or a write to a volatile variable, then,

  - You do not need to stub a *write* access. If you want to do so, stub a write access to an empty action (`void func(void)`).
  - Stub *read* accesses to "read all possible values (volatile)".

- A write to a global variable, you may need to consider which procedures or functions write to `func` and why. Do not stub the concerned `func` if:

  - The variable is volatile.
  - The variable is a task list. Such lists are accounted for by default because tasks declared with the `-task` option are automatically modelled as though they have been started. Write `func` manually if:

    - The variable is a regular variable read by other procedures or functions.
    - The variable is a read from a global variable. If you want Polyspace software to detect that the variable is a shared variable, stub a read access. Copy the value into a local variable.

Provide Stubs for Functions

The following example shows a header for a missing function (which might occur, for example, if the code is a subset of a project). The missing function copies the value of the `src` parameter to `dest` so there would be a division by zero, a run-time error..

```
void main(void)
{
 a = 1;
 b = 0;
 a_missing_function(&a, b);
 b = 1 / a;
}
```

Due to the reliance on the software's default stub, the division is shown with an orange warning because a is assumed to be anywhere in the full permissible integer range (including 0). If the function is commented out, then the division would be a green "/ ". You could only achieve a red "/ " with a manual stub.

<table>
<tr><th>Default Stubbing</th><th>Manual Stubbing</th><th>Function Ignored</th></tr>
<tr><td><pre>void main(void)
{
 a = 1;
 b = 0;
 a_missing_function(&a,
b);
 b = 1 / a;
// orange division
}</pre></td><td><pre>void a_missing_function
(int *x, int y;)
{ *x = y; }

void main(void)
{
 a = 1;
 b = 0;
 a_missing_function(&a,
b);
 b = 1 / a;
// red division</pre></td><td><pre>void a_missing_function
(int *x, int y;)
{ }

void main(void)
{
 a = 1;
 b = 0;
 a_missing_function(&a,
b);
 b = 1 / a;
// green division</pre></td></tr>
</table>

Due to the reliance on the software's default stub, the software ignores the assembly code and the division " /" is green. You could only achieve the red division "/" with a manual stub.

Stubbing Examples

The following examples consider the pros and cons of manual and automatic stubbing.

Example: Specification

```
typedef struct _c {
int cnx_id;
int port;
int data;
} T_connection ;

int Lib_connection_create(T_connection *in_cnx) ;
int Lib_connection_open (T_connection *in_cnx) ;
```

File: connection_lib		**Function: Lib_connection_create**
param in	None	
param in/out	in_cnx	all fields might be changed in case of a success
returns	int	0 : failure of connection establishment 1 : success

Note: Default stubbing is suitable here.

Here are the reasons why:

- The content of the *in_cnx* structure might be changed by this function.
- The possible return values of 0 or 1 compared to the full range of an integer wont have much impact on the Run-Time Error aspect. It is unlikely that the results of this operation will be used to compute some mathematical algorithm. It is probably a Boolean status flag and if so is likely to be stored and compared to 0 or 1. Therefore, the default stub does not have a detrimental effect.

File: connection_lib		**Function: Lib_connection_open**
param in	T_connection *in_cnx	in_cnx->cnx_id is the only parameter used to open the connection, and is a read-only parameter.

File: connection_lib		**Function: Lib_connection_open**
		cnx_id, port and data remain unchanged
param in/out	None	
returns	int	0 : failure of connection establishment 1 : success

Note: Default stubbing works here but manual stubbing would give more benefit.

Here are the reasons why:

- For the return value, default stubbing would be applicable as explained in the previous example.
- Since the structure is a read-only parameter, it will be worth creating manually a stub that reflects the behavior of the missing code. Benefits: Polyspace verification will find more red and gray code

Note: Even in the examples above, it concerns some C code like; stubs of functions members in classes follow same behavior.

Example: Colored Source Code

```
typedef struct _c {
int a;
int b;
} T;

void send_message(T *);
void main(void)
{
int i;
T x = {10, 20};
send_message(&x);
i = x.b /x.a;  // orange with the default stubbing
}
```

Suppose that it is known that send_message does not write into its argument. The division by x.a will be orange if default stubbing is used, warning of a potential division by zero. A manual stub that accurately reflects the behavior of the missing code will result in a green division instead, thus increasing the selectivity.

Manual stubbing examples for send_message:

```
void send_message(T *) {}
```

In this case, an empty function would be a sound manual stub.

Automatic Stubbing Behavior for C++ Pointer/Reference

For parameters of a pointer/reference type, the behavior of automatically stubbed C++ functions differs from the behavior of automatically stubbed C functions. As a result, automatic stubs for C++ do not always write to their arguments.

For C++, the software stubs functions by randomizing the contents of the object passed as actual of the stubbed function, but does not modify the object pointed to by the actual (or by one component of the actual if the latter is a `struct`/`class` object or an array).

Consider the following example:

```
extern void stub_def_pointer(struct S *p);
extern void stub_def_array(struct S *p);

int fx = 0, fw = 0;
struct S def = {"-dummy", &fx};
struct S def_array[] = {{ "-foo", &fw } };

assert(*(def.pvar) == 0); // GREEN
stub_def_pointer(&def);
assert(fx == 0);          // GREEN because stubbed stub_def_pointer
          // does not write *(def.pvar)

assert(*(def_array[0].pvar) == 0);  // GREEN
stub_def_array(def_array);
assert(fw == 0);       // GREEN because stubbed stub_def_array
                        // does not write *(def_array[0].pvar)
```

In this situation, you should manually stub the missing routine. For example, you could stub `stub_def_pointer` and `stub_def_array` as follows:

```
volatile int rd;

void stub_def_pointer(struct S *p)
 {
  *(p->pvar) = rd;   // write the object pointed to by p->pvar
 }

void stub_def_array(struct S *p)
 {
  int i = rd;
  for (i; i < rd; i++)
```

```
  {
   *(p[i].pvar) = rd; // write the object pointed to
          // by p[i]->pvar
   i++;
  }
 }
```

Using these manual stubs, the verification result become:

```
assert(*(def.pvar) == 0);           // GREEN
stub_def_pointer(&def);
assert(fx == 0);                    // ORANGE

assert(*(def_array[0].pvar) == 0); // GREEN
stub_def_array(def_array);
assert(fw == 0);                    // ORANGE
```

Specify Functions to Stub Automatically

You can specify a list of functions that you want the software to stub automatically.

To specify functions to stub:

1. On the **Configuration** pane, select **Inputs & Stubbing**.
2. To the right of the **Functions to stub** view, click +. The software creates a new row.
3. In the new row, enter the name of a function that you want to stub. Enter one function name per row.

Special Characters in Function Names

The following special characters are allowed for C functions:
( ) < > ; _

The following special characters are allowed for C++:
( ) < > ; _ * & [ ]

Space characters are allowed for C++, but are not allowed for C functions.

Function Syntax for C++

When entering function names, two syntaxes are supported for C++:

- Basic syntax, with extensions for classes and templates:

Function Type	Syntax
Simple function	test
Class method	A::test
Template method	A<T>::test

- Syntax with function arguments, to differentiate overloaded functions. Function arguments are separated with semicolons:

Function Type	Syntax
Simple function	test()

Function Type	Syntax
Class method	`A::test(int;int)`
Template method	`A<T>::test(T;T)`

Note: Overloaded versions of the function will be discarded.

Constrain Data with Stubbing

In this section...

Add Precision Constraints Using Stubs

You can improve the selectivity of your verification by using stubs to indicate that some variables vary within functional ranges instead of the full range of the considered type.

You can apply this approach to:

- Parameters passed to functions.
- Variables that change from one execution to another (mostly globals), for example, calibration data or mission specific data. These variables might be read directly within the code, or read through an API of functions.

If a function returns an integer, default automatic stubbing assumes the function can take any value from the full range of the integer type. This can lead to unproven code (orange checks) in your results. You can achieve more precise results by providing a manual stub that provides external data that is representative of the data expected when the code is implemented.

There are a number of ways to model such data ranges within the code. The following table shows some approaches.

with volatile and assert	with assert and without volatile	without assert, without volatile, without "if"

`#include <assert.h>`
 	
`int stub(void)`
`{`
` volatile int random;`
	`#include <assert.h>`
	
	`extern int other_func(void);`
	`int stub(void)`
	`{`
		
		`extern int other_func(void);`
		`int stub(void)`
		`{`

```
int tmp;
tmp = random;
assert(tmp>=1 && tmp<=10 );
return
```

```
int tmp;
tmp= other_func();
assert(tmp>=1 && tmp<=10);
return
}
```

```
int tmp;
do {tmp= other_func();}
while (tmp<1 || tmp>10);
return tmp;
}
```

There is no particular advantage to any one of these approaches, except that the assertions in the first two approaches can produce orange checks in your results.

Default Behavior of Global Data

Initially, consider how Polyspace verification handles the verification of global variables.

There is a maximum range of values which may be assigned to each variable as defined by its type. By default, Polyspace verification assigns that full range for each global variable, ensuring that a meaningful verification of such a variable can take place even when the functions that write to it are not included. If a range of values was not considered in these circumstances, such a variable would be assumed to have a value of zero throughout.

Sometimes, to reflect practical use, it is helpful to limit the range of values assigned to some variables . These ranges will be propagated to the whole call tree, and hence will limit the number of “impossible values” that are considered throughout the verification.

This thinking does not just apply to global variables; it is equally appropriate where such a variable is passed as a parameter to a function, or where return values from stubbed functions are under consideration.

To some extent, the effectiveness of this technique is limited by compromises made by Polyspace verification to deal with issues of code complexity. For instance, you cannot assume that all of these ranges will be propagated throughout all function calls. Sometimes, perhaps as a result of complex function interactions or constructions where Polyspace verification is known to be imprecise, the potential value of a variable will assume its full “type” range despite this technique having been applied.

Constraining the Data

Restricting data, such as global variables, to a functional range can be a useful technique if the process can be automated. The technique may not be advantageous if the process requires significant manual effort.

The technique requires:

- A knowledge of the variables and the maximum ranges they may take in practice.
- A data dictionary in electronic format from which the variable names and their minimum and maximum values can be extracted.

Apply the Technique

1. Create the range setting stubs:
   a. create 6 functions for each type (8,16 or 32 bits, signed and unsigned)
   b. declare 6 global volatile variables for each type
   c. write the functions which returns sub-ranges (an example follows)
2. Gather the initialization of relevant variables into a single procedure
3. Call this procedure at the beginning of the main. This should replace existing initialization code.

Integer Example

```
volatile int tmp;

int polyspace_return_range(int min_value, int max_value)
{
int ret_value;

ret_value = tmp;
assert (ret_value>=min_value && ret_value<=max_value);

return ret_value;
}
void init_all(void)
{
x1 = polyspace_return_range(1,10);
x2 = polyspace_return_range(0,100);
x3 = polyspace_return_range(-10,10);
}

void main(void)
{
init_all();

while(1)
```

```
 {
 if (tmp) function1();
 if (tmp) function2();
 // ...
 }
}
```

Recode Specific Functions

Once data ranges have been specified (above), it may be beneficial to recode some functions in support of them.

Sometimes, perhaps as a result of complex function interactions or constructions where Polyspace verification is known to be imprecise, the potential value of a variable will assume its full "type" range data ranges having been restricted. Recoding those complex functions will address this issue.

Identify in the modules:

- API which read global variables through pointers

  Replace this API:

```
 typedef struct _points {
 int x,y,nb;
 char *p;
 }T;

 #define MAX_Calibration_Constant_1 7
char Calibration_Constant_1[MAX_Calibration_Constant_1] =     \
 { 1, 50, 75, 87, 95, 97, 100} ;
 T Constant_1 = { 0, 0,
   MAX_Calibration_Constant_1,
   &Calibration_Constant_1[0] } ;

 int read_calibration(T * in, int index)
 {
 if ((index <= in->nb) && (index >=0)) return in->p[index];
 }

 void interpolation(int i)
 {
 int a,b;

 a= read_calibration(&Constant_1,i);
 }
```

  With this one:

```
char Constant_1 ;

#define read_calibration(in,index) *in

void main(void)
{
Constant_1 = polyspace_return_range(1, 100);
}

void interpolation(int i)
{
int a,b;

a= read_calibration(&Constant_1,i);
}
```

- Points in the source code which expand the data range perceived by Polyspace verification
- Functions responsible for full range data, as shown by the VOA (Value on assignment) check.

  if direct access to data is responsible, define the functions as macros.

```
#define read_from_data(param) read_from_data##param

int read_from_data_my_global1(void)
{ return [a functional range for my_global1]; }

Char read_from_data_my_global2(void)
{ }
```

- stub complicated algorithms, calibration read accesses and API functions reading global data - as usual. For instance, if an algorithm is iterative - stub it.
- variables
  - where the data range held by each element of an array is the same, replace that array with a single variable.
  - where the data range held by each element of an array differs, separate it into discrete variables.

Default and Alternative Behavior for Stubbing

External functions are assumed to have no effect (read, write) on global variables. Any external function for which this assumption is not valid must be explicitly stubbed.

Consider the example `int f(char *);`.

When verifying this function, there are three options for automatic stubbing, as shown in the following table.

Approach	Worst Case Scenario in Stub

Default automatic stubbing	`int f(char *x)`
	`{`
	`*x = rand();`
	`return 0;`
	`}`

pragma POLYSPACE_WORST	`int f(char *x)`
	`{`
	`strcpy(x, "the quick`
	`brown fox, etc.");`
	`return &(x[2]);`
	`}`

pragma POLYSPACE_PURE	`int f(char *x)`
	`{`
	`return strlen(x);`
	`}`

If the automatic stub does not accurately model the function using any of these approaches, you can use manual stubbing to achieve more precise results.

PURE and WORST Stubbing Examples

The following table provides examples of stubbing approaches.

Initial Prototype	With pragma POLYSPACE_PURE	With pragma POLYSPACE_WORST	Default Automatic Stubbing
`void f1(void);`	Do nothing		
`int f2` `(int u);`	Returns [-2^31, 2^31-1]		Returns [-2^31, 2^31-1]

Initial Prototype	With pragma POLYSPACE_PURE	With pragma POLYSPACE_WORST	Default Automatic Stubbing
`int f3` ` (int *u);`		Returns [-2^31, 2^31-1] **and** assumes the ability to write into (int *) u	Assumes the ability to write into *u to any depth **and** returns [-2^31, 2^31-1]
`int* f4` ` (int u);`	Returns an absolute address (AA)	Returns AA or (int *) u **and** assumes the ability to write into (int *) u	Returns an absolute address
`int* f5` ` (int *u);`	Returns an absolute address	Returns [-2^31, 2^31-1] **and** assumes the ability to write into *u, to any depth	Assumes the ability to write into *u, to any depth **and** returns an absolute address

`void f6`
` (void (*ptr)(int),`
`param2)`
	Does nothing	The function pointed to by ptr is called with a full-range random value for the integer. Rules for param2 are the same as the preceding rules.	

`void f7`
` (void (*ptr)(`
`param2)`
		This function is not stubbed. The parameter (`int *`) associated with the function pointer is too complicated for the software to stub it, and verification stops. You must stub this function manually.
		
		Note: If (*ptr) contains a pointer as a parameter, it is not stubbed automatically and with –`permissive-stubber`, the function pointer ptr is called with random as a parameter.	

Function Pointer Cases

<table>
<tr><th>Function Prototype</th><th>Comments</th></tr>
<tr><td><pre>
void _reg(int);
int _seq(void *);

unsigned char bar(void){
 return 0;
}

void main(void){
 unsigned char x=0;
 _reg(_seq(bar));
}
</pre></td><td>Both functions, “_reg” and “_seq”, are automatically stubbed, but the Polyspace software does not exercise the call to the <code>bar</code> function.

The function that is a parameter is only called in stubbed functions if the stubbed function prototype contains a function pointer as parameter.

Because in this example, the stubbed function is a “void *”, it is not a function pointer.</td></tr>
</table>

Stub Functions with Variable Argument Number

Polyspace software can stub most `vararg` functions. However:

- This stubbing can generate imprecision in pointer verification.
- The stubbing causes a significant increase in complexity and in verification time.

There are three ways that you can deal with this stubbing issue:

- Stub manually
- On every `varargs` function that you know to be pure, add a `#pragma POLYSPACE_PURE "function_1"`. This action reduces greatly the complexity of pointer verification tenfold.

  For example:

  ```
  #pragma POLYSPACE_PURE f

  void main(void) {
    int x = 0;
    f(&x);
    assert ( x == 0 ); // Green assertion,
          //orange without use of #pragma POLYSPACE_PURE
  }
  ```

- Use `#define` to eliminate calls to functions. For example, functions like `printf` generate complexity but are not useful for verification because they only display a message.

  For example:

  ```
  #ifdef POLYSPACE
   #define example_of_function(format, args...)
  #else
   void example_of_function(char * format, ...)
  #endif
  void main(void)
  {
   int i = 3;
   example_of_function("test1 %d", i);
  }

  polyspace-code-prover-nodesktop -D POLYSPACE
  ```

You can place this kind of line in any `.c` or `.h` file of the verification.

Note: Use `#define` only with functions that are pure.

Stub Standard Library Functions

Polyspace provides the file `__polyspace__stdstubs.c`, which stubs functions of the C standard library. During a verification, Polyspace uses the function stubs to generate `STD_LIB` checks. These checks indicate whether the arguments of standard library function calls in your code are valid. See “Invalid use of standard library routine”.

For more information about how you can use `__polyspace__stdstubs.c`, see “Standard Library Function Stubbing Errors”.

Check Variable Ranges with `assert`

`assert` is a macro that aborts a program if the test performed inside the `assert` statement is false.

You can use `assert` to constrain input variables to values within a particular range, for example:

```
#include <stdlib.h>

int random(void);

int return_betweens_bounds(int min, int max)
{
  int ret; // ret is not initialized
  ret = random(); // ret ~ [-2^31, 2^31-1]
  assert ((min<=ret) && (ret<=max));
  // assert is orange because the condition may or may not
  // be fulfilled
  // ret ~ [min, max] here because all execution paths that don't
  // meet the condition are stopped
  return ret;
}
```

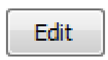
Check Global Variable Ranges with Global Assert

Use the **Global Assert** mode to constrain the range of a global variable. In this mode, Polyspace performs a **Correctness condition** check on each write access to the global variable. After the write access, this check determines whether the variable is within the range that you specified.

1. Run verification on your code. Open the results in the Results Manager perspective.
2. On the **Source** pane, select the **Data Range Configuration** tab.

   Under the **Global Variables** node, you see a list of global variables.
3. For the global variable that you want to constrain, from the drop-down list on the **Global Assert** column, select `YES`.
4. In the **Global Assert Range** column, enter the range in the format *`min..max`*. *`min`* is the minimum value and *`max`* the maximum value for the global variable.
5. To save your specifications, click the  button.

   A **Save Data Range Specifications (DRS) as** window opens. Save your entries as an `xml` file.
6. Return to the Project Manager perspective. On the **Configuration** pane, under **Inputs & Stubbing**, in the **Variable/function range setup** field, enter the full path to the `xml` file.

   Instead of typing the location, you can use the 

button to navigate to the location of the `.xml` file.
7. Rerun the verification and open the results.

   For every write access on the global variable, you see a green, orange or red **Correctness condition** check. If the check is:

   - Green, the variable is within the range that you specified.
   - Orange, the variable can be outside the range that you specified.
   - Red, the variable is outside the range that you specified.

   In a multitasking application, when two or more tasks access the same global variable, if a **Correctness condition** check on a write access in one task turns orange, the **Correctness condition** check on write accesses in all other tasks appear orange. The other orange checks appear even if the other write accesses do not take the variable outside the **Global Assert** range.

See Also

"Variable/function range setup (C/C++)" | "Correctness condition"

Related Examples

- "Create Data Range Specification Template"

More About

- "DRS Configuration Settings"

Model Variables External to Application

Express external variables using the keywords `volatile` and `extern`.

- A variable defined with keyword `volatile` can have any value allowed by its type. The value can change at any time, even between two successive memory accesses.
- A variable declared with keyword `extern` and not initialized is presumed to be defined elsewhere.

More About

- “External Variables”
- “Volatile Variables”

External Variables

Polyspace verification works on the principle that a global or static external variable could take any value within the range of its type.

```
extern int x;
void f(void)
int y;
y = 1 / x;  // orange because x ~ [-2^31, 2^31-1]
y = 1 / x;  // green because x ~ [-2^31 -1] U [1, 2^31-1]
```

For more information on color propagation, refer to "Color Sequence of Checks".

For external structures containing fields of type "pointer to function", this principle leads to red errors in the verification results. In this case, the resulting default behavior is that these pointers do not point to any valid function. For meaningful results, you need to define these variables explicitly.

Volatile Variables

Polyspace verification assumes that hardware can assign a value to a volatile variable, but will not de-initialize it. Therefore, NIV checks cannot be red.

```
volatile int x;  // x ~ [-2^31, 2^31-1], although x has not been
initialised
```

- If `x` is a global variable, the NIV is green.
- If `x` is a local variable, the NIV is green if `x` is initialized by the code, and orange if `x` has not been initialized by the code.

Absolute Addresses

The content of an absolute address is considered to be potentially uninitialized:

```
int y;

void f1(void)  {
#define X (* ((int *)0x20000))
 X = 100;
     // Orange ABS_ADDR for address of X
 y = 1 / X;
     // Orange divison by zero as X is potentially unitialized
}

void f2(void) {
 int *p = (int *)0x20000;
    // Orange absolute address
 *p  = 100;
 y  = 1/ *p;
 }
```

Data Rules

Data rules are design rules which dictate how modules and/or files interact with each other.

For instance, consider global variables. It is not always apparent which global variables are produced by a given file, or which global variables are used by that file. The excessive use of global variables can lead to problems in a design. For example:

- File APIs (or functions accessible from outside the file) without procedure parameters.
- The requirement for a formal list of variables which are produced and used, as well as the theoretical ranges they can take as input and/or output values.

Definitions and Declarations

The definition and declaration of a variable are two different but related operations.

Definition

- **for a function**: the body of the function has been written: `int f(void) { return 0; }`
- **for a variable:** a part of memory has been reserved for the variable: `int x;` or `extern int x=0;`

When a variable is not defined, the software considers the variable to be initialized, and to have potentially any value in its full range. For more information, see "External Variables".

When a function is not defined, it is stubbed automatically.

Declaration

- **for a function**: the prototype: `int f(void);`
- **for an external variable:** `extern int x;`

A declaration provides information about the type of the function or variable. If the function or variable is used in a file where it has not been declared, a compilation error results.

Prepare Code for Built-In Functions

In this section...

Overview

Polyspace software stubs functions that are not defined within the verification. Polyspace software provides an accurate stub for the functions defined in the `stl` and in the standard `libc`, taking into account functional aspects of the function.

Stubs of `stl` Functions

Functions of the `stl` are stubbed by Polyspace software. Using the `-no-stl-stubs` option allows deactivating standard stl stubs (not recommended for further possible scaling trouble).

Note: Allocation functions found in the code to analyze like new, new[], delete and delete[] are replaced by internal and optimized stubs of new and delete. A warning is given in the log file when such replace occurs.

Stubs of `libc` Functions

Functions are declared in the standard list of headers. You can redefine these functions by invalidating the associated set of functions and providing new definitions in your code.

To invalidate standard functions, use:

- `-D POLYSPACE_NO_STANDARD_STUBS` for functions declared in Standard ANSI® headers: `assert.h`, `ctype.h`, `errno.h`, `locale.h`, `math.h`, `setjmp.h` (`setjmp` and `longjmp` functions are partially implemented — see *`Polyspace_Install`*`/polyspace/verifier/cxx/cinclude/__polyspace__stdstubs.c`), `signal.h` (`signal` and `raise` functions are partially implemented — see *`Polyspace_Install`*`/polyspace/verifier/cxx/cinclude/`

__polyspace__stdstubs.c), stdio.h, stdarg.h, stdlib.h, string.h, and time.h.

- -D POLYSPACE_STRICT_ANSI_STANDARD_STUBS for functions declared only in strings.h, unistd.h, and fcntl.h.

Note: You cannot redefine the following functions that deal with memory allocation: malloc(), calloc(), realloc(), valloc(), alloca(), __built_in_malloc(), and __built_in_alloca().

To invalidate a specific function, use -D __polyspace_no_*function_name*.

For example, if you want to redefine the fabs() function:

- For the verification, specify the option -D __polyspace_no_fabs.
- In the code, provide your fabs() function.

If your **Include** folders contain the standard header files stdio.h and string.h, Polyspace may recognize your function declarations even if they do not exactly match the standard declarations. For example, you might declare memset as:

```
void memset ( void * ptr, unsigned int value, size_t num );
```

instead of:

```
void * memset ( void * ptr, int value, size_t num );
```

In this case, a verification does not generate a compilation error. If your **Include** folders do not contain stdio.h and string.h, you can activate this Polyspace feature by specifying the option -D__polyspace_adapt_types_for_stubs. If your **Include** folders contain stdio.h and string.h but you want to deactivate the feature, specify the option -D__polyspace_static_types_for_stubs.

Note: If your function version differs from the standard function, the internal conversion of parameters and return type during verification may cause a loss of precision.

Model Tasks

This example shows how to prepare for verification of multitasking code. If your code has functions that are intended for concurrent execution, you must specify them before verification. For this example, save the following code in a file `multitasking_code.c`.

```
int a;

void performTaskCycle(void);

void task(void) {
 while(1) {
  performTaskCycle();
 }
}

void interrupt(int val) {
 a=val;
}

void main() {
}
```

The code has two functions intended for concurrent execution.

- The function `task` must execute indefinitely.
- The function `interrupt` can execute any number of times.

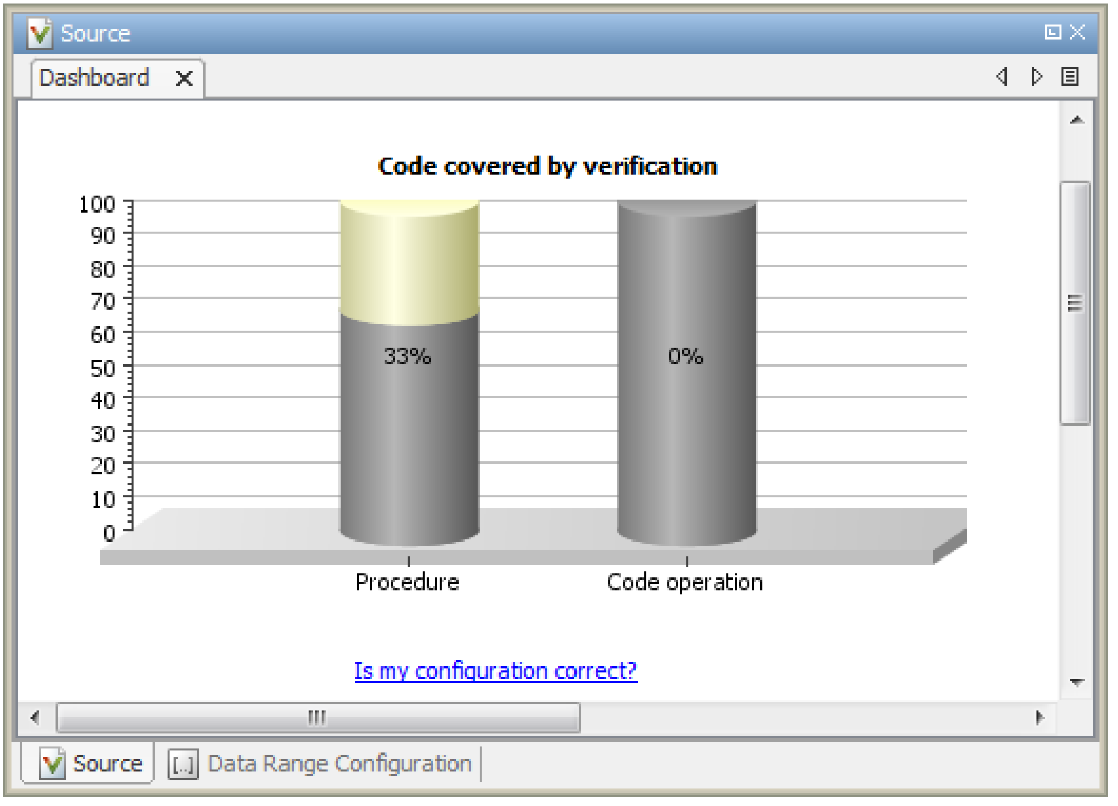
In this example, you learn what happens when you:

1. Run verification without specifying entry points.
2. Specify entry points but do not modify your code.
3. Modify code appropriately so that Polyspace can accept your entry points.

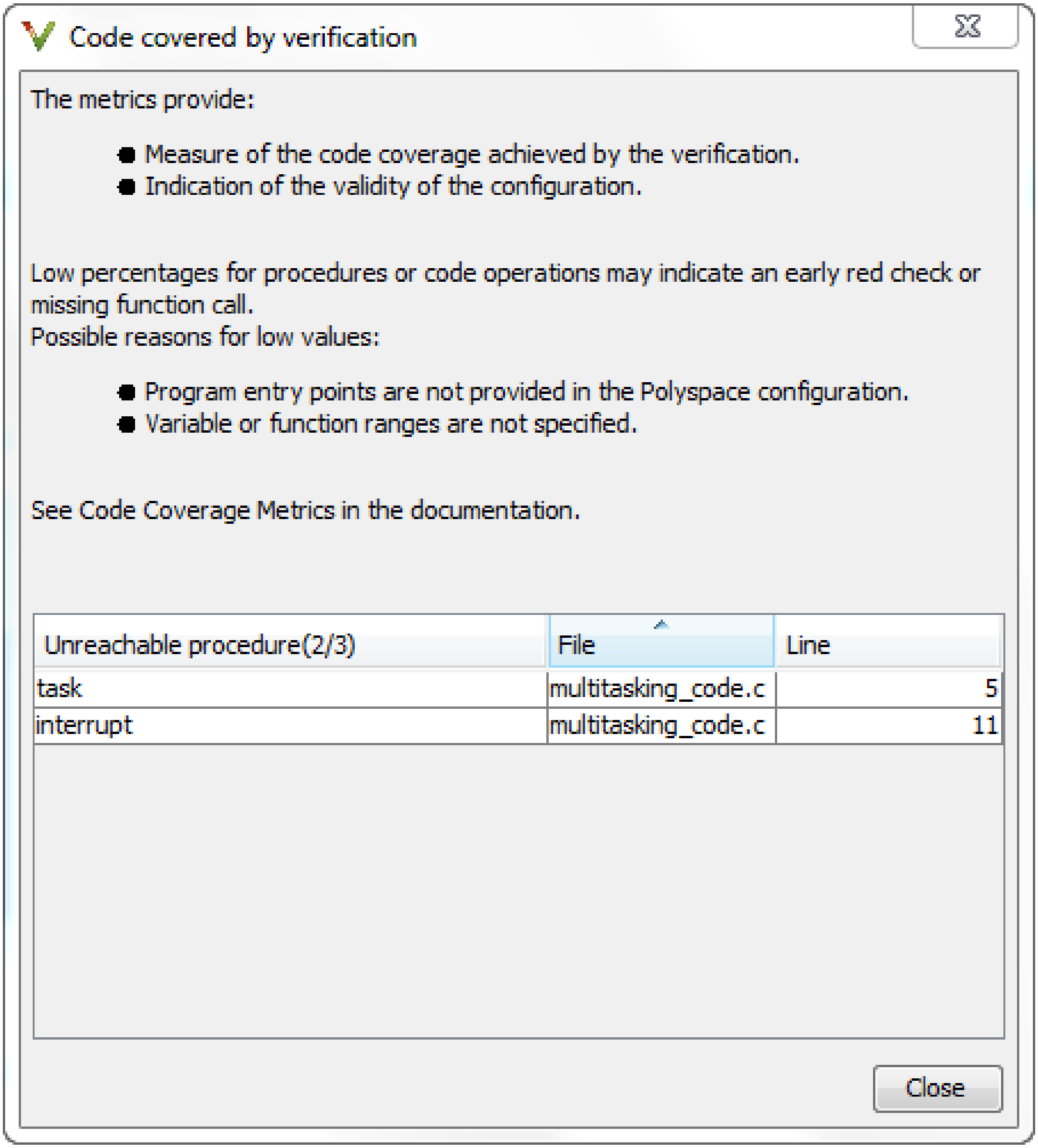
Run Non-Multitasking Verification

1. Create a Polyspace project. Add `multitasking_code.c` to the project.
2. On the **Configuration** pane, select **Code Prover Verification**. Then select **Verify whole application**.
3. Run verification on your project. Open the results.

- On the **Source** pane **Dashboard**, you find that the verification covered only a third of the procedures. This information indicates that `task` and `interrupt` were not covered.



- If you click the **Code covered by verification** graph, you see `task` and `interrupt` listed as **Unreachable procedure**.


Code covered by verification
The metrics provide:
Measure of the code coverage achieved by the verification.
Indication of the validity of the configuration.
Low percentages for procedures or code operations may indicate an early red check or missing function call.
Possible reasons for low values:
Program entry points are not provided in the Polyspace configuration.
Variable or function ranges are not specified.
See Code Coverage Metrics in the documentation.
Unreachable procedure(2/3)
File
Line
task
multitasking_code.c
5
interrupt
multitasking_code.c
11
Close

The verification did not cover `task` and `interrupt` because if you do not run a multitasking verification, `main` is the only entry point. In this case, the `main` did not call `task` and `interrupt`, so they are unreachable.

Run Multitasking Verification Without Modifying Tasks

1. On the **Configuration** pane, select **Mulitasking**. Select the **Multitasking** check box.
2. Specify `task` and `interrupt` as **Entry points**.

   a. Click the  button to create a text field.

   b. In each field, enter one function name.

   The next verification recognizes that these functions are intended for concurrent execution.
3. Run verification again. You get the following compilation error:

   ```
   task 'interrupt' has non-void prototype
   ```
   This error appears because functions specified as entry points must have the prototype

   ```
   void func(void)
   ```
   If your entry point functions do not have this form, you must write a wrapper function to encapsulate them. In this example, `interrupt` takes an `int` argument. You must encapsulate it in a wrapper function.

Run Multitasking Verification After Modifying Tasks

1. Create a wrapper function `interrupt_handler` both argument and return type `void`. Call `interrupt` inside `interrupt_handler` with a `volatile int` argument. To do this:

   a. In a new file, enter the following code.

   ```
   void interrupt_handler(void) {
    volatile int input = 0;
    volatile int randomValue = 0;
    while(randomValue) {
        interrupt(input);
     }
   }
   ```

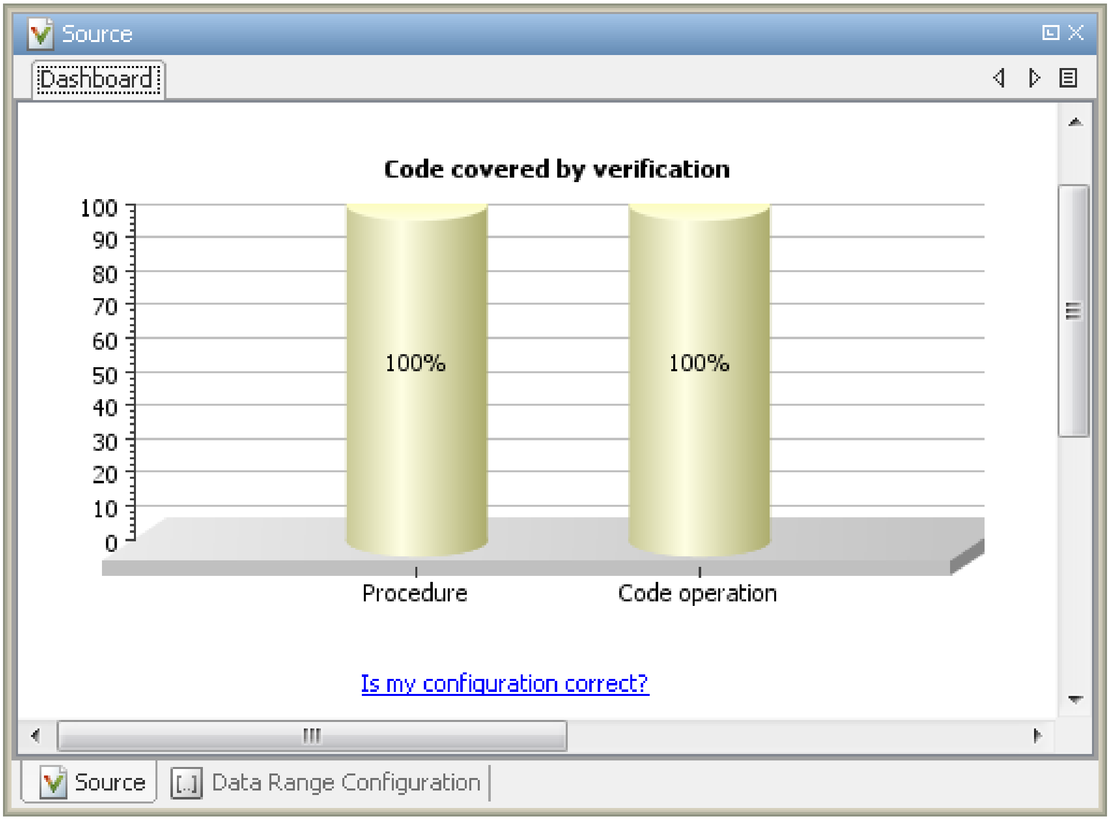
Polyspace considers that a `volatile int` variable can have any value allowed by its type at any time during execution. By defining `randomValue` as a `volatile int` variable, you specify that `interrupt` can run any number of times. Also, you initialize `randomValue` to zero to prevent an orange **Non-initialized local variable** check.

b. Add the new file to your Polyspace project. Copy it to the module on which you are running verification.

2. On the **Configuration** pane, select **Multitasking**. Replace the entry point `interrupt` by `interrupt_handler`.

3. Run verification again. Open the results.

   From the **Procedure** column on the **Source** pane **Dashboard**, you find that the verification covered all procedures.



Polyspace recognizes that:

- Your code is intended for multitasking.
- `task` and `interrupt_handler` are the entry points to your code.

Related Examples

- "Model Tasks if main Contains Infinite Loop"
- "Model Execution Sequence in Tasks"
- "Prevent Concurrent Access Using Temporally Exclusive Tasks"
- "Prevent Concurrent Access Using Critical Sections"

More About

- “Requirements for Multitasking Verification”

Model Tasks if `main` Contains Infinite Loop

This example shows how to model tasks if your `main` function contains an infinite loop. Polyspace requires that before tasks begin, the `main` function has completed execution. If you want your `main` to run concurrently with the tasks instead of completing before them, your `main` function might already contain an infinite loop. If so, for precise multitasking verification using Polyspace, you must modify your code. For this example, use the following code:

```
void performTask1Cycle(void);
void performTask2Cycle(void);

void main() {
 while(1) {
    performTask1Cycle();
  }
}

void task2() {
 while(1) {
    performTask2Cycle();
  }
}
```

In this example, you learn what happens when you:

1. Specify entry points but retain an infinite loop in `main`.
2. Modify the `main` appropriately so that Polyspace can verify entry point functions.

Run Multitasking Verification Without Modifying Code

1. Save the code in a file `multi.c`.
2. Create a Polyspace project and add `multi.c` to it.
3. On the **Configuration** pane, specify the following analysis options:
   a. Select **Code Prover Verification** > **Verify whole application**.
   b. Select **Multitasking** > **Multitasking**.
   c. For **Multitasking** > **Entry Points**, specify `task2`. You do not have to specify `main` because Polyspace considers `main` as an entry point by default.
4. Run verification and open the results. On the **Results Summary** pane, you find a gray **Function not reachable** check on `task2`.

Polyspace treats `task2` as not reachable, even though you specified it as an entry point, because the `main` function contains an infinite loop.

Run Multitasking Verification After Modifying Code

1 Replace the following portion of the code

```
void main() {
 while(1) {
    performTask1Cycle();
  }
}
```

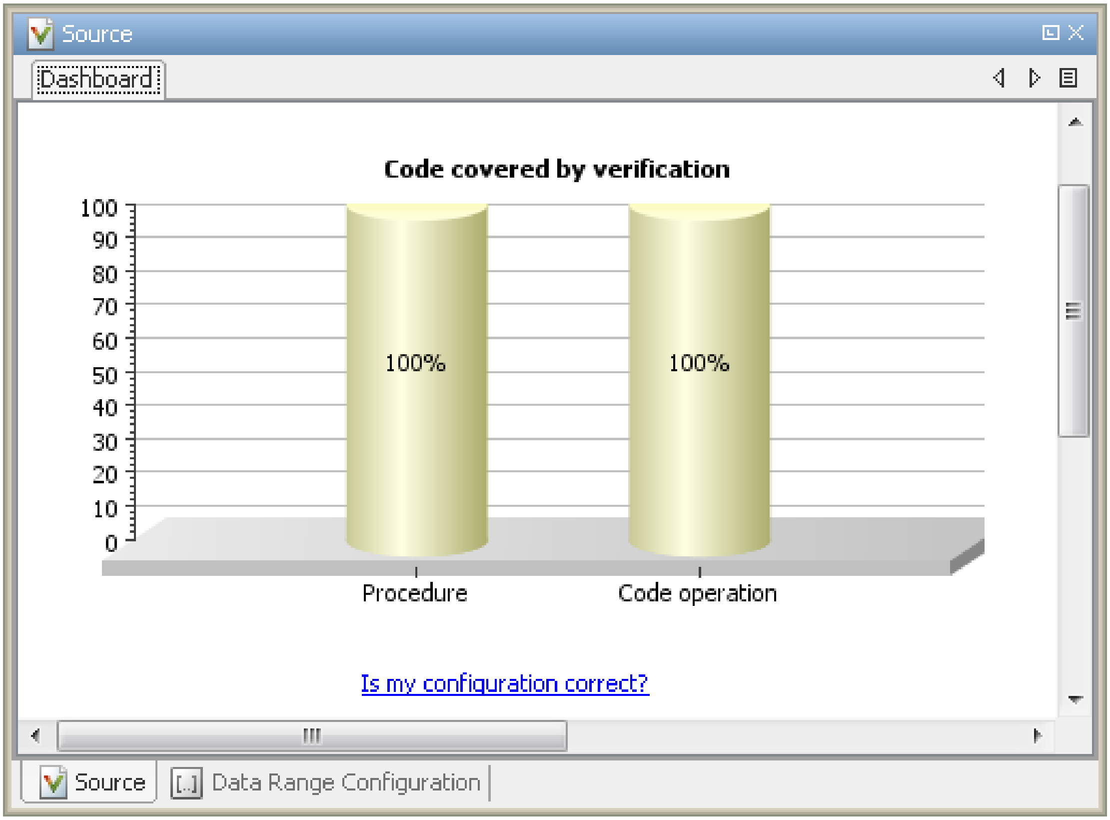
with

```
void main() {
}

void task1() {
 while(1) {
    performTask1Cycle();
  }
}
```

2 Run verification again. Open the results.

From the **Procedure** column on the **Source** pane **Dashboard**, you find that the verification covered all procedures.



Polyspace verifies both `task1` and `task2` because the `main` function executes to completion.

Related Examples

- "Model Tasks"
- "Model Execution Sequence in Tasks"
- "Prevent Concurrent Access Using Temporally Exclusive Tasks"
- "Prevent Concurrent Access Using Critical Sections"

More About

- "Requirements for Multitasking Verification"

Model Execution Sequence in Tasks

This example shows how to create a wrapper task for your functions so that they execute in a specific sequence in the task. For this example, save the following code in a file `multi.c`.

```
int var;

void reset(void) {
 var=0;
}

void inc(void) {
  var+=2;
}


void task1(void) {
 volatile int randomValue = 0;
 while(randomValue) {
   inc();
  }
}

void task2(void) {
 volatile int randomValue = 0;
 while(randomValue) {
   reset();
  }
}

void main() {
}
```

In this example, you will learn what happens when you:

1 Specify entry points without modifying your code. The tasks execute in an arbitrary sequence and can interrupt each other any time.

2 Create a new entry point so that the tasks execute in a definite sequence.

3 Modify the new entry point so that each task in the sequence might or might not execute.

Specify Entry Points

1. Create a Polyspace project and add `multi.c` to it.
2. On the **Configuration** pane, specify the following analysis options:
   a. Select **Code Prover Verification** > **Verify whole application**.
   b. Select the **Multitasking** > **Multitasking** box.
   c. For **Multitasking** > **Entry Points**, specify `task1` and `task2`, each on its own line.
3. Run verification and open the results.

   An orange **Overflow** error appears on the addition operator in `inc`. The error is not red because it does not occur along all execution paths. The error occurs only if `task1` executes sufficient number of times in succession without interruption from `task2`.

Specify Definite Execution Sequence

Suppose that you want to model that `reset` executes after `inc` has executed five times. This task sequence resets `var` after every five additions and prevents an overflow. To do this:

1. In a separate file `multi_sequence.c`, define a new wrapper function `task` as follows:

```
void task() {
 volatile int randomValue = 0;
 while(randomValue) {
   inc();
   inc();
   inc();
   inc();
   inc();
   reset();
   }
 }
```

2. Add `multi_sequence.c` to the project that you are running verification on.
3. On the **Configuration** pane, under **Multitasking**, do the following to the **Entry points** list:
   a. Remove `task1` and `task2`.

b Add `task`.

4 Run verification and open results.

The orange **Overflow** error does not appear in `inc`. The **Overflow** check is green.

Specify Indefinite Execution Sequence

Suppose, you want to model that `reset` can execute after `inc` has executed zero to five times. This task sequence resets `var` after zero to five additions and also prevents an overflow. To do this:

1 In the file `multi_sequence.c`, modify `task` as follows:

```
void task() {
 volatile int randomValue = 0;
 while(randomValue) {
   if(randomValue)
     inc();
   if(randomValue)
     inc();
   if(randomValue)
     inc();
   if(randomValue)
     inc();
   if(randomValue)
     inc();
   reset();
   }
 }
```

Because `randomValue` is a `volatile` variable, Polyspace considers that the execution can enter or skip any of the five `if` branches.

2 Run verification and open the results.

Again, the **Overflow** check on the addition in `inc` is green.

Related Examples

- “Model Tasks”
- “Model Tasks if main Contains Infinite Loop”
- “Prevent Concurrent Access Using Temporally Exclusive Tasks”

- “Prevent Concurrent Access Using Critical Sections”

More About

- “Requirements for Multitasking Verification”

Prevent Concurrent Access Using Temporally Exclusive Tasks

This example shows how to protect shared variables from concurrent access. A shared variable is written or read by more than one task. Therefore, when the tasks accessing this variable execute concurrently, the variable value at a given time can be undetermined. To protect variables from concurrent access by multiple tasks:

- Specify that the tasks are temporally exclusive.
- If you do not want to specify the tasks as temporally exclusive, place read or write access to those variables inside critical sections.

This example shows the first approach. For this example, save the following code in a file `multi.c`.

```
#include <limits.h>
int shared_var;

void inc() {
 shared_var+=2;
}

void reset() {
 shared_var = 0;
}

void task() {
  volatile int randomValue = 0;
  while(randomValue) {
    reset();
    inc();
    inc();
  }
}

void interrupt() {
 shared_var = INT_MAX;
}

void interrupt_handler() {
  volatile int randomValue = 0;
  while(randomValue) {
   interrupt();
  }
```

```
}

 void main() {
}
```

In this example, you will learn what happens when you:

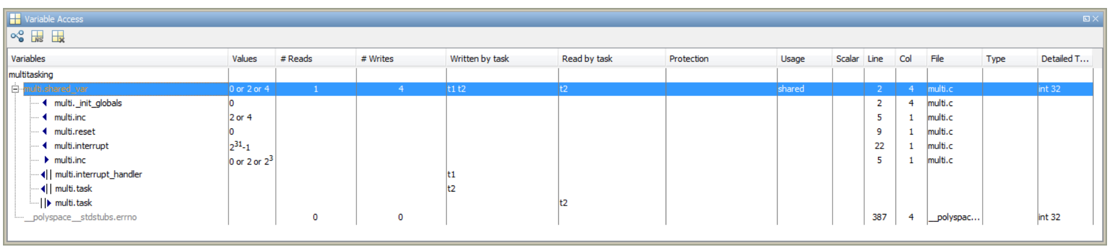
1 Specify entry points and run verification. Your tasks can interrupt each other any time.
2 Run verification after specifying temporally exclusive tasks.

View Unprotected Access in Polyspace Results

1 Create a Polyspace project and add `multi.c` to it.
2 On the **Configuration** pane, specify the following analysis options:
   a Select **Code Prover Verification** > **Verify whole application**.
   b Select the **Multitasking** > **Multitasking** check box.
   c For **Multitasking** > **Entry Points**, specify `task` and `interrupt_handler`, each on its own line.
3 Run verification and open the results.

   On the **Variable Access** pane, you see the following:

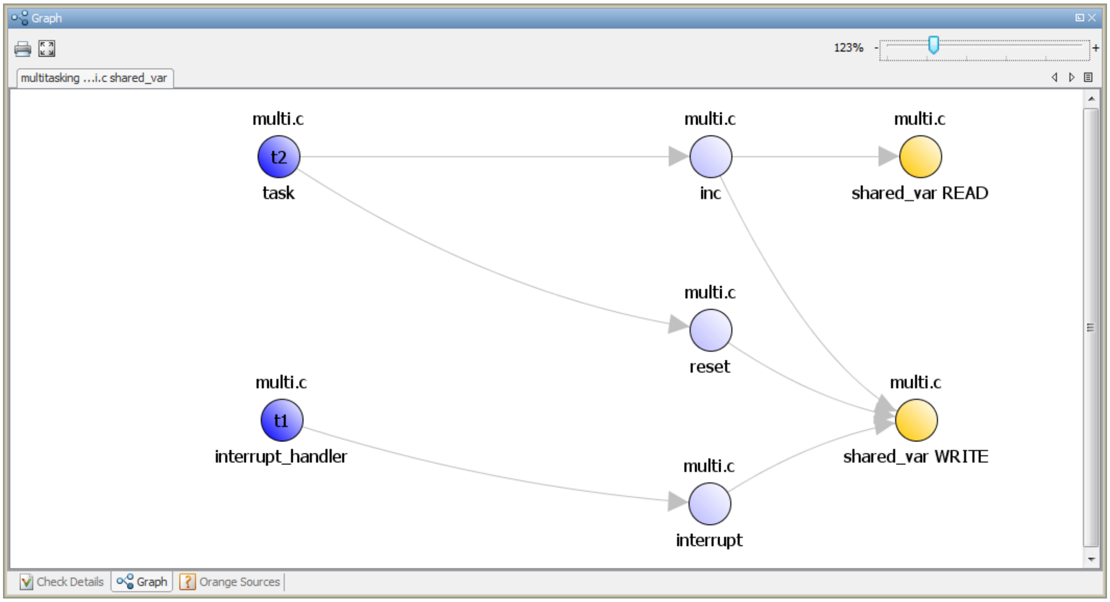
   - The node `multi.shared_var` representing the variable `shared_var` in the file `multi.c` is orange.
   - The **Protection** column is empty.



   The global variable `shared_var` is not protected from concurrent access by tasks `task` and `interrupt_handler`.

4 On the **Variable Access** pane, click the  button.

You see a graphical view of the access on the global variable `shared_var`. The final nodes of the graph are orange, indicating unprotected access.



Specify Temporally Exclusive Tasks

You can protect `shared_var` from concurrent access by making `task` and `interrupt_handler` temporally exclusive tasks.

1 On the **Configuration** pane:

- Retain the analysis options from the previous verification.
- For the option **Multitasking > Temporally exclusive tasks**, click the  button. Enter `task interrupt_handler`.

2 Run verification and open your results.

On the **Variable Access** pane, you see the following:

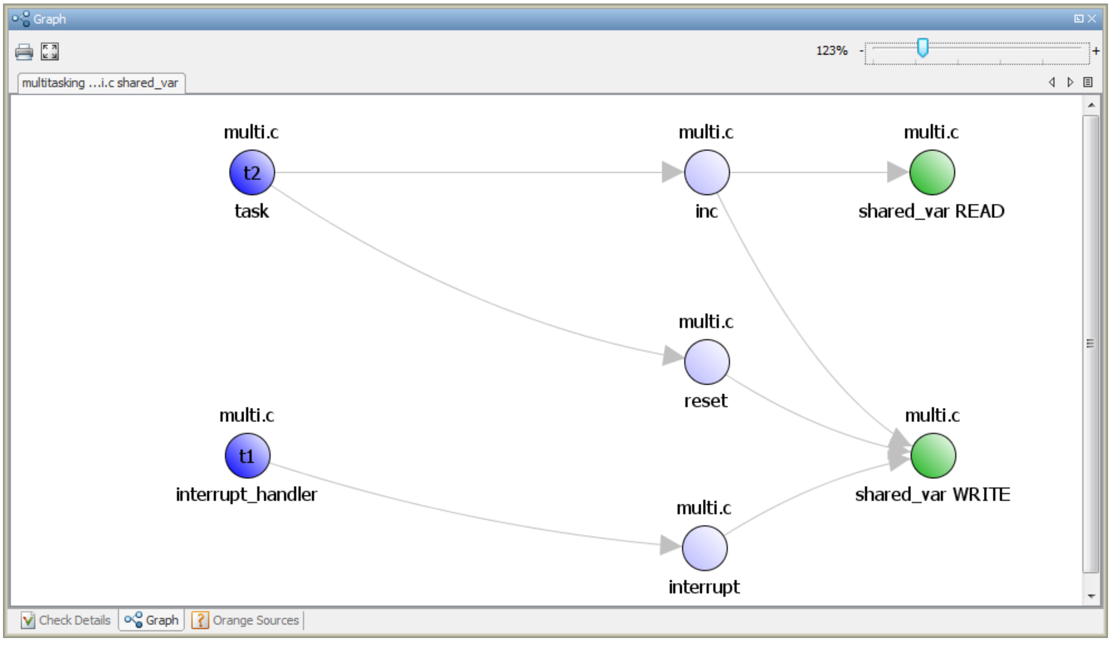
- The node `multi.shared_var` representing the variable `shared_var` in the file `multi.c` is green.

- The **Protection** column entry against the node is **Temporal exclusion**.

Polyspace Code Prover has proved the protection of `shared_var` from concurrent access.

3 On the **Variable Access** pane, click the  button.

The final nodes of the graph are green indicating protected access.



4 On the **Results Summary** pane, there is still an orange **Overflow** error.

a Select this error.

b On the **Source** pane, place your cursor on the orange plus sign.

You see that the left operand can be $2^{31}-1$.

Although Polyspace proves that `shared_var` is protected from concurrent access by `task` and `interrupt_handler`, it does not take this fact into account during verification. Therefore, it considers that an **Overflow** can occur if:

a. Inside `task`, `reset` executes and assigns 0 to `shared_var`.
b. `interrupt_handler` executes and assigns `INT_MAX` or $2^{31}-1$ to `shared_var`.
c. Inside `task`, `inc` executes and adds 2 to `INT_MAX` causing the overflow.

Related Examples

- "Prevent Concurrent Access Using Critical Sections"
- "Model Tasks"
- "Model Tasks if main Contains Infinite Loop"
- "Model Execution Sequence in Tasks"

More About

- "Requirements for Multitasking Verification"
- "Variable Access"

Prevent Concurrent Access Using Critical Sections

This example shows how to protect shared variables from concurrent access. A shared variable is written or read by more than one task. Therefore, when the tasks accessing this variable execute concurrently, the variable value at a given time can be undetermined. To protect variables from concurrent access by multiple tasks:

- Specify that the tasks are temporally exclusive.
- If you do not want to specify the tasks as temporally exclusive, place read or write access to those variables inside critical sections.

This example shows the second approach. For this example, save the following code in a file `multi.c`.

```
#include <limits.h>
int shared_var;

void inc() {
 shared_var+=2;
}

void reset() {
 shared_var = 0;
}

void task() {
  volatile int randomValue = 0;
  while(randomValue) {
    reset();
    inc();
    inc();
  }
}

void interrupt() {
 shared_var = INT_MAX;
}

void interrupt_handler() {
  volatile int randomValue = 0;
  while(randomValue) {
   interrupt();
  }
```

```
}

 void main() {
}
```

In this example, you will learn what happens when you:

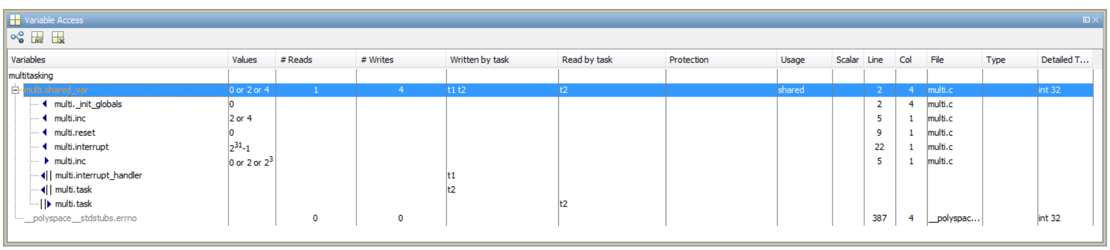
1. Specify entry points and run verification. Your tasks can interrupt each other any time.
2. Protect two sections of code from interruption by each other using a critical section. To implement the critical section, place the two sections of code between calls to the same two functions.

View Unprotected Access in Polyspace Results

1. Create a Polyspace project and add `multi.c` to it.
2. On the **Configuration** pane, specify the following analysis options:
   a. Select **Code Prover Verification** > **Verify whole application**.
   b. Select the **Multitasking** > **Multitasking** check box.
   c. For **Multitasking** > **Entry Points**, specify `task` and `interrupt_handler`, each on its own line.
3. Run verification and open the results.

   On the **Variable Access** pane, you see the following:

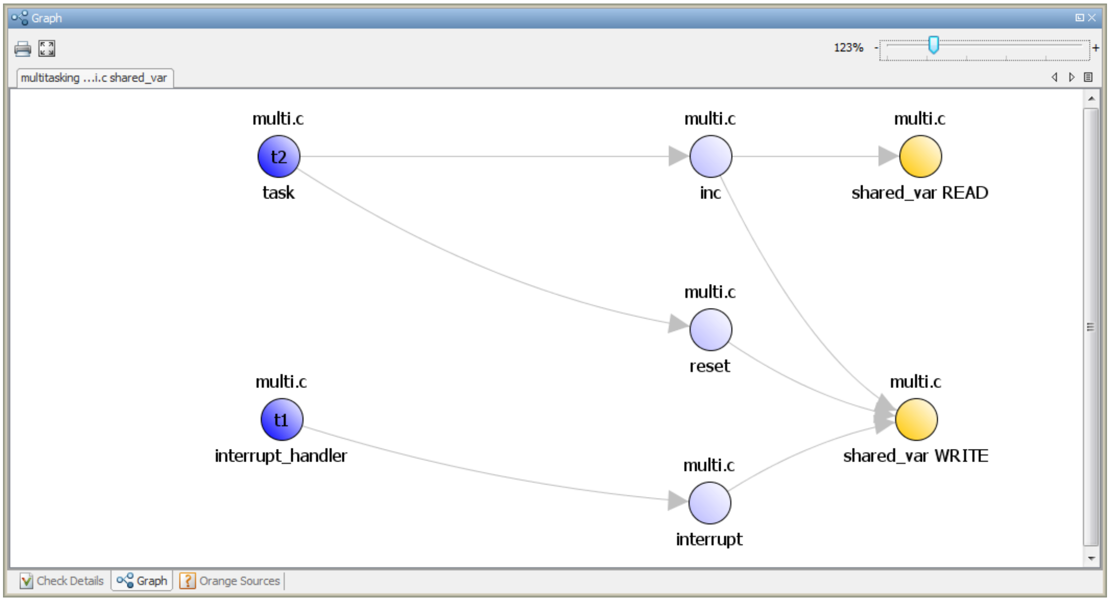
   - The node `multi.shared_var` representing the variable `shared_var` in the file `multi.c` is orange.
   - The **Protection** column is empty.



   The global variable `shared_var` is not protected from concurrent access by tasks `task` and `interrupt_handler`.

4 On the **Variable Access** pane, click the  button.

You see a graphical view of the accesses on the global variable `shared_var`. The final nodes of the graph are orange, indicating unprotected access.



Specify Critical Sections

You can protect `shared_var` from concurrent access by placing the accesses inside a critical section.

1 Save the following code in another file `multi_critical_section.c`.

```
#include <limits.h>
int shared_var;

void inc() {
 shared_var+=2;
}

void reset() {
 shared_var = 0;
```

```
}

void take_semaphore(void);
void give_semaphore(void);

void task() {
  volatile int randomValue = 0;
  while(randomValue) {
    take_semaphore();
    reset();
    inc();
    inc();
    give_semaphore();
  }
}

void interrupt() {
 shared_var = INT_MAX;
}

void interrupt_handler() {
  volatile int randomValue = 0;
  while(randomValue) {
   take_semaphore();
   interrupt();
   give_semaphore();
  }
}

void main() {
}
```

The differences between `multi.c` and `multi_critical_section.c` are:

- There are two new functions `take_semaphore()` and `give_semaphore()` in `multi_critical_section.c` with the prototype:

  `void` *`func_name`*`(void);`

- The cycle code in functions `task()` and `interrupt_handler()` is between calls to `take_semaphore()` and `give_semaphore()`.

2. Add `multi_critical_section.c` to your project. Create a new module in your project and copy the file to that module.
3. On the **Configuration** pane:

- Retain the analysis options from the previous verification.
- For the option **Multitasking** > **Critical section details**, specify `take_semaphore` as the **Starting procedure** and `give_semaphore` as the **Ending procedure**.

4 Run verification on the module and open your results.

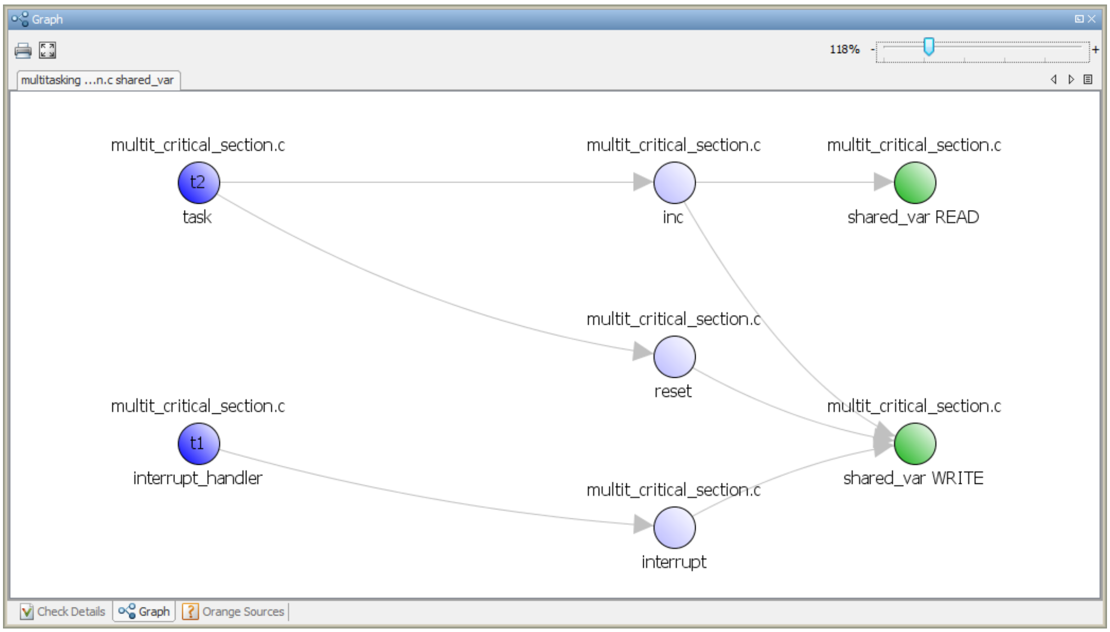
On the **Variable Access** pane, you see the following:

- The node `multi_critical_section.shared_var` representing the variable `shared_var` in the file `multi_critical_section.c` is green.
- The **Protection** column entry against the node is **Critical section**.

The global variable `shared_var` is protected from concurrent access.

5 On the **Variable Access** pane, click the  button.

The final nodes of the graph are green, indicating protected access.



6 On the **Results Summary** pane, there is still an orange **Overflow** error.

a Select this error.

b On the **Source** pane, place your cursor on the orange + sign.

You see that the left operand can be 2^{31}-1.

Although Polyspace proves that shared_var is protected from concurrent access by task and interrupt_handler, it does not take this fact into account during verification. Therefore, it considers that an **Overflow** can occur if:

a Inside task, reset executes and assigns 0 to shared_var.

b interrupt_handler executes and assigns INT_MAX or 2^{31}-1 to shared_var.

c Inside task, inc executes and adds 2 to INT_MAX causing the overflow.

Related Examples

- "Prevent Concurrent Access Using Temporally Exclusive Tasks"
- "Model Tasks"
- "Model Tasks if main Contains Infinite Loop"
- "Model Execution Sequence in Tasks"

More About

- "Requirements for Multitasking Verification"
- "Variable Access"

Requirements for Multitasking Verification

Your source code can contain functions that are intended to execute concurrently in separate threads (tasks). Before you specify tasks to Polyspace, you must code them in a specific format. If your code is already written and does not follow the format, you can make minor adjustments to make your code suitable for multitasking verification. The following table lists the requirements and points to examples of how you can satisfy those requirements.

Requirement	Example
The tasks must have the following prototype: `void func(void)`	"Model Tasks"
The `main` function must not contain an infinite loop or a run-time error. Polyspace requires that before tasks begin, your `main` function has completed execution.	"Model Tasks if main Contains Infinite Loop"
If your task executes indefinitely in cycles, it must contain an infinite loop.	"Model Tasks"

If your task acts as an interrupt that can execute any number of times, it must contain a loop with unspecified number of runs. Use the following code in the task definition:
 	
`volatile int randomValue = 0;`
`while(randomValue) {`
` /* Your task body goes here */`
`}`
	"Model Tasks"

If your interrupt occurs only after another task has executed a certain number of times, you can a create wrapper task to model this sequence.	"Model Execution Sequence in Tasks"
If you want two sections of code to execute without interruption from each other, you can enclose them in the same critical section. Place the two sections of code between calls to the same two functions.	"Prevent Concurrent Access Using Critical Sections"

Requirement	Example
If you want two tasks to execute without interruption from each other, you can specify them to be temporally exclusive.	“Prevent Concurrent Access Using Temporally Exclusive Tasks”

Comment Code for Known Defects

This example shows how to place comments in your code to mark defects that you are already aware of but do not intend to fix immediately. Using your comments, Polyspace populates the defect **Classification**, **Status** and **Comment** fields on the **Results Summary** pane. After you have placed your comments in your code, you or another reviewer can avoid reviewing the same defect twice. The example uses the following code that is stored in a file `divideByDifference.c`.

```
#include <math.h>
int divideByDifference(int num, int x, int y)
{
 if(x >= y)
   return(num/(abs(x)-abs(y)));
  else
   return 0;
}
```

Verify Source File and Review Results

1 Create a new Polyspace project. Add the file `divideByDifference.c` to the project.

2 Click 

to start verification on your project.

   The verification uses the default options on the **Configuration** pane. It uses a generated `main` to call the function, `divideByDifference`.

3 Open the verification results. On the **Results Summary** pane, select:

   - One of the two orange **Invalid use of standard library routine** errors. On the **Check Details** pane, you can see an error message that the orange error on the `abs` functions can be due to unbounded input values.

     Enter the following review information for the error.

Column name	Review Information
Classification	**Not a defect**
Status	**No action planned**
Comment	`Argument of abs is bounded.`

   - The orange **Division by Zero** error.

Enter the following review information for the error.

Column name	Review Information
Classification	**High**
Status	**Investigate**
Comment	`To check if x can be equal to y.`

Comment Code for `STD_LIB` error

1 On the **Results Summary** pane, right-click one of the orange **Invalid use of standard library routine** errors. Select **Add Pre-Justification to Clipboard**.

   This action copies your **Classification**, **Status**, and **Comment** in a form that you can insert in your source code.

2 Using the paste option in your text editor, in the file `divideByDifference.c`, paste what you copied just before the line `return(num/(abs(x)-abs(y)));`.

   Your source code appears as follows:

```
#include <math.h>
int divideByDifference(int num, int x, int y)
{
 if(x >= y)
   /* polyspace<RTE:STD_LIB:Not a defect:No action planned>
Argument of abs is bounded. */
   return(num/(abs(x)-abs(y)));
  else
   return 0;
}
```

3 Run the verification again. Open your results.

   On the **Results Summary** pane, both instances of **Invalid use of standard library routine** on the line `return(num/(abs(x)-abs(y)));` have the **Classification**, **Status**, and **Comment** that you entered.

Comment Code for `OVFL` error

1 In the file `divideByDifference.c`, edit the comment that you entered.

Original	Replace with
`STD_LIB`	`STD_LIB,OVFL`
`Not a defect`	`Low`
`Argument of abs is bounded.`	`Error does not occur for values of x and y.`

2 Run the verification again. Open your results.

On the **Results Summary** pane, the **Overflow** and **Invalid use of standard library routine** checks on the line `return(num/(abs(x)-abs(y)));` have the following review information:

Column name	Review Information
Classification	**Low**
Status	**No action planned**
Comment	`Error does not occur for values of x and y.`

Comment Code for ZDV error

1 On the **Results Summary** pane, right-click the orange **Division by Zero** error. Select **Add Pre-Justification to Clipboard**.

This action copies your **Classification**, **Status**, and **Comment** in a form that you can insert in your source code.

2 In the file `divideByDifference.c`, paste what you copied after the already existing comment.

Your source code appears as follows:

```
#include <math.h>
int divideByDifference(int num, int x, int y)
{
 if(x >= y)
   /* polyspace<RTE:STD_LIB,OVFL:Not a defect:
No action planned> Error does not occur for values of x and y. */
   /* polyspace<RTE:ZDV:High:Investigate>
To check if x can be equal to y. */
   return(num/(abs(x)-abs(y)));
```

```
  else
   return 0;
}
```

3 Run the verification again. Open your results.

   On the **Results Summary** pane, the **Division by Zero** error on the line `return(num/(abs(x)-abs(y)));` has the **Classification**, **Status**, and **Comment** that you entered. The other errors retain the earlier review information.

More About

- "Comment Syntax for Marking Known Defects"

Comment Syntax for Marking Known Defects

You can place comments in your code to mark defects that you are already aware of but do not intend to fix immediately. Using your comments, Polyspace populates the defect **Classification**, **Status** and **Comment** fields of the **Results Summary** pane. After you have placed your comments in your code, you or another reviewer can avoid reviewing the same defects twice.

To place comments, you can:

- Use the right-click option **Add Pre-Justification To Clipboard** on the **Results Summary** pane.
- Manually enter the comments in a specific syntax just before the line containing the defect.

  To comment:

  - An individual line of code, use the following syntax:

    ```
    /* polyspace<Defect:Kind1[,Kind2] : [Classification] : [Status] >
    [Additional text] */
    ```

  - A section of code, use the following syntax:

    ```
    /* polyspace:begin<Defect:Kind1[,Kind2] : [Classification] : [Status] >
    [Additional text] */

    ... Code section ...

    /* polyspace:end<Defect:Kind1[,Kind2] : [Classification] : [Status] > */
    ```

  The square brackets *[ ]* indicate optional information.

Replace	Replace with
Defect	**Runtime errors:** `RTE`
	Coding rule violations: • `MISRA-C` • `MISRA-AC-AGC` • `MISRA-C3`

<table>
<tr><th>Replace</th><th>Replace with</th></tr>
<tr><td></td><td><code>MISRA-CPP</code>
<code>JSF</code>
<code>Custom</code></td></tr>
<tr><td rowspan="2"><code>Kind1,Kind2,...</code></td><td>Runtime errors:

Acronyms for checks such as <code>ZDV</code>, <code>OVFL</code>, etc..

If you want the comment to apply to all checks on the following line, specify <code>ALL</code>.</td></tr>
<tr><td>Coding rule violations:

Rule number. For more information, see:
“MISRA C:2004 Coding Rules”
“MISRA C:2012 Coding Directives and Rules”
“MISRA C++ Coding Rules”
“JSF C++ Coding Rules”
“Custom Naming Convention Rules”
If you want the comment to apply to all coding rule violations on the following line, specify <code>ALL</code>.</td></tr>
<tr><td><code>Classification</code></td><td>Text that indicates the severity of the defect. Enter one of the following:
<code>Unset</code>
<code>High</code>
<code>Medium</code>
<code>Low</code>
<code>Not a defect</code>
This text populates the Classification column on the Results Summary pane.</td></tr>
</table>

Replace	Replace with
`Status`	Text that indicates how you intend to correct the error in your code. Enter one of the following or any other text: • `Fix` • `Improve` • `Investigate` • `Justify with annotations` • `No action planned` • `Restart with different options` • `Other` • `Undecided` This text populates the **Status** column on the **Results Summary** pane.
`Additional text`	Any text. This text populates the **Comment** column on the **Results Summary** pane.

Syntax Examples: Runtime Errors

- Non terminating call:

```
/* polyspace<RTE: NTC : Low : No Action Planned > Known issue */
```

- Division by zero:

```
/* polyspace<RTE: ZDV : High : Fix > Denominator cannot be zero */
```

Syntax Examples: Coding Rule Violations

- MISRA C rule violation:

```
/* polyspace<MISRA-C:6.3 : Low : Justify with annotations> Known issue */
```

- JSF C++ rule violation:

```
/* polyspace<JSF:9 : Low : Justify with annotations> Known issue */
```

Related Examples

- "Comment Code for Known Defects"

More About

- "Check Acronyms"

Check Acronyms

The following table lists alphabetically the check acronyms that you must use in code comments or custom software quality objectives:

Check	Acronym
"Absolute address"	ABS_ADDR
"C++ specific checks"	CPP
"Correctness condition"	COR
"Division by zero"	ZDV
"Exception handling"	EXC
"Function not called"	FNC
"Function not reachable"	FNR
"Function returns a value"	FRV
"Illegally dereferenced pointer"	IDP
"Initialized return value"	IRV
"Inspection points"	IPT
"Invalid use of standard library routine"	STD_LIB
"Known non-terminating call"	k_NTC
"Non-initialized local variable"	NIVL
"Non-initialized pointer"	NIP
"Non-initialized variable"	NIV
"Non-null this-pointer in method"	NNT
"Non-terminating call"	NTC
"Non-terminating loop"	NTL
"Object oriented programming"	OOP
"Out of bounds array index"	OBAI
"Overflow"	OVFL
"Shift operations"	SHF
"Unreachable code"	UNR

Check	Acronym
"User assertion"	ASRT

Related Examples

- "Comment Code for Known Defects"
- "Customize Software Quality Objectives"

More About

- "Comment Syntax for Marking Known Defects"

Types Promotion

In this section...

Unsigned Integers Promoted to Signed Integers

You need to understand the circumstances under which signed integers are promoted to unsigned.

For example, the execution of the following code would produce an assertion failure and a core dump.

```
#include <assert.h>
int f1(void) {
 int x = -2;
 unsigned int y = 5;
 assert(x <= y);
}
```

Implicit promotion explains this behavior. In this example, `x <= y` is implicitly:

```
((unsigned int) x) <= y /* implicit promotion since y is unsigned */
```

A negative cast into unsigned gives a large value. This value can never be <= 5, so the assertion can never hold true.

In this second example, consider the range of possible values for x:

```
void f2(void)
volatile int random;
unsigned int y = 7;
int x = random;
assert ( x >= -7 && x <= y );

assert (x>=0 && x<=7);
```

The first assertion is orange; it may cause an assert failure. However, given that the range of x after the first assertion is **not [-7 .. 7]**, but rather **[0 .. 7]**, the second assertion would hold true.

Promotions Rules in Operators

Familiarity with the rules applying to the standard operators of the C language helps you to analyze those orange and **red** checks which relate to overflows on type operations. Those rules are:

- Unary operators operate on the type of the operand.
- Shifts operate on the type of the left operand.
- Boolean operators operate on Booleans.
- Other binary operators operate on a common type. If the types of the two operands are different, they are promoted to the first common type which can represent both of them.
- Be careful of constant types.
- Be careful when verifying a operation between variables of different types without an explicit cast.

Example

Consider the integer promotion aspect of the ANSI C standard (see 6.2.1 in ISO®/IEC 9899:1990). On arithmetic operators like +, -, *, % and / , an integer promotion is applied on both operands. For verification, that can imply an OVFL or a UNFL orange check.

```
2 extern char random_char(void);
3 extern int random_int(void);
4
5 void main(void)
6 {
7  char c1 = random_char();
8  char c2 = random_char();
9  int i1 = random_int();
10  int i2 = random_int();
11
12  i1 = i1 + i2;   // A typical OVFL/UNFL on a + operator
13  c1 = c1 + c2;   // An OVFL/UNFL warning on the c1
14       // assignment [from int32 to int8]
15 }
```

Unlike the addition of two integers at line 12, an implicit promotion is used in the addition of the two chars at line 13. Consider this second “equivalence” example.

```
extern char random_char(void);

void main(void)
{
 char c1 = random_char();
 char c2 = random_char();

 c1 = (char)((int)c1 + (int)c2);  // Warning OVFL: due to
             // integer promotion
}
```

An orange check represents a warning of a potential overflow (OVFL), generated on the (char) cast [from int32 to int8]. A green check represents a verification that the + operator does not produce an overflow (OVFL).

Integer promotion requires that the abstract machine must promote the type of each variable to the integral target size before realizing the arithmetic operation and subsequently adjusting the assignment type. See the preceding equivalence example of a simple addition of two *char*.

Integer promotion respects the size hierarchy of basic types:

- *char (signed or not)* and *signed short* are promoted to *int*.
- *unsigned short* is promoted to *int* only if *int* can represent all possible values of an *unsigned short*. If that is not the case (because of a 16-bit target, for example) then *unsigned short* is promoted to *unsigned int*.
- Other types such as*(un)signed int*, *(un)signed long int*, and *(un)signed long long int* promote themselves.

Ignored Inline Assemblers

Polyspace recognizes the following inline assemblers as introduction of assembly code. During verification, it ignores the assembly code introduced by these assemblers.

- `asm`

  Examples:

  - ```
    int f(void)
    {
     asm ("% reg val; mtmsr val;");
     asm("\tmove.w #$2700,sr");
     asm("\ttrap #7");
     asm(" stw r11,0(r3) ");
     assert (1); // is green
     return 1;
    }
    ```
  - ```
    int other_ignored2(void)
    {
     asm "% reg val; mtmsr val;";
     asm mtmsr val;
     assert (1); // is green
     asm ("px = pm(0,%2); \
      %0 = px1; \
      %1 = px2;"
      : "=d" (data_16), "=d" (data_32)
      : "y" ((UI_32 pm *)ram_address):
    "px");
     assert (1); // is green
    }
    ```
  - ```
    int other_ignored4(void)
    {
     asm {
      port_in: /* byte = port_in(port); */
      mov EAX, 0
      mov EDX, 4[ESP]
       in AL, DX
       ret
       port_out: /* port_out(byte,port); */
      mov EDX, 8[ESP]
      mov EAX, 4[ESP]
      out DX, AL
    ```
    ```

```
  ret }
assert (1); // is green
}
```

- `__asm__`

Examples:

- ```
  int other_ignored6(void)
  {
  #define A_MACRO(bus_controller_mode) \
   __asm__ volatile("nop"); \
   __asm__ volatile("nop"); \
   __asm__ volatile("nop"); \
   __asm__ volatile("nop"); \
   __asm__ volatile("nop"); \
   __asm__ volatile("nop")
    assert (1); // is green
    A_MACRO(x);
    assert (1); // is green
    return 1;
  }
  ```
- ```
  int other_ignored1(void)
  {
   __asm
    {MOV R8,R8
    MOV R8,R8
    MOV R8,R8
    MOV R8,R8
    MOV R8,R8}
   assert (1); // is green
  }
  ```
- ```
  int GNUC_include (void)
  {
   extern int __P (char *__pattern, int __flags,
   int (*__errfunc) (char *, int),
   unsigned *__pglob) __asm__ ("glob64");
   __asm__ ("rorw $8, %w0" \
    : "=r" (__v) \
    : "0" ((guint16) (val)));
   __asm__ ("st g14,%0" : "=m" (*(AP)));
   __asm("" \
    : "=r" (__t.c) \
    : "0" ((((union { int i, j; } *) (AP))++)->i));
  ```
  ```

```
 assert (1); // is green
 return (int) 3 __asm__("% reg val");
}
```

- ```
  int other_ignored3(void)
  {
   __asm {ldab 0xffff,0;trapdis;};
  __asm {ldab 0xffff,1;trapdis;};
   assert (1); // is green
   __asm__ ("% reg val");
   __asm__ ("mtmsr val");
   assert (1); // is green
   return 2;
  }
  ```

- `#pragma asm #pragma endasm`

  Examples:

  - ```
    int pragma_ignored(void)
    {
     #pragma asm
      SRST
     #pragma endasm
      assert (1); // is green
    }
    ```
  - ```
    void test(void)
    {
      #asm
        mov _as:pe, reg
        jre _nop
      #endasm
      int r;
      r=0;
      r++;
    }
    ```

Related Examples

- "Exclude Assembly Code if Compiler Generates Errors"
    ```

Exclude Assembly Code if Compiler Generates Errors

Polyspace ignores most assembly code during verification.

If Polyspace cannot parse assembly code during the **Compile** phase, use the command line options `-asm-begin` and `-asm-end` to indicate assembly code sections.

Consider the following code.

```
int x=12;

void f(void)
{
#pragma will_be_ignored
 x =0;
 x= 1/x;           // no color is displayed
                        // not even C code
#pragma was_ignored
 x++;
 x=15;
}

void main (void)
{
 int y;
 f();
 y = 1/x + 1 / (x-15);  // Red ZDV, x is equal to 15

}
```

The verification ignores text or code placed between the two `#pragma` statements if you specify the following options:

```
-asm-begin will_be_ignored -asm-end was_ignored
```

This approach allows an unsupported assembly code section to be ignored without changing the meaning of the original code.

See Also

"-asm-begin -asm-end"

More About

- "Ignored Inline Assemblers"

Stub Single Function Containing Assembly Code

The software automatically stubs a function that is preceded by `asm`, even if a body is defined.

```
asm int h(int tt)              // function h is stubbed even if body is defined
{
  % reg val;                   // ignored
  mtmsr val;                  // ignored
  return 3;                     // ignored
};

void f(void) {
  int x;
  x = h(3);                     // x is full-range
}
```

Stub Multiple Functions Containing Assembly Code

The functions that you specify through the following pragma are stubbed automatically, even if function bodies are defined:

```
#pragma inline_asm(list of functions)
```

The following code provides examples:

```
#pragma inline_asm(ex1, ex2)
   // The functions ex1 and ex2 are
   // stubbed, even if their bodies are defined

int ex1(void)
{
  % reg val;
  mtmsr val;
  return 3;                       // ignored
};

int ex2(void)
{
  % reg val;
  mtmsr val;
  assert (1);                    // ignored
  return 3;
};


#pragma inline_asm(ex3)  // the definition of ex3 is ignored

int ex3(void)
{
  % reg val;
  mtmsr val;     // ignored
  return 3;
};

void f(void) {
  int x;

  x = ex1();       // ex1 is stubbed : x is full-range
  x = ex2();       // ex2 is stubbed : x is full-range
  x = ex3();       // ex3 is stubbed : x is full-range
```

```
}
```

Local Variables in Functions with Assembly Code

In functions containing assembly code, the software treats local variables that are not explicitly initialized as potentially initialized variables.

Consider the following function.

```
inline int f(void) {
  int r;
  asm("mov 4%0,%%eax"::"m"(r));
  return r;     // orange NIVL (red NIVL before 12a) because r is not initialized
}
```

The software treats `r` as a potentially initialized variable. Verification generates an orange NIVL check for `r`.

Consider another function.

```
1  int dummy(void) {
2    int g,h;
3    h = g * 2;      // orange NIVL for g (red NIVL before 12a)
4    h = 2;           // h is assigned the value 2
5    asm("int $0x3");
6    asm("mov 4%0,%%eax"::"m"(g));
7    asm("movss 4%0,%%xmm1"::"m");
8    return h;       // value returned is 2
9  }
```

In line 3, the variable `g` is not initialized. Verification:

- Generates an orange NIVL check for `g`.
- Assigns a full-range value to `g`.

Using memset and memcpy

In this section...

Polyspace Specifications for memcpy

Syntax:

```
#include <string.h>
void * memcpy ( void * destinationPtr, const void * sourcePtr, size_t num );
```

If your code uses the `memcpy` function, see the information in this table.

<table>
<tr><th>Specification</th><th>Example</th></tr>
<tr><td>Polyspace runs a Invalid use of standard library routine check on the function. The check determines if the memory block that <code>sourcePtr</code> or <code>destinationPtr</code> points to is greater than or equal in size to the memory assigned to them through <code>num</code>.</td>
<td>In the following code, Polyspace produces a red Invalid use of standard library routine error because:

<code>d</code> is an <code>int</code> variable.
<code>sizeof(S)</code> is greater than <code>sizeof(int)</code>.
A memory block of size <code>sizeof(S)</code> is assigned to <code>&d</code>.

<pre>#include <string.h>
typedef struct {
    char a;
    int b;
 } S;

void func(int);

void main() {
  S s;
  int d;
  memcpy(&d, &s, sizeof(S));
}</pre></td></tr>
</table>

<table>
<tr><th>Specification</th><th>Example</th></tr>
<tr><td>

Polyspace does not check if the memory that `sourcePtr` points to is itself initialized.

</td><td>

In the following code, Polyspace does not produce a red **Non-initialized local variable** error when the `memcpy` function copies `s` to `d`.

```
#include <string.h>
typedef struct {
    char a;
    int b;
 } S;

void func(int);

void main() {
  S s, d;
  memcpy(&d, &s, sizeof(S));
  func(d.b);
}
```

</td></tr>
<tr><td>

Following the use of `memcpy`, Polyspace considers that the variables that `destinationPtr` points to can have any value allowed by their type.

</td><td>

In the following code, Polyspace considers that the fields of `d` can have any value allowed by their type. For instance, `d.b` can have any value in the range allowed for an `int` variable.

```
#include <string.h>
typedef struct {
    char a;
    int b;
 } S;

void func(int);

void main() {
  S s, d={'a',1};
  int val;
  val = d.b; // val=1

  memcpy(&d, &s, sizeof(S));
  val = d.b;
  // val can have any int value
}
```

</td></tr>
</table>

Polyspace Specifications for memset

Syntax:

```
#include <string.h>
void * memset ( void * ptr, int value, size_t num );
```

If your code uses the memset function, see the information in this table.

<table>
<tr><th>Specification</th><th>Example</th></tr>
<tr><td>Polyspace runs a Invalid use of standard library routine check on the function. The check determines if the memory block that ptr points to is greater than or equal in size to the memory assigned to them through num.</td><td>In the following code, Polyspace produces a red Invalid use of standard library routine error because:
• val is an int variable.
• sizeof(S) is greater than sizeof(int).
• A memory block of size sizeof(S) is assigned to &val.
<pre>#include <string.h>
typedef struct {
    char a;
    int b;
} S;

void main() {
 int val;
 memset(&val,0,sizeof(S));
}</pre></td></tr>
<tr><td>If value is 0, following the use of memset, Polyspace considers that the variables that ptr points to have the value 0.</td><td>In the following code, Polyspace considers that following the use of memset, each field of s has value 0.
<pre>#include <string.h>
typedef struct {
    char a;
    int b;
} S;

void main() {
 S s;</pre></td></tr>
</table>

<table>
<tr><th>Specification</th><th>Example</th></tr>
<tr><td></td><td><pre> int val;
 memset(&s,0,sizeof(S));
 val=s.b; //val=0
}</pre></td></tr>
<tr><td>If <code>value</code> is anything other than 0, following the use of <code>memset</code>, Polyspace considers that:

The variables that <code>ptr</code> points to can be non-initialized.
If initialized, the variables can have any value allowed by their type.
</td><td>In the following code, Polyspace considers that following the use of <code>memset</code>, each field of <code>s</code> has any value allowed by its type. For instance, <code>s.b</code> can have any value in the range allowed for an <code>int</code> variable.
<pre>#include <string.h>
typedef struct {
    char a;
    int b;
} S;

void main() {
 S s;
 int val;
 memset(&s,1,sizeof(S));
 val=s.b;
 // val can have any int value
}</pre></td></tr>
</table>

8

Running a Verification

Types of Verification

You can run a local or remote verification. You can specify the type of verification on the **Configuration** pane.

<table>
<tr><th>Verification type</th><th>How to specify verification</th><th>Use when</th></tr>
<tr><td rowspan="2">Remote</td><td>1 Select Distributed Computing.
2 Select Batch.</td><td>You want to run verification on a dedicated remote server. Possible reasons:
• You want to free execution time on your local machine.
• You want to shut down your local machine but not interrupt the verification.</td></tr>
<tr><td>1 Select Distributed Computing.
2 Select Add to results repository.</td><td>You want to generate metrics for your project. Through these metrics, you can:
• Monitor evolution of run-time errors over multiple verifications.
• Monitor evolution of code metrics over multiple verifications.</td></tr>
<tr><td>Local</td><td>1 Select Distributed Computing.
2 Clear Batch.</td><td>You want to run verification on your local machine.</td></tr>
</table>

Select Analysis Options Configuration

Each module in the Project Browser can contain multiple configurations, with each configuration specifying a set of analysis options. This allows you to verify the same source files multiple times using different analysis options for each verification.

If you have created multiple configurations, you must choose a configuration before starting a verification.

To specify the configuration for a verification:

1. In the **Project Browser**, select the module you want to run.
2. In the **Configuration** folder of the module, right-click the configuration that you want to use. Select **Set as Default**.

   When you start the verification, the software uses the analysis options from this configuration.

For more information, see "Specify Analysis Options".

Check for Compilation Problems

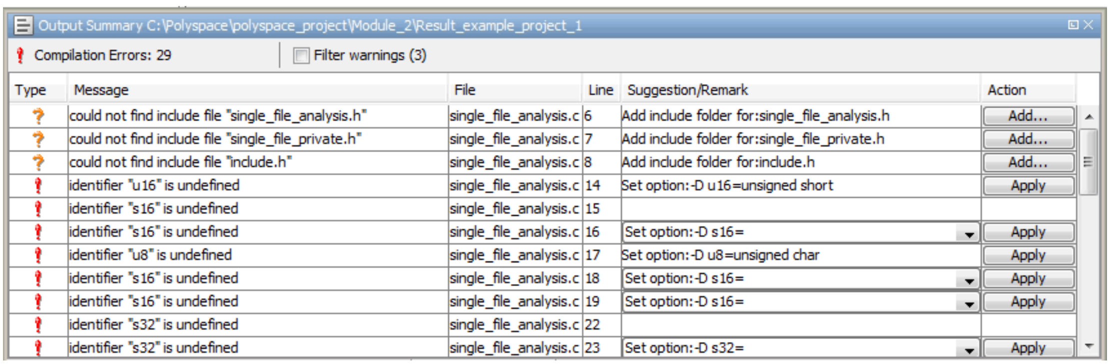
During a verification, if the Compilation Assistant detects compilation errors, the verification stops and the software displays errors and possible solutions on the **Output Summary**.

To check your project for compilation problems:

1. Select **Tools** > **Preferences**.
2. In the Polyspace Preferences dialog box, click the **Project and Results Folder** tab.
3. Select **Use Compilation Assistant**.
4. On the Project Manager toolbar, click 

.

   The software compiles your code and checks for errors, and reports the results on the **Output Summary** tab.
5. Select a **Suggestion/Remark** cell to see a list of possible solutions for the problem.



In this example, you can either add the missing include files, or set options to compile the code without the missing include files:

- Select **Apply** to set the selected option for your project. The software automatically sets the option.
- Select **Add** to add suggested include folders to your project. The Add Source Files and Include Folders dialog box opens, allowing you to add additional include folders.

When you have addressed compilation problems, run the verification again.

The Compilation Assistant is automatically disabled if you specify one of the following options:

- `-unit-by-unit`
- `-post-preprocessing-command`

Start Local Verification

To start a verification on your local computer:

1. In the Project Manager perspective, from the **Project Browser** view, select the module you want to verify.
2. On the **Configuration** pane, select **Distributed Computing**.
3. By default, **Batch** is not selected. However, if this check box is selected, you must clear the check box.
4. On the Project Manager toolbar, click 

.

You can monitor the progress of the verification through the **Output Summary** and **Full Log** tabs. See "Monitor Progress of Verification" on page 8-18.

Start Remote Verification

Before you run a remote verification, you must set up a server for this purpose. For more information, see “Set Up Remote Verification and Analysis”.

To start a remote verification:

1. In the Project Manager perspective, on the **Project Browser** pane, select the module you want to verify.
2. On the **Configuration** pane, select **Distributed Computing**.
3. Select **Batch**. The software runs the verification on your computer cluster.
4. On the Project Manager toolbar, click 

.

   On the local host computer, the Polyspace Code Prover software performs code compilation and coding rule checking . Then the Parallel Computing Toolbox™ software submits the verification to the MATLAB job scheduler (MJS) on the head node of the MATLAB Distributed Computing Server™ cluster. For more information, see “Phases of Verification” on page 8-9.

Note: If you see the message `Verification process failed`, click **OK**. For more information on errors related to remote verification, see “Polyspace Cannot Find the Server”.

By default, the software also selects **Add to results repository**, which enables the generation of Polyspace Metrics. If you clear this check box, the software does not generate Polyspace Metrics but downloads results automatically after the verification is complete.

To monitor progress and manage the verification, see “Manage Remote Verifications” on page 8-17.

Stop Verification

In this section...

Stop Remote Verification

1 Select **Tools** > **Open Job Monitor**.
2 In the Polyspace Job Monitor, right-click your verification. From the context menu, select **Remove From Queue**.

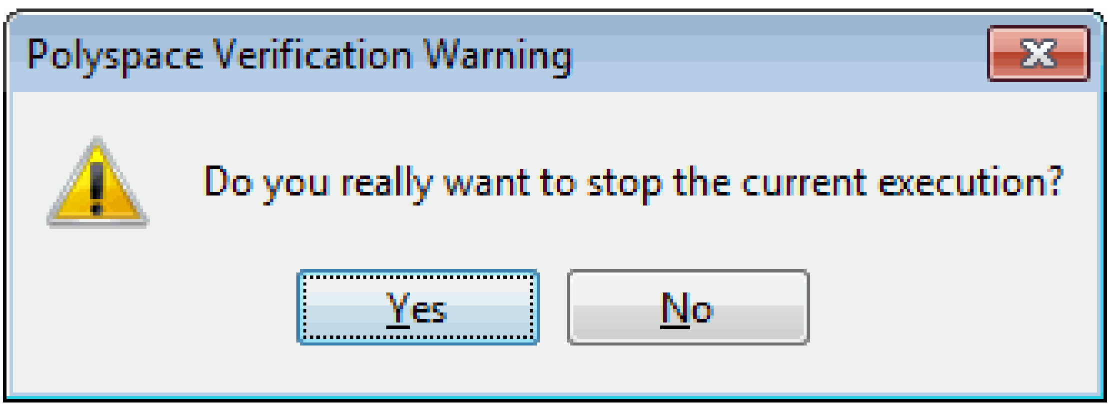
For more information, see "Manage Previous Verifications With Polyspace Metrics".

Stop Local Verification

To stop a local verification:

1 On the Project Manager toolbar, click the **Stop** button.

   A warning dialog box opens.



2 Click **Yes**. The verification stops, and results are incomplete. If you start another verification, the verification starts from the beginning.

Phases of Verification

A verification has three main phases:

1. Checking syntax and semantics (the compile phase). Because Polyspace software is compiler-independent, it helps you to produce code that is portable, maintainable, and compliant with ANSI standards.
2. Generating a main if the Polyspace software does not find a main and you have selected the **Verify module** option. For more information about generating a main, see:
   - "Verify module (C)" — C verification
   - "Verify module (C++)" — C++ verification
3. Analyzing the code for run-time errors and generating color-coded results.

Run File-by-File Verification

This example shows how to verify each file independently of other files in the module. You can run a file-by-file verification in one of the following ways:

- You can run the verification in batch mode on a server. When you run a verification in batch mode, your verification is queued on the server after it is past the **Compile** phase.
- You can run the verification directly without queuing it on a server.

This example shows how to run file-by-file verification directly without queuing it on a server.

1. On the **Configuration** pane, specify that each file must be verified independently of other files.

   a. Select the **Code Prover Verification** node.

   b. Select **Verify files independently**.

   c. For **Common source files**, enter files that you want to include with verification of each file. Enter the full path to a file. Enter one file path per row.

      For example, if multiple files use a function, you must include the file containing the function definition as a common source file. Otherwise, Polyspace stubs the undefined functions leading to more orange checks.

2. On the Project Manager toolbar, click **Run**.

   On the **Output Summary** pane, you can see that after the **Compile** phase, each file is verified independently.

3. After verification, open your results. For more information, see "Open Results of File-by-File Verification".

See Also

"Verify files independently (C/C++)" | "Common source files (C/C++)"

Related Examples

- "Run File-by-File Batch Verification"
- "Open Results of File-by-File Batch Verification"

Run File-by-File Batch Verification

This example shows how to verify each file independently of other files in the module. You can run a file-by-file verification in one of the following ways:

- You can run the verification in batch mode on a server. When you run a verification in batch mode, your verification is queued on the server after it is past the **Compile** phase.
- You can run the verification directly without queuing it on a server.

This example shows how to run file-by-file verification in batch mode.

1. Set up batch verification. As the server, you can use either your local computer or a remote computer. If you use your local computer as a server, you cannot exit the Polyspace user interface till the verification is over.

   - To set up remote batch verification, see “Configure Polyspace Preferences”.
   - To set up local batch verification, select **Tools** > **Preferences**. On the **Server Configuration** tab, for **Job scheduler host name**, enter `local`.

2. On the **Configuration** pane, specify batch verification.

   a. Select the **Distributed Computing** node.

   b. Select **Batch**.

   c. Select **Add to results repository**.

      After verification, your results are uploaded to Polyspace Metrics. Once the results are uploaded, you can download the results from Polyspace Metrics to another computer.

3. On the **Configuration** pane, specify that each file must be verified independently of other files.

   a. Select the **Code Prover Verification** node.

   b. Select **Verify files independently**.

   c. For **Common source files**, enter files that you want to include with verification of each file. Enter the full path to a file. Enter one file path per row.

      For example, if multiple files use a function, you must include the file containing the function definition as a common source file. Otherwise, Polyspace stubs the undefined functions leading to more orange checks.

4. On the Project Manager toolbar, click **Run**.

   - If you are running remote batch verification, the Parallel Computing Toolbox software submits the verification units as separate jobs to your scheduler. The scheduler is on the head node of the MATLAB Distributed Computing Server cluster.
   - If you are running local batch verification, the Parallel Computing Toolbox software stores the verification units as separate jobs on your local computer.

   After the **Compile** phase, you can view the jobs in the Polyspace Job Monitor.
5. Select **Tools** > **Open Job Monitor**.

   Your files appear as child nodes under the main verification node.
6. After verification, open your results. For more information, see “Open Results of File-by-File Batch Verification”.

See Also

“Batch (C/C++)” | “Verify files independently (C/C++)” | “Common source files (C/C++)”

Related Examples

- “Run File-by-File Verification”
- “Open Results of File-by-File Verification”

Verify All Modules in Project

You can have many modules within a project, each module containing a set of source files and an active configuration.

To verify all modules in a project:

1. In the Project Manager perspective, on the **Project Browser** pane, select the project for which you want to run verifications.
2. Select **Run** > **Run All Modules**.

   The software verifies each module as an individual job. For information on the verification process, see "Phases of Verification" on page 8-9.

Note: If the verification fails, go to "Troubleshooting in Polyspace Code Prover".

Manage Previous Verifications With Polyspace Metrics

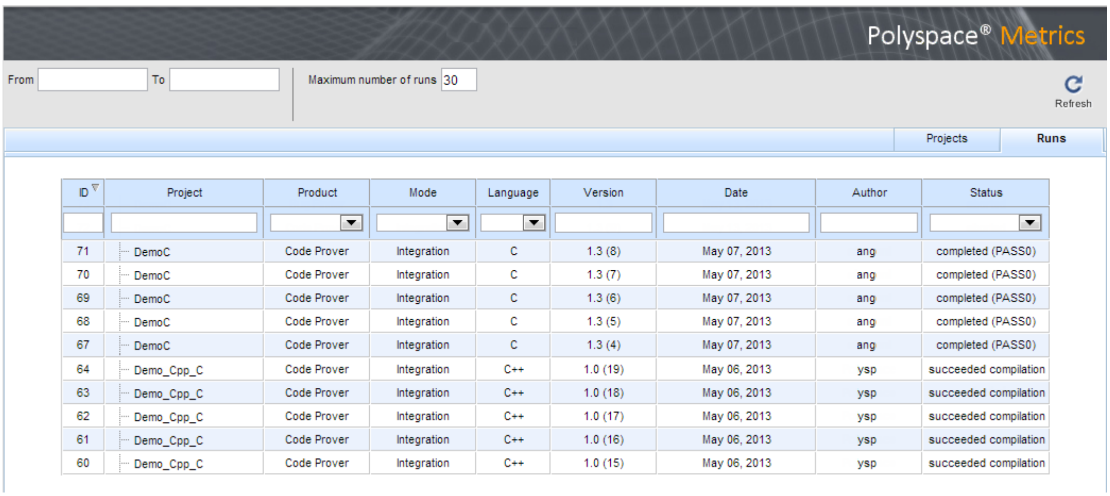
Use the **Runs** view of Polyspace Metrics to administer previous remote verifications. For example, you can:

- Delete verification results from the results repository.
- Set or change the password for projects.

To open the **Runs** view of Polyspace Metrics, in the address bar of your Web browser, enter the following URL:

protocol://*ServerName*:*PortNumber*

- *protocol* is either http (default) or https.
- *ServerName* is the name or IP address of your Polyspace Metrics server.
- *PortNumber* is the Web server port number (default 8080).



ID	Project	Product	Mode	Language	Version	Date	Author	Status
71	DemoC	Code Prover	Integration	C	1.3 (8)	May 07, 2013	ang	completed (PASS0)
70	DemoC	Code Prover	Integration	C	1.3 (7)	May 07, 2013	ang	completed (PASS0)
69	DemoC	Code Prover	Integration	C	1.3 (6)	May 07, 2013	ang	completed (PASS0)
68	DemoC	Code Prover	Integration	C	1.3 (5)	May 07, 2013	ang	completed (PASS0)
67	DemoC	Code Prover	Integration	C	1.3 (4)	May 07, 2013	ang	completed (PASS0)
64	Demo_Cpp_C	Code Prover	Integration	C++	1.0 (19)	May 06, 2013	ysp	succeeded compilation
63	Demo_Cpp_C	Code Prover	Integration	C++	1.0 (18)	May 06, 2013	ysp	succeeded compilation
62	Demo_Cpp_C	Code Prover	Integration	C++	1.0 (17)	May 06, 2013	ysp	succeeded compilation
61	Demo_Cpp_C	Code Prover	Integration	C++	1.0 (16)	May 06, 2013	ysp	succeeded compilation
60	Demo_Cpp_C	Code Prover	Integration	C++	1.0 (15)	May 06, 2013	ysp	succeeded compilation

To perform a task:

1. Right-click your verification.
2. From the context menu, select your task.

The following table describes the tasks that you can perform.

Task	Details
Rename	Available only for **Project** and **Version**. When you select this menu item, the text becomes editable. Enter your new project name or version number. Then press **Return**.
Delete Run from Repository	Remove verification from Polyspace Metrics results repository.
Go to Metrics Page	Open the Polyspace Metrics **Summary** view of the verification.
Change/Set Password	Control access to the metrics for the project by specifying a password. See "Protect Access to Project Metrics".

In the **Runs** view, you can use Polyspace Metrics controls to specify the list of verifications displayed.

Control	Details
From	If you click the field, the software displays a calendar. Use this calendar to select the start date for your list.
To	If you click the field, the software displays a calendar. Use this calendar to select the end date of for your list.
Maximum number of runs	Specify the maximum number of verifications that you want to display. The default is 30.
ID	If you enter a numeric string in the field, the software displays verifications with IDs that contain this string.
Project	If you enter a string in the field, the software displays verifications with project names that contain this string.
Product	Polyspace Metrics displays results from Polyspace Bug Finder analyses and Polyspace Code Prover verifications. To display only verifications, from the drop-down list, select `Code Prover`.

Control	Details
Mode	Use the drop-down list to select verifications that are either `Integration` or `Unit By Unit`. By default, both verification types are displayed.
Language	Use the drop-down list to select language type. By default, verifications for all language types are displayed.
Version	If you enter a string in the field, the software displays verifications with version numbers that contain this string.
Date	If you enter a string in the field, the software displays verifications with dates that contain this string.
Author	If you enter a string in the field, the software displays verifications with author names that contain this string.
Status	Use the drop-down list to select verifications with a specific status, for example, `completed (PASS4)`.

Manage Remote Verifications

You can manage your verification through the Polyspace Job Monitor:

1. Select **Tools** > **Open Job Monitor**.
2. In the Polyspace Job Monitor, right-click your verification.
3. From the context menu, select your management task:

   - **View Log File** — Open the verification log.
   - **Download Results** — Download verification results from remote computer if the verification is complete.
   - **Remove From Queue** — Remove verification from the submission queue.

Monitor Progress of Verification

To monitor the progress of a remote verification, open the verification log:

1. Select **Tools** > **Open Job Monitor**.
2. In the Polyspace Job Monitor, right-click your verification.
3. From the context menu, select **View Log File**.

To monitor the progress of a local verification, use the following tabs in the Project Manager perspective of Polyspace Code Prover:

- **Output Summary** — Displays progress of verification, compile phase messages and errors. To search for a term, in the **Search** field, enter the required term. Click the up or down arrow to move sequentially through occurrences of the term.
- **Full Log** — This tab displays messages, errors, and statistics for all phases of the verification. To search for a term, in the **Search** field, enter the required term. Click the up arrow or down arrow to move sequentially through occurrences of this term.

At the end of a local verification, the **Dashboard** tab displays statistics, for example, code coverage and check distribution.

Run Verification from Command Line

Use the following command to run a local verification:

```
MATLAB_Install\polyspace\bin\polyspace-code-prover-nodesktop [options]
```

Use the following command to run a remote verification:

```
MATLAB_Install\polyspace\bin\polyspace-code-prover-nodesktop
-batch -scheduler NodeHost | MJSName@NodeHost [options]
```

- *MATLAB_Install* is your MATLAB installation folder, for example:

  `C:\Program Files\MATLAB\R2013b`
- *NodeHost* is the name of the computer that hosts the head node of your MDCS cluster.
- *MJSName* is the name of the MATLAB Job Scheduler (MJS) on the head node host.

Note: Before you run a remote verification, you must set up a server for this purpose. For more information, see “Set Up Remote Verification and Analysis”.

You can also run verifications from the MATLAB Command Window using the `polyspaceCodeProver` command. For information about this command, in the MATLAB Command Window, enter:

```
polyspaceCodeProver('-help');
```

Manage Remote Analyses at the Command Line

To manage remote analyses, use this command:

```
MATLAB_Install\polyspace\bin\polyspace-jobs-manager action [options]
         [-scheduler schedulerOption]
```

MATLAB_Install is your MATLAB installation folder, for example:

```
C:\Program Files\MATLAB\R2014a
```

`schedulerOption` is one of the following:

- Name of the computer that hosts the head node of your MDCS cluster (*NodeHost*).
- Name of the MJS on the head node host (*MJSName@NodeHost*).
- Name of a MATLAB cluster profile (*ClusterProfile*).

  For more information about clusters, see "Clusters and Cluster Profiles"

If you do not specify a job scheduler, `polyspace-job-manager` uses the scheduler specified in the **Polyspace Preferences** > **Server Configuration** > **Job scheduler host name**.

The following table lists the possible action commands to manage jobs on the scheduler.

Action	Options	Task
`listjobs`	None	Generate a list of Polyspace jobs on the scheduler. For each job, the software produces the following information: • `ID` — Verification or analysis identifier. • `AUTHOR` — Name of user that submitted job. • `APPLICATION` — Name of Polyspace product, for example, Polyspace Code Prover or Polyspace Bug Finder. • `LOCAL_RESULTS_DIR` — Results folder on local computer, specified through the **Tools** > **Preferences** > **Server Configuration** tab. • `WORKER` — Local computer from which job was submitted.

Action	Options	Task
		• `STATUS` — Status of job, for example, `running` and `completed`. • `DATE` — Date on which job was submitted. • `LANG` — Language of submitted source code.
`download`	`-job` *`ID`* `-results-folder` *`FolderPath`*	Download results of analysis with specified ID to folder specified by *`FolderPath`*.
`getlog`	`-job` *`ID`*	Open log for job with specified ID.
`remove`	`-job` *`ID`*	Remove job with specified ID.

Modularization of Large Applications

The source code within your project may represent a single application. In this case, you might want to analyze all of the code together. However, if the application is extremely large, the verification might take a long time, for example, days.

For a large application, Polyspace allows you to:

- Partition the application into modules that individually require less time to verify — see “Partition Application into Modules” on page 8-23 and “Partition Application Using Batch Command” on page 8-27.
- Specify the number of modules in a trade-off between verification speed and precision — see “Choose Number of Modules for Application” on page 8-25.

Polyspace Model Link products do not support modularization of applications.

You can carry out faster analysis with a larger number of small modules. However, with more modules, greater cross-module referencing is required during verification, which results in a loss of precision.

Note: During partitioning, the software automatically minimizes cross-module references.

Partition Application into Modules

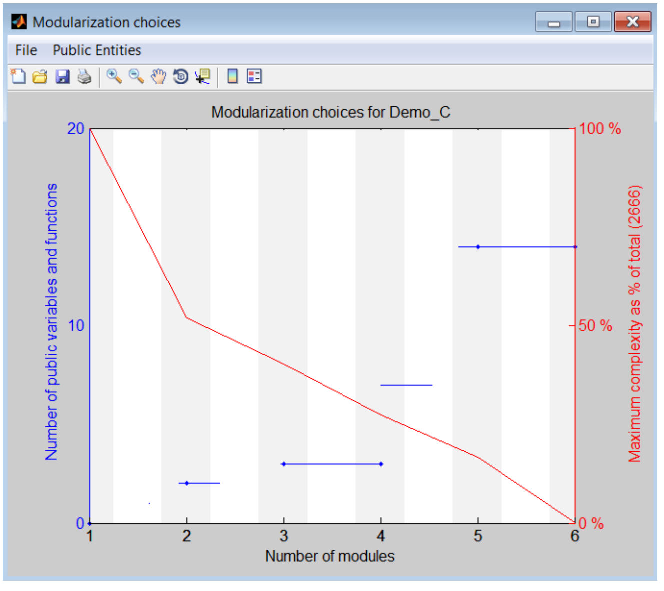
To partition your application into modules:

1 Run an initial verification, which performs a limited analysis but processes all the files of your application. For example, run a verification with the following **Precision** pane settings:

- **Precision level** — `0`
- **Verification level** — `Software Safety Analysis level 0`

2 In the Project Browser view, select the results folder.

3 From the Project Manager toolbar, select **Tools** > **Run Modularize**. The software analyzes your application code and displays two plots in a new Modularization choices window.



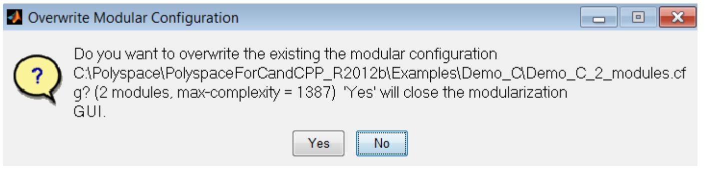
The plots show the following information:

- Red — Maximum complexity of a module versus number of modules, which is expressed as a percentage of the total complexity of the application.

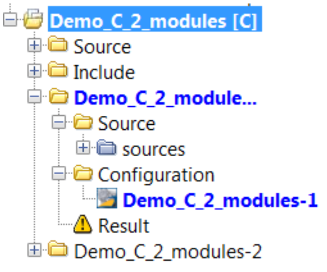
- Blue — Number of public variables and functions when modules are limited by a given complexity.

4 From the plots, identify the number of modules into which your application must be partitioned. See “Choose Number of Modules for Application” on page 8-25. In this example, a suitable number is 2 or 4.

5 Click the vertical gray region associated with the number of modules that you choose, for example, 2. A dialog box opens.



6 Click **Yes**. The software generates a new project with two modules containing the partitioned code.



You can now verify each module separately — with the precision and verification levels that you require. The configuration (`.psprj`) file for each module specifies the default values:

- **Precision level** — 2
- **Verification level** — `Software Safety Analysis level 4`

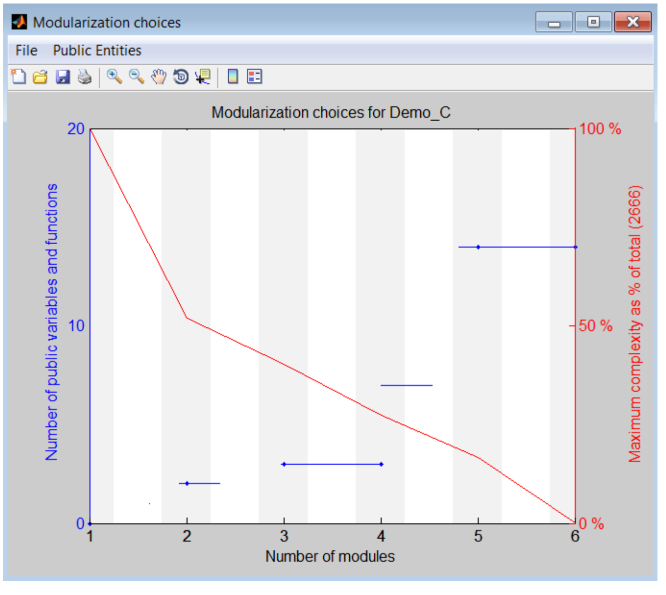
You can change these values through the **Configuration** > **Precision** pane.

Choose Number of Modules for Application

Use the Modularizing choices window to select the number of partitioned modules. The number of partitioned modules that you choose involves a trade-off between the following:

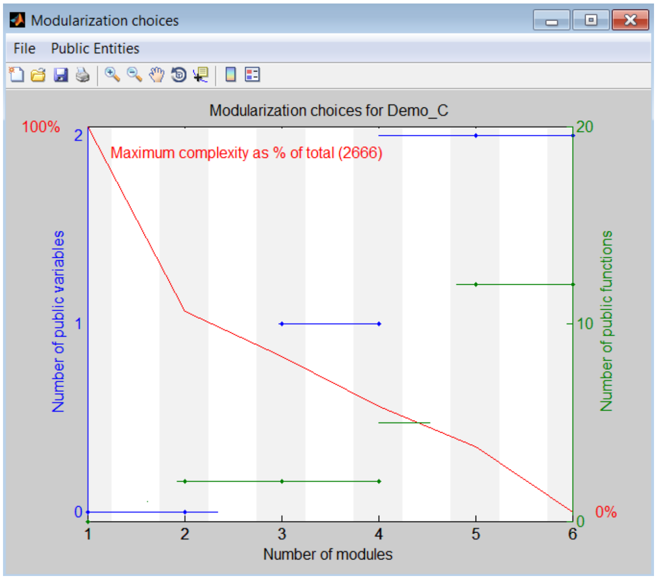
- Time — The smaller the maximum complexity, the shorter the time required for verification. This time saving is even greater if the different modules are verified in parallel.
- Precision — The smaller the number of public variables and functions, the greater the precision of the verification.

Select a number just after a big drop in maximum complexity and before a big increase in the number of public functions and variables. In the following example, you must click the gray region associated with either 2 (just after a big drop in maximum complexity) or 4 (before a big increase in public functions and variables).



The precision of a modular verification can be very sensitive to the number of public variables. If the series of horizontal blue lines ascends so gradually that there is no clear number choice, then:

1 On the toolbar, select **Public Entities** > **Separate functions and variables**. The software displays the number of public variables and functions separately.



2 Select a point just before a big jump in the number of public variables. In this example, you must click the gray region associated with 2.

Partition Application Using Batch Command

In this section...

Basic Options

You can partition an application into modules using the following batch command:

`polyspace-modularize [`*`target_folder`*`] {`*`options`*`}`

This table describes the basic options that you can use.

Option	Description
`target_folder`	Folder that contains the results of the initial run that processes source files. Default is the folder from which you run `polyspace-modularize`.
`-o` *`output_folder`*	Output folder for partitioned application. Default is the folder from which you run `polyspace-modularize`.
`-gui` *`max_n`*	The Polyspace verification environment displays the Modularizing choices window with a predefined limit for the maximum number of modules that you can select. Use this option to specify a new limit *`max_n`*.
`-matlab` *`max_n`*	If data cache for Modularizing choices window does not exist, create cache *`project_name_max_n`*`.m`. Cache enables faster display of Modularizing choices window. *`project_name`* is the value used by `-prog` option. *`max_n`* is the limit for the maximum number of modules that you can select. No action if cache already exists.

Option	Description
`-modules` *n*	Partition application into *n* modules. Identical to clicking the gray region associated with *n* in the Modularizing choices window.
`-max-complexity` *max_c*	Partitions application into modules with reference to specified maximum complexity *max_c*. The complexity of a function is a number that is related to the size of the function. The complexity of a module is the sum of the complexities of the functions in the module. When partitioning your application, the software minimizes the use of cross-module references to functions and variables, subject to the constraint that the complexity of a module does not exceed *max_c*. If you make *max_c* sufficiently large, the software generates only one module, which is identical to the original, unpartitioned application.

Constrain Module Complexity During Partitioning

Each Polyspace verification produces two "module dependence graph" files in *target_folder*/`ALL/`:

- *project_name*`.mdg` — Created early in verification, even for very large applications.
- *project_name*`_IL.mdg` — Similar to *project_name*`.mdg`, but based on alias analysis and generated later in verification.

You can partition your application provided an earlier verification has generated the following files in *target_folder*:

- `ALL/`*project_name*`.mdg`
- `ALL/ SRC/_original.txt`
- `options`
- `sources_list.txt`

By default, the software uses *project_name*`.mdg` when partitioning an application. However, in some cases, using *project_name*`_IL.mdg` might generate more precise results. To specify *project_name*`_IL.mdg`, run the following command:

```
polyspace-modularize –IL
```

Note: The `-IL` option does not support C++.

If you specify the `-IL` option, then the software computes modules applying the constraint that the complexity of a function is always 1. In addition, using the options:

- `-gui n` and `-matlab n` generates a file named *`project_name`*`_IL_n.m`.
- `-max-complexity` *`max_c`* generates a file named *`project_name_n`*`_modules-IL.psprj`.

  `n` is the number of modules. The results folder for the *`i`*th module is *`project_name_n`*`_modules-IL-`*`i`*.

To force all functions to have a complexity of 1 without specifying the `-IL` option, run the following command:

```
polyspace-modularize -uniform-complexities
```

Control Naming of Result Folders

You can control the naming of result folders in the *`i`*th module using the `-stem` option:

```
polyspace-modularize -stem stem_format
```

`stem_format` is a string. The `#` and `@` characters in the string are processed as follows:

- `#` — Replaced by the number of modules in the partitioning.
- `@` — Replaced by the argument of `-max-complexity`.

If you do not specify `-stem`, then the default string *`stem_format`* has the form *`project_nameCCkk_modules`*:

- *`CC`* is `_IL_` when you use `-IL`, but `_` otherwise.
- *`kk`* is `@` when you use `-max-complexity` or `#` when you use the Polyspace verification environment.

For example, if you want a specific name, `MyName`, which overrides the project name and does not incorporate the module number, then run:

```
polyspace-modularize -stem  MyName
```

Forbid Cycles in Module Dependence Graph

By default, the software allows the module dependence graph to have cycles. However, in some cases, you might get better results with acyclic graphs. Use the following command:

```
polyspace-modularize -forbid-cycles
```

9

Troubleshooting Verification Problems

View Error Information When Verification Stops

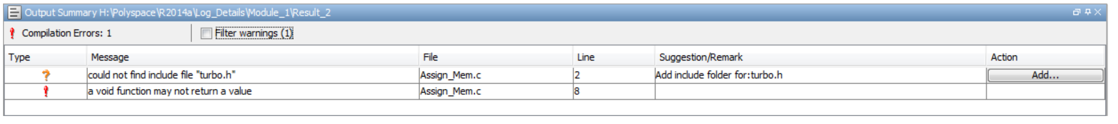
If verification stops, you can view error information in the Project Manager interface or in the log file.

In this section...

View Error Information in Project Manager

1. View the errors on the **Output Summary** tab.
2. If you have the **Compilation Assistant** on, to fix the error, you can perform certain actions on the **Output Summary** tab.

   The following figure shows an error due to a missing include file `turbo.h`. You can add the missing file through the **Output Summary** tab.

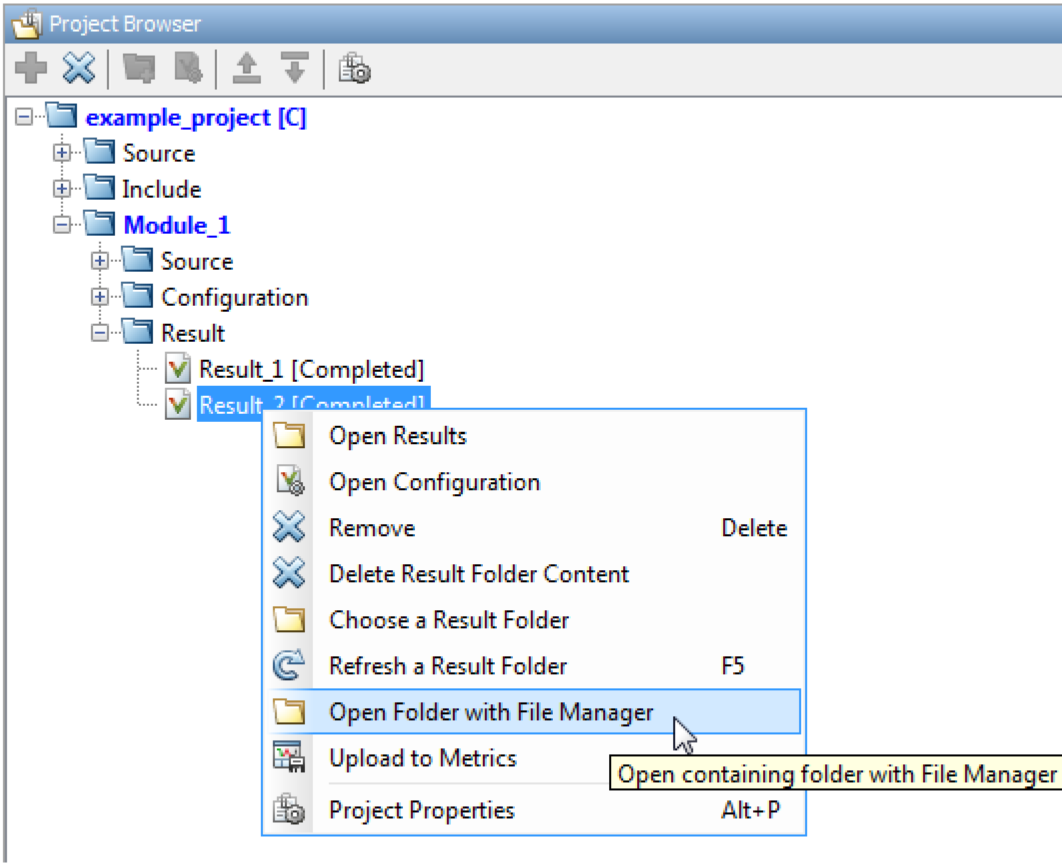
3. To open the source code at the line containing the error, double-click the message.
4. For more information, right-click the message. From the context menu, select **Open Preprocessed File**.

   The `.ci` file opens. The Polyspace software uses this file to compile the source file. The file contents can help you understand the compilation error.
5. To search the log, enter search terms in the **Search** box.

View Error Information in Log File

You can view errors directly in the log file. The log file is in *`Results_folder`*.

1. To open the `Results` folder in your file browser, right-click the result folder name on the **Project Browser** pane. From the context menu, select **Open Folder with Files Manager**.



2 To view the errors, scroll through the verification log file, starting at the end and working back.

The following example shows sample log file information. The error has occurred because the C++ option `-class-analyzer` *`arg`* was used, but the verification cannot find *`arg`* in the source code.

```
----------------------------------------------------------------------
User Program Error: Argument of option -class-analyzer not found.
|                   Class or typedef MyClass does not exist.
|Please correct the program and restart the verifier.
----------------------------------------------------------------------
```

```
-------------------------------------------------------------------
---                                                             ---
---  Verifier has encountered an internal error.                ---
---  Please contact your technical support.                     ---
---                                                             ---
-------------------------------------------------------------------
Failure at: Sep 24, 2009 17:16:26
User time for polyspace-code-prover-nodesktop: 25.6real, 25.6u + 0s
                                                            (0gc)
Error: Exiting because of previous error
***
*** End of Polyspace Verifier analysis
***
```

Troubleshoot Compiler and Linking Errors

When you obtain an error message related to compilation or linking, try:

- Checking whether the error message is related to the dialect that you specified. To specify a different dialect:

  - In the user interface, choose a dialect on the **Configuration** pane. In the **Configuration** tree view, select **Target & Compiler**. From the **Dialect** drop-down list, select an option.
  - At the command line, use the `-dialect` option.

  For more information, see "Dialect (C)".
- Checking whether the error message is related to stubbing of standard library functions. To avoid this stubbing by Polyspace implementations:

  - For `C`: Use option `-D POLYSPACE_NO_STANDARD_STUBS` or `-D POLYSPACE_STRICT_ANSI_STANDARD_STUBS`.
  - For `C++`: Use option `-no-stl-stubs`.

  For more information, see "Prepare Code for Built-In Functions".
- Checking the preprocessed files with extension `.ci` to view:

  - Expanded headers.
  - Expanded macros.
  - Active branch of `#ifdef` conditional statement.

  For more information, see "Troubleshoot Using Preprocessed Files".

Obtain System Information for Technical Support

When you enter a support request, you must provide your system information.

In this section...

Information Required

- Hardware configuration
- Operating system
- Polyspace and MATLAB licenses
- Specific version numbers for Polyspace products
- Installed Bug Report patches

How to Obtain Required Information

To obtain your configuration information, either:

- In the Polyspace user interface, select **Help** > **About**.
- At the command line, run the following command:
  - UNIX — `MATLAB_Install/polyspace/bin/polyspace-code-prover-nodesktop -ver`
  - DOS — `MATLAB_Install\polyspace\bin\polyspace-code-prover-nodesktop -ver`

Header File Location Not Specified

Message

```
include.h: No such file or folder
```

Possible Cause

- You did not specify include folders.
- You specified include folders, but a header file is missing from the specified folders.

Solution

Do one of the following:

- Add the missing header file to the specified include folder.
- Specify another include folder that contains the missing file.

For more information, see “Add Source Files and Include Folders”.

Polyspace Cannot Find the Server

Message

```
Error: Cannot instantiate Polyspace cluster
| Check the -scheduler option validity or your default cluster profile
| Could not contact an MJS lookup service using the host computer_name.
    The hostname, computer_name, could not be resolved.
```

Possible Cause

Polyspace uses information provided in **Preferences** to locate the server. If this information is incorrect, the software cannot locate the server.

Solution

Provide correct server information.

1. Select **Tools** > **Preferences**.
2. Select the **Server Configuration** tab. Provide your server information.

For more information, see "Set Up Remote Verification and Analysis".

Errors From Disk Defragmentation and Antivirus Software

Message

```
Some stats on aliases use:
  Number of alias writes:      22968
  Number of must-alias writes: 3090
  Number of alias reads:       0
  Number of invisibles:        949
Stats about alias writes:
  biggest sets of alias writes: foo1:a (733), foo2:x (728), foo1:b (728)
  procedures that write the biggest sets of aliases: foo1 (2679), foo2 (2266),
                                                     foo3 (1288)
**** C to intermediate language translation - 17 (P_PT) took 44real, 44u + 0s (1.4gc)
exception SysErr(OS.SysErr(name="Directory not empty", syserror=notempty)) raised.
unhandled exception: SysErr: No such file or directory [noent]


-------------------------------------------------------------------------
---                                                                   ---
---  Verifier has encountered an internal error.      ---
---  Please contact your technical support.          ---
---                                                                   ---
---------------------------------------------------------------------------
```

Possible Cause

A disk defragmentation tool or antivirus software is running on your machine.

Solution

Try:

- Stopping the disk defragmentation tool.
- Deactivating the antivirus software. Or, configuring exception rules for the antivirus software to allow Polyspace to run without a failure.

Note: Even if the verification does not fail, the antivirus software can reduce the speed of your verification. This reduction occurs because the software checks the temporary verification files. Configure the antivirus software to exclude your temporary folder, for example, `C:\Temp`, from the checking process.

Insufficient Memory During Report Generation

Message

```
....
Exporting views...
Initializing...
Polyspace Report Generator
Generating Report
 .....
    Converting report
Opening log file:  C:\Users\auser\AppData\Local\Temp\java.log.7512
Document conversion failed
.....
Java exception occurred:
java.lang.OutOfMemoryError: Java heap space
```

Possible Cause

During generation of very large reports, the software can sometimes indicate that there is insufficient memory.

Solution

If this error occurs, try increasing the Java® heap size. The default heap size in a 64-bit architecture is 1024 MB.

To increase the size:

1. Navigate to `*MATLAB_Install*\polyspace\bin\*architecture*`. Here:
   - *`MATLAB_Install`* is the installation folder, for instance, `C:\Program Files\MATLAB\R2014a`.
   - *`architecture`* is your computer architecture, for instance, `win32`, `win64`, etc.
2. Change the default heap size that is specified in the file, `java.opts`. For example, to increase the heap size to 2 GB, replace `1024m` with `2048m`.
3. If you do not have write permission for the file, copy the file to another location. After you have made your changes, copy the file back to *`MATLAB_Install`*`\polyspace\bin\`*`architecture`*`\`.

Compilation Error Overview

You can use Polyspace software instead of your compiler to make syntactical, semantic, and other static checks. The Polyspace compiler follows the ANSI C90 standard.

Polyspace detects compilation errors during the standard compliance checking stage, which takes place before the verification stage. The compliance checking stage takes about the same amount of time to run as a compiler. Using Polyspace software early in development yields a number of benefits:

- Detection of link errors
- Detection of errors that only appear with two or more files
- Detection of compiler directives that you need to explicitly declare
- Objective, automatic, and early control of development work (possibly to check code into a configuration management system)

Running Multiple Polyspace Processes

Polyspace Code Prover can be opened simultaneously with Polyspace Bug Finder. However, only one code analysis can be run at a time.

If you try to run multiple Polyspace processes, you will get a `License Error –4,0`. To avoid this error, close any additional Polyspace windows before running an analysis.

Troubleshoot Using Preprocessed Files

In this section...

Preprocessed Files

Content: The Polyspace software, like other compilers, converts source code to preprocessed code. The preprocessed files have a `.ci` extension. The preprocessed file expands preprocessor directives, including:

- Header files in `#include` statements.
- Macros defined with `#define` statements.
- Conditional compilations defined with `#if`, `#ifdef` or `#ifndef` statements.

Stage	Location of `.ci` files
Before compilation	*Results_folder*/ALL/SRC/
After compilation	In a zipped file, `ci.zip`, in *Results_folder*/ALL/SRC/MACROS/

Troubleshoot Using Preprocessed Files

To quickly find errors, view the preprocessed code when:

1. Your source code includes several header files. Check the preprocessed `*.ci` file to see the header files expanded in one code.
2. Your source code contains conditional compilations using `#if`, `#ifdef` or `#ifndef` statements. Check the preprocessed files to find which branch of the conditional statements are active.

Examples

This example shows how to use preprocessed files for troubleshooting.

View Expanded Headers and Macros

The following example uses a source file `Extension.cpp` that:

- Includes a header file `Extension.h`.
- Uses an object-like macro `MAX_VALUE` and a function-like macro `ABS(x)`.
- Uses a conditional compilation statement with the flag `_DEBUG`.

The resulting preprocessed file `Extension.ci`:

- Expands the header file `Extension.h`.
- Replaces the macros `MAX_VALUE` and `ABS(x)` with their contents.
- Replaces the conditional compilation statement based on whether you used the compile flag `_DEBUG`.

Extension.cpp	**Extension.h**	**Partial content of Extension.ci, using compile flag _DEBUG**

#include "Extension.h"
 	
Extension::Extension(int val)
{
num = 0;
ABS(val);
 	
if (val > MAX_VALUE)
num = -1;
}
 	
#ifdef _DEBUG
void Extension::message(char*)
#else
void print(char*) {}
#endif
	#define MAX_VALUE 10
	#define ABS(x) ((x)>0?(x):-(x))
	
	class Extension
	{
	public:
	int num;
	Extension(int val);
	
	#ifdef _DEBUG
	void message(char*);
	#else
	void print(char*);
	#endif
	};
		# 1 "H:\\Polyspace\\Sources
		\\PreProcessor\\Extension.cpp" 2
		# 1 "H:\\Polyspace\\Sources
		\\PreProcessor\\Extension.h" 1
		class Extension
		{
		public:
		int num;
		Extension(int val);
		void message(char*);
		};
		# 2 "H:\\Polyspace\\Sources
		\\PreProcessor\\Extension.cpp" 2
		
		Extension::Extension(int val)
		{
		num = 0;
		((val)>0?(val): -(val));
		
		if (val > 10)
		num = -1;
		}
		void Extension::message(char*) {}

Investigate Linking Error

The following example uses two source files, `Child1.cpp` and `Child2.cpp`, that include a header file `Test.h`. Running verification on the two files together causes a linking error because:

- The header file defines a class `Test` that uses a conditional compilation with a `#ifdef` statement. The `#ifdef` statement uses a variable `DEBUG`.
- `DEBUG` is defined in `child1.cpp` but not in `child2.cpp`. This mismatch causes two conflicting definitions of the class `Test`.

<table>
<tr><th>Child1.cpp</th><th>Child2.cpp</th><th>Test.h</th></tr>
<tr><td><pre>#define DEBUG

#include "Test.h"

class Child1 : public Test
{
public:
 Child1();
 Child1(int val);

 void search(int val);

};</pre></td><td><pre>#undef DEBUG

#include "Test.h"

class Child2 : public Test
{
public:
 Child2();
 Child2(int val);

 void qshort(int val);

protected:
 int m_status;
};</pre></td><td><pre>class Test
{
public:

 Test();
 Test(int val);

 int getVal();
 void setVal(int val);

#ifdef DEBUG
 void algorithm(int val,
int max);
#endif

private:
 int m_val;
};</pre></td></tr>
</table>

Error message: For the following error message, the source files are located in `H:\Polyspace\Sources\PreProcessor\`.

```
File H:\Polyspace\Sources\PreProcessor\Test.h  line 1
Error: declaration of function "Test::Test(const Test &)" does not match ...
        function "Test::algorithm" during compilation of ...
        "H:\Polyspace\Sources\PreProcessor\Child2.cpp"
        (one may have been removed due to #define)
```

Preprocessed Files: To find the conflicting definitions of the class `Test`, compare the two `.ci` files. Class `Test` in `Child1.ci` contains a method `algorithm`;`Child2.ci` does not.

<table>
<tr><th>Child1.ci</th><th>Child2.ci</th></tr>
<tr><td><pre>....

1 "../sources/Test.cpp" 2
1 "../sources/test.h" 1

class Test
{
public:
 Test();</pre></td><td><pre>....

1 "../sources/Child2.cpp" 2
1 "../sources/Child2.h" 1
1 "../sources/test.h" 1

class Test
{
public:</pre></td></tr>
</table>

<table>
<tr><th>Child1.ci</th><th>Child2.ci</th></tr>
<tr><td><pre>
 Test(int val);

 int getVal();
 void setVal(int val);

 void algorithm(int val, int max);

private:
 int m_val;
};

2 "../sources/Test.cpp" 2

....
</pre></td><td><pre>
 Test();
 Test(int val);

 int getVal();
 void setVal(int val);

private:
 int m_val;
};

2 "../sources/Child2.h" 2

....
</pre></td></tr>
</table>

Check Compilation Before Verification

Before running a verification, you can enable the Compilation Assistant. If the Compilation Assistant detects compilation errors, the software stops the verification. In the Project Manager perspective, on the **Output Summary** tab, the software displays errors and suggests possible solutions.

For more information, see “Check for Compilation Problems”.

Syntax Error

Message

```
Verifying compilation.c
compilation.c:3: syntax error; found `x' expecting `;'
```

Code Used

```
void main(void)
{
int far x;
x = 0;
x++;
}
```

Solution

The `far` keyword is unknown in ANSI C. This causes confusion at compilation time. Should `far` be a variable or a qualifier? The `int far x;` construction is illegal.

Possible corrections include:

- Remove `far` from the source code.
- Define `far` as a qualifier, such as `const` or `volatile`.
- Remove `far` artificially by specifying a compilation flag such as `-D far= ` (with a space after the equal sign).

Note: To specify `-D` compilation flags that are generic to the project, for efficiency, use the `-include` option. Refer to "Gather Compilation Options Efficiently".

Undeclared Identifier

Message

```
Verifying compilation.c
compilation.c:3: undeclared identifier `x'
```

Code Used

```
void main(void)
{
x = 0;
x++;
}
```

Solution

The type is unknown, and therefore the compilation stops. Should `x` be a `float`, an `int`, or a `char`?

Some cross compilers define variables implicitly. Your code must declare variables verification. Polyspace software has no knowledge about implicit variables.

Similarly, some compilers interpret `__SP` as a reference to the stack pointer. Use the `-D` compilation flag.

Note: To specify `-D` compilation flags that are generic to the project, for efficiency, use the `-include` option. Refer to "Gather Compilation Options Efficiently".

Missing Identifiers with Keil or IAR Dialect

Message

`expected an identifier`

Possible Cause

If you select Keil or IAR as your dialect, the software removes certain keywords during preprocessing. If you use these keywords as identifiers such as variable names, a compilation error occurs. For a list of keywords that are removed, see “Verify Keil or IAR Dialects”.

In general, if you receive the above error message despite an identifier being present in your source code, check the preprocessed file to see if the identifier is removed during preprocessing. For more information, see “Troubleshoot Using Preprocessed Files”.

Solution

To avoid removal of keywords and the compilation error, do one of the following:

- In the user interface, enter `__PST_KEIL_NO_KEYWORDS__` or `__PST_IAR_NO_KEYWORDS__` for **Preprocessor definitions**.
- At the command line, use the flag `-D __PST_KEIL_NO_KEYWORDS__` or `-D __PST_IAR_NO_KEYWORDS__`.

Unknown Prototype

Message

```
Error: function 'myfunc' has unknown prototype
```

Code Used

```
var = myfunc(s32var1, ptr->s32var2, 24);
```

`var`, `s32var` are `signed long` data types.

Solution

1. In an include file, for example, `myinclude.h`, specify the complete prototype for the function:

   ```
   #ifndef _INC_H
   #define _INC_H

   extern signed long myfunc(signed long, signed long, signed long);

   #endif
   ```

2. Rerun your verification with the option `-include myinclude.h`.

No Such File or Folder

Messages

Here are examples of messages that include `No such file or folder` and `catastrophic error: could not open source file`:

`compilation.c:1: one_file.h: No such file or folder`

`compilation.c:1: catastrophic error: could not open source file "one_file.h"` (where `one_file.h` is an include file)

Code Used

```
#include "one_file.h"
```

Solution

The `one_file.h` file is missing.

These files are essential for Polyspace software to complete the compilation, for

- Data coherency
- Automatic stubbing

The Polyspace software must be able to find the include folder that contains this file. Specify the include folder In the Project Manager perspective, or use the `-I` option at the command line, as described in the“-I” reference page.

#error Directive

The Polyspace software can terminate during compilation with an unsupported platform #error. This error means that the software does not recognize the header data types due to missing compilation flags.

Message

```
#error directive: !Unsupported platform; stopping!
```

Code Used

```
#if defined(__BORLANDC__) || defined(__VISUALC32__)
#  define MYINT int // then use the int type
#elif defined(__GNUC__) // GCC doesn't support myint
#  define MYINT long // but uses 'long' instead
#else
#  error !Unsupported platform; stopping!
#endif
```

Solution

In the Polyspace software, compilation directives must be explicit. In this example, the compilation stops because you did not specify the __BORLANDC__, or the __VISUALC32__, or the __GNUC__ compilation flags. To fix this error, on the **Configuration** pane, select **Macros**. For **Preprocessor definitions**, specify one of those three compilation flags and restart the verification.

Object is Too Large

A verification can terminate during compilation with a message saying that an object is too large. This error means that the software has detected an object such as an array, union, struct, or class, that is too big for the pointer size of the selected target.

Messages

- `error: array is too large`
- `error: struct or union is too large`
- `error: class is too large for pointer type of %*d*-bits`

Code Used

```
struct S
{
  char tab[32728];
}s;
```

When using a 16-bit target (for example: `-target mcpu`)

Solution

Use a larger pointer size.

To select a larger pointer:

- If you are using `-target mcpu`, specify `-pointer-is-32bits`.
- If you are using a specific target, specify `-pointer-is-`*`xx`*`bits` if available, otherwise use a larger target.

Unsupported Non-ANSI Keywords (C)

Code that includes non-ANSI keywords (such as @interrupt) that Polyspace software does not support generate compilation errors. For example, keywords containing `@` as a first character cause a compilation error. But in this case, you cannot address the problem by using a compilation flag, nor with a file associated with the `-include` option.

To address this problem, use the `-post-preprocessing-command` option.

When you use the `-post-preprocessing-command` option, write a script or command to replace the unsupported, non-ANSI keyword with a supported keyword. The command must process the standard output from preprocessing and produce its results in accordance with standard output.

The specified script file or command runs just after the preprocessing phase on each source file. The script executes on each preprocessed `c` file.

Note: Preprocessed files have the extension `.ci`. Preprocessed files are contained in a single compressed file named `ci.zip`. This file is in the `results` folder in one of the following locations:

- `<results>/ALL/SRC/MACROS/ci.zip`
- `<results>/C-ALL/ci.zip`.

Caution Always preserve the number of lines in a preprocessed `.ci` file. Adding or removing a line, can result in unpredictable behavior, including changes to the location of checks and MACROS in the Run-Time checks perspective.

Here is an example of such a script file. Save the script in a file named `myscript.pl`.

```
#!/usr/bin/perl
binmode STDOUT;

# Process every line from STDIN until EOF
while ($line = <STDIN>)
{
# Replace keyword “titi” with “toto”
$line =~ s/titi/toto/g;
```

```
# Remove “@interrupt” (replace with nothing)
$line =~ s/@interrupt/ /g;

# DONT DELTE: Print the current processed line to STDOUT
  print $line;
}
```

To run the script on each preprocessed `C` file, use this command:

```
-post-preprocessing-command MATLAB_Install\sys\perl\win32\bin\perl.exe
<absolute path to myscript.pl>\myscript.pl
```

Initialization of Global Variables (C++)

When a data member of a class is declared static in the class definition, it is a *static member* of the class. Static data members are initialized and destroyed outside the class, as they exist even when no instance of the class has been created.

```
class Test
{
public:

 static int m_number = 0;
};
```

Error message:

```
Verifying test_ko.cpp
/sources/test_ko.cpp, line 4: error: a member with an in-class
initializer must be const
|  static int m_number = 0;
|                     ^

1 error detected in the compilation of "test_ko.cpp".
```

Corrected code:

<table>
<tr><th>in file Test.h</th><th>in file Test.cpp</th></tr>
<tr><td><pre>class Test
{
public:
static int m_number;
};</pre></td><td><pre>int Test::m_number = 0;</pre></td></tr>
</table>

Note: Some dialects, other than those supported by Polyspace Code Prover, accept the default initialization of static data member during the declaration.

Double Declarations of Standard Template Library Functions

Consider the following code.

```
#include <list>

void f(const std::list<int*>::const_iterator it) {}
void f(const std::list<int*>::iterator it) {}
void g(const std::list<int*>::const_reverse_iterator it) {}
void g(const std::list<int*>::reverse_iterator it) {}
```

The declared functions belong to `list` container classes with different iterators. However, the software generates the following compilation errors:

```
error: function "f" has already been defined
error: function "g" has already been defined
```

You would also see the same error if, instead of `list`, the specified container was `vector`, `set`, `map`, or `deque`.

To avoid the double declaration errors, use the following Polyspace preprocessing directives:

- `__PST_STL_LIST_CONST_ITERATOR_DIFFER_ITERATOR__`
- `__PST_STL_VECTOR_CONST_ITERATOR_DIFFER_ITERATOR__`
- `__PST_STL_SET_CONST_ITERATOR_DIFFER_ITERATOR__`
- `__PST_STL_MAP_CONST_ITERATOR_DIFFER_ITERATOR__`
- `__PST_STL_DEQUE_CONST_ITERATOR_DIFFER_ITERATOR__`

For example, for the given code, run the verification with the directive for the `list` container:

```
-D __PST_STL_LIST_CONST_ITERATOR_DIFFER_ITERATOR__
```

Large Static Initializer

If you see a large initializer warning during the compilation phase, for example,

```
lsi_eg.c, line 86: warning: initializer is too large, this may cause scaling troubles.
Please refer to the "Troubleshooting" section of the User Guide
|  const unsigned char CJK_S_MKT_CTS_BE_HDB[] = {
|                                               ^
```

the compilation might:

- Fail with an error if no memory space is available:
  - Windows — `Error: A segmentation fault occurred in "edgcpfe.x86-mingw32.exe"`
  - Linux — `Error: The process "edgcpfe.x86-linux" received the signal 11`
- Take a long time to complete.

To avoid this issue, rerun your verification with the following option:

```
-cfe-extra-flags --truncate_huge_initializer
```

This option is valid:

- For a C verification only.
- Only if no variable or function address is referenced within the initializer

Compilation Messages

Phrase Found in Message	See
`syntax error`	"Syntax Error" on page 9-19
`undeclared identifier`	"Undeclared Identifier" on page 9-20
`unknown prototype`	"Unknown Prototype" on page 9-22

`No such file or folder`
 	
or
 	
`Catastrophic error: could not open source file`
	"No Such File or Folder" on page 9-23

`#error: directive`	"`#error` Directive" on page 9-24

For messages triggered by unsupported keywords, see "Unsupported Non-ANSI Keywords (C)" on page 9-26.

C++ Dialect Issues

In this section...

ISO versus Default Dialects

The ISO dialect strictly follows the ISO/IEC 14882:1998 ANSI C++ standard. If you specify the `-dialect iso` option, the Polyspace compiler might produce permissiveness errors. The following code contains five common permissiveness errors that occur if you specify the `-dialect iso` option. These errors are explained in detail following the code.

If you do not specify the `-dialect` option, the Polyspace compiler uses a default dialect that many C++ compilers use; the default dialect is more permissive with regard to the C ++ standard.

Original code (file `permissive.cpp`):

```

class B {} ;
class A
{
friend B ;
enum e ;
void f() { long float ff = 0.0 ;}
enum e { OK = 0, KO } ;
};
template <class T>
struct traits
{
typedef T * pointer ;
typedef T * pointer ;
} ;
template<class T>
struct C
```

```
18  {
19  typedef traits<T>::pointer pointer ;
20  } ;
21  int main()
22  {
23  C<int> c ;
23  }
```

- Using `-dialect iso`, line 5 should be: `friend class B`:

```
"./sources/permissive.cpp", line 5: error: omission of "class"
is nonstandard
  friend B ;
```

- Using `-dialect iso`, the line 6 must be removed:

```
"./sources /permissive.cpp", line 6: error: forward declaration
of enum type
is nonstandard
  enum  e ;
    ^
```

- Using `-dialect iso`, line 7 should be: `double ff = 0.0`:

```
"./sources/permissive.cpp", line 7: error: invalid combination
of type
specifiers
  long float ff = 0.0 ;
  ^
```

- Using `-dialect iso`, line 14 needs to be removed:

```
"./sources/permissive.cpp", line 14: error: class member typedef
may not be
redeclared
  typedef T *  pointer ; // duplicate !
       ^
```

- Using `-dialect iso`, line 21 needs to be changed by: `typedef` *`typename`* `traits<T>::pointer pointer`

```
"./sources/permissive.cpp", line 21: error: nontype
"traits<T>::pointer [with T=T]" is not a type name
  typedef traits<T>::pointer pointer ;
```

These error messages disappear if you specify the `-dialect` default option.

CFront2 and CFront3 Dialects

The cfront2 and cfront3 dialects were being used before the publication of the ANSI C ++ standard in 1998. Nowadays, these two dialects are used to compile legacy C++ code.

If the cfront2 or cfront3 options are not selected, you may get the common error messages below.

Variable Scope Issues

The ANSI C++ standard specifies that the scope of the declarations occurring inside loop definition is local to the loop. However some compilers may assume that the scope is local to the bloc ({ }) that contains the loop.

Original code:

```
for (int i = 0; i < maxval; i++) {...}
if (i == maxval) {
 ...
}
```

Error message:

```
Verifying Test.cpp
"../sources/Test.cpp", line 26: error: identifier "i" is undefined
  if (i == maxval) {
      ^
```

Note: This kind of construction has been allowed by compilers until 1999, before the standard became more strict.

"bool" Issues

Standard type may need to be turned into boolean type.

Original code:

```
enum bool
 {
  FALSE=0,
  TRUE
 };
```

```
class CBool
{
public:
 CBool ();
 CBool (bool val);
 bool m_val;
};
```

Error message:

```
Verifying C++ sources ...
Verifying CBool.cpp
"../sources/CBool.h", line 4: error: expected either a definition
or a tag name
 enum  bool
   ^
```

Visual Dialects

The following messages appears if the compiler is based on a Visual® dialect (including `visual8`).

Import Folder

When a Visual application uses `#import` directives, the Visual C++ compiler generates a header file that contains some definitions. These header files have a `.tlh` extension, and Polyspace for C/C++ requires the folder containing those files.

Original code:

```
#include "stdafx.h"
#include <comdef.h>
#import <MsXml.tlb>
MSXML::_xml_error e ;
MSXML::DOMDocument* doc ;
int _tmain(int argc, _TCHAR* argv[])
{
 return 0;
}
```

Error message:

```
"../sources/ImportDir.cpp", line 7: catastrophic error: could not
open source file "./MsXml.tlh"
```

```
#import <MsXml.tlb>
        ^
```

The Visual C++ compiler generates these files in its “build-in” folder (usually Debug or Release). Therefore, in order to provide those files, the application needs to be built first. Then, the option -import-dir=<*build folder*> must be set with the path folder.

pragma Pack

Using a different value with the compile flag (#pragma pack) can lead to a linking error message.

Original code:

test1.cpp	type.h	test2.cpp
#pragma pack(4) #include "type.h"	struct A { char c ; int i ; } ;	#pragma pack(2) #include "type.h"

Error message:

```
Pre-linking C++ sources ...
"../sources/type.h", line 2: error: declaration of class "A" had
a different meaning during compilation of "CPP-ALL/SRC/MACROS/test1.cpp"
(class types do not match)
 struct A
    ^
   detected during compilation of secondary translation unit
"CPP-ALL/SRC/MACROS/test2.cpp"
```

The option -ignore-pragma-pack is mandatory to continue the verification.

GNU Dialect

For the GNU dialect, you can select the GCC 3.4 or GCC 4.6 version. If you use this dialect, Polyspace does not produce an error during the **Compile** phase because of assembly language keywords such as __asm__ __volatile__. However, for verification, Polyspace ignores the content of the assembly-language code.

Polyspace software supports the following GNU elements:

- Variable length arrays

- Anonymous structures:

```
void f(int n) { char tmp[n] ; /* ... */ }

union A {
 struct {
  double x ;
  double y ;
  double z ;
 };
 double tab[3];
} a ;


void main(void) {

 assert(&(a.tab[0]) == &(a.x)) ;

}
```

- Other syntactic constructions allowed by GCC, except as noted below

Partial Support

Zero-length arrays have the same support as in Visual Mode. They are allowed when used through a pointer, but not in a local variable.

Syntactic Support Only

Polyspace software provides syntactic support for the following options, but not semantic support:

- `__attribute__(...)` is allowed, but generally not taken into account.
- No special stubs are computed for predeclared functions such as `__builtin_cos`, `__builin_exit`, and `__builtin_fprintf`).

Not Supported

The following options are not supported:

- The keyword `__thread`
- Statement expressions:

```
int i = ({ int tmp ; tmp = f() ; if (tmp > 0 ) { tmp = 0 ; } tmp ; })
```

- Taking the address of a label:

  ```
  { L : void *a = &&L ; goto *a ; }
  ```
- General C99 features supported by default in GCC, such as complex built-in types (`__complex__`, `__real__`, etc.).
- Extended designators initialization:

  ```
  struct X { double a; int b[10] } x = { .b = { 1, [5] =2 },
  .b[3] = 1, .a = 42.0 };
  ```
- Nested functions

Examples

Example 1: `_asm_volatile_` keyword

In the following example, for the `inb_p` function to manage the return of the local variable `_v`, the `__asm__ __volatile__` keyword is used as follows:

```
extern inline unsigned char
inb_p (unsigned short port)
{
  unsigned char _v;

  __asm__ __volatile__ ("inb %w1,%0\noutb %%al,$0x80":"=a"
         (_v):"Nd" (port));
  return _v;
}
...
```

Although Polyspace does not produce an error during the **Compile** phase, it ignores the assembly code. An orange **Non-initialized local variable** error appears on the `return` statement after verification. For more information, see "Local Variables in Functions with Assembly Code".

Example 2: Anonymous Structure

The following example shows an unnamed structure supported by GNU:

```
class x
{
public:

  struct {
```

```
    unsigned int a;
    unsigned int b;
    unsigned int c;
    };
    unsigned short pcia;
    enum{
    ea = 0x1,
    eb = 0x2,
    ec = 0x3
    };

    struct {
    unsigned int z1;
    unsigned int z2;
    unsigned int z3;
    unsigned int z4;
    };
  };

  int main(int argc, char *argv[])
  {
    class x myx;

    myx.a = 10;
    myx.z1 = 11;
    return(0);
  }
```

C Link Errors

Link Error Overview (C)

This section describes how to address some common types of link errors for C code.

Link errors result from the checking that Polyspace performs for compliance with ANSI C standards. Link error messages can apply to functions, variables, and varargs.

The error message includes specific information that reflects the code that the Polyspace software is checking, such as the function name and type declaration.

Examining Preprocessed Code

Looking at the preprocessed code can help you to find link errors faster.

Preprocessed files have the extension `.ci`. Preprocessed files are contained in a single compressed file named `ci.zip`. This file is in the `results` folder in one of the following locations:

- `<results>/ALL/SRC/MACROS/ci.zip`
- `<results>/C-ALL/ci.zip`.

Function: Procedure Multiply Defined

Files Used

header.h	file1.c	file2.c

`#include <stdio.h>`
 	
`void func() {`
` }`
	`#include "header.h"`	`#include "header.h"`

Polyspace Output

```
Error:
procedure func multiply defined
```

Solution

For C code, to allow such multiple inclusion of the header containing the function body, use the option `-static-headers-object`.

Function: Wrong Argument Type

Polyspace Output

```
Error:
global declaration of 'f' function has incompatible type with its definition
Declared function type has 'arg 1' type incompatible with definition.
```

```
int f(float y)
{
  int r;
  r=12;
}
```

```
int f(int *y);

void main(void)
{
  int r;
  r = f(&r);
}
```

Solution

The first parameter for the `f` function is either a float or a pointer to an integer. The global declaration must match the definition.

Function: Wrong Argument Number

Polyspace Output

```
Error:
```

```
global declaration of 'f' function has incompatible type with its definition
Declared function type has incompatible number of arguments with definition.
```

```
int f(float y)           int f(float y, float x);
{
  int r;                 void main(void)
  r=12;                  {
}                          int a;
                           float b, c;
                           a = f(b, c);
                         }
```

Solution

These two functions have a different number of arguments. This mismatch in the number of arguments results in a nondeterministic execution.

Function: Wrong Return Type

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
Error: global declaration of 'f' function has incompatible type with its definition
declared function type has incompatible return type with definition
declared 'float' (size 64) type incompatible with defined 'int' (size 32) type
```

```
float f(int y)           int f(int y);
{
float r;                 void main(void)
r=1.0;                   {
return r;                int r;
}                        r = f(r);
                         }
```

Solution

Use the same return type for the declaration and definition of function `f`.

Variable: Wrong Type

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
Error: global declaration of 'x' variable has incompatible type with its definition
  declared 'float' (32) type incompatible with defined 'int' (32) type
```

```
extern float x               int x;
                             void main(void)
                             {}
```

Solution

Declare the `x` variable the same way in every file. If a variable `x` is as an integer equal to 1, which is 0x0001, what does this value mean when seen as a float? It could result in a NaN (Not a Number) during execution.

Variable: Signed/Unsigned

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
Error: global declaration of 'x' variable has incompatible type with its definition
  declared 'unsigned' type incompatible with defined 'signed' type
```

```
extern unsigned char x;      char x;
                             void main(void)
                             {}
```

Solution

Consider the 8-bit binary value 10000010. Given that a `char` is 8 bits, it is not clear whether it is 130 (unsigned), or maybe -126 (signed).

Variable: Different Qualifier

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
Warning: global declaration of 'x' variable has incompatible type with its definition
  declared 'non qualified' type incompatible with defined 'volatile' type
  'volatile' qualifier used
```

```
extern int x;            volatile int x;

                         void main(void)
                         {}
```

Solution

Polyspace software flags the volatile qualifier, because that qualifier has major implications for the verification. Because it is not clear which statement is correct, the verification process generates a warning.

Variable: Array Against Variable

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
```

```
Error: global declaration of 'x' variable has incompatible type with its definition
  declared 'array' (384) type incompatible with defined 'int' (32) type

extern int x[12];          int x;

                           void main(void)
                           {

                           }
```

Solution

The real allocated size for the x variable is one integer. Any function attempting to manipulate x[] corrupts memory.

Variable: Wrong Array Size

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
Warning: global declaration of 'x' variable has incompatible type with its definition
 declared array type has 'upper bound' 5 inferior to definition 'upper bound' 12

extern int x[12];          int x[5];

                           void main(void)
                           {

                           }
```

Solution

The real allocated size for the x variable is five integers. Any function attempting to manipulate x[] between x[5] and x[11] corrupts memory.

Missing Required Prototype for varargs

Polyspace Output

```
Verifying cross-files ANSI C compliance ...
Error: missing required prototype for varargs. procedure 'g'.

void g(int, ...);          void main(void)
                           {
void f(void)               g(4);
{                          }
g(12,“abcde“,40)
}
```

Solution

Declare the prototype for `g` when `main` executes.

To eliminate this error, you can add the following line to `main`:

```
void g(int, ...)
```

Or, you can avoid modifying `main` by adding that same line in a new file and then when you launch the verification, use the "`-include`" option:

```
–include c:\Polyspace\new_file.h
```

where `new_file.h` is the new file that includes the line `void g(int, ...)`.

C++ Link Errors

In this section...

STL Library C++ Stubbing Errors

Polyspace software provides an efficient implementation of all functions in the Standard Template Library (STL). The STL and platforms may have different declarations and definitions; otherwise, the following error messages appear:

Original code:

```
#include <map>

struct A
{
 int m_val;
};

struct B
{
 int m_val;
 B& operator=(B &) ;
};

typedef std::map<A, B> MAP ;

int main()
{
 MAP m ;
 A a ;
 B b ;

 m.insert(std::make_pair(a,b)) ;
}
```

Error message:

```
Verifying template.cpp
"<Product>/Verifier/cinclude/new_stl/map", line 205: error: no operator
```

```
"=" matches these operands
 operand types are: pair<A, B> = const map<A, B, less<A>>::value_type
 { volatile int random_alias = 0 ; if (random_alias) *((pair<Key, T> * )
_pst_elements) = x ; } ; // read of x is done here

 detected during instantiation of
"pair<__pst__generic_iterator<bidirectional_iterator_tag, pair<const Key,
T>>, bool> map<Key, T, Compare>::insert(const map<Key, T, Compare>::
value_type &) [with Key=A, T=B, Compare=less<A>]" at line 23 of "/cygdrive/
c/_BDS/Test-Polyspace/sources/template.cpp"
```

Using the `-no-stub-stl` option avoids this error message. Then, you need to add the folder containing definitions of own STL library as a folder to include using the option `-I`.

The preceding message can also appear with the folder names:

```
"<Product>/cinclude/new_stl/map", line 205: error: no operator "="
matches these operands
```

```
"<Product>/cinclude/pst_stl/vector", line 64: error: more than one
operator "=" matches these operands:
```

Be careful that other compile or linking troubles can appear with your own template definitions.

Lib C Stubbing Errors

Extern C Functions

Some functions may be declared inside an `extern “C” { }` bloc in some files, but not in others. In this case, the linkage is different which causes a link error, because it is forbidden by the ANSI standard.

Original code:

```
extern "C" {
 void* memcpy(void*, void*, int);
}
class Copy
{
public:
 Copy() {};
 static void* make(char*, char*, int);
};
void* Copy::make(char* dest, char* src, int size)
{
```

```
 return memcpy(dest, src, size);
}
```

Error message:

```
Pre-linking C++ sources ...

<results_dir>/test.cpp, line 2: error: declaration of function "memcpy"
is incompatible with a declaration in another translation unit
(parameters do not match)
|            the other declaration is at line 4096 of "__polyspace__stdstubs.c"
|    void* memcpy(void*, void*, int);
|          ^
|          detected during compilation of secondary translation unit "test.cpp"
```

The function `memcpy` is declared as an external "C" function and as a C++ function. It causes a link problem. Indeed, function management behavior differs whether it relates to a C or a C++ function.

When such error happens, the solution is to homogenize declarations, i.e. add `extern "C" { }` around previous listed C functions.

Another solution consists in using the permissive option `-no-extern-C`. It removes all `extern "C"` declarations.

Functional Limitations on Some Stubbed Standard ANSI Functions

- `signal.h` is stubbed with functional limitations: `signal` and `raise` functions do not follow the associated functional model. Even if the function raise is called, the stored function pointer associated to the signal number is not called.
- No jump is performed even if the `setjmp` and `longjmp` functions are called.
- `errno.h` is partially stubbed. Some math functions do not set `errno`, but instead, generate a red error when a range or domain error occurs with **ASRT** checks.

You can also use the compile option `POLYSPACE_STRICT_ANSI_STANDARD_STUBS` (`-D` flag). This option only deactivates extensions to ANSI C standard libC, including the functions `bzero`, `bcopy`, `bcmp`, `chdir`, `chown`, `close`, `fchown`, `fork`, `fsync`, `getlogin`, `getuid`, `geteuid`, `getgid`, `lchown`, `link`, `pipe`, `read`, `pread`, `resolvepath`, `setuid`, `setegid`, `seteuid`, `setgid`, `sleep`, `sync`, `symlink`, `ttyname`, `unlink`, `vfork`, `write`, `pwrite`, `open`, `creat`, `sigsetjmp`, `__sigsetjmp`, and `siglongjmpare`.

Standard Library Function Stubbing Errors

In this section...

Conflicts Between Library Functions and Polyspace Stubs

A code set compiles successfully for a target, but during the `__polyspace_stdstubs.c` compilation phase for the same code, Polyspace software generates an error message.

The error message highlights conflicts between:

- A standard library function that the application includes
- One of the standard stubs that Polyspace software uses in place of the function

For more information about errors generated during automatic stub creation, see "Automatic Stubbing Errors" on page 9-55.

_polyspace_stdstubs.c Compilation Errors

Here are examples of the errors relating to stubbing standard library functions. The code uses standard library functions such as `sprintf` and `strcpy`, illustrating possible problems with these functions.

Example 1

```
C-STUBS/__polyspace__stdstubs.c:1117: string.h: No such file or
folder

Verifying C-STUBS/__polyspace__stdstubs.c
```

```
C-STUBS/__polyspace__stdstubs.c:1118: syntax error; found `strlen'
expecting `;'

C-STUBS/__polyspace__stdstubs.c:1120: syntax error; found `i'
expecting `;'

C-STUBS/__polyspace__stdstubs.c:1120: undeclared identifier `i'
```

Example 2

```
Verifying C-STUBS/__polyspace__stdstubs.c

Error: missing required prototype for varargs. procedure 'sprintf'.
```

Example 3

```
Verifying C-STUBS/__polyspace__stdstubs.c

C-STUBS/__polyspace__stdstubs.c:3027: missing parameter 4 type

C-STUBS/__polyspace__stdstubs.c:3027: syntax error; found `n'
expecting `)'

C-STUBS/__polyspace__stdstubs.c:3027: skipping `n'

C-STUBS/__polyspace__stdstubs.c:3037: undeclared identifier `n'"
```

Troubleshooting Approaches for Standard Library Function Stubs

You can use a range of techniques to address errors relating to stubbing standard library functions. These techniques reflect different balances for the verification between:

- Precision
- Amount of time preparing the code
- Execution time

Try the techniques in any order. Consider trying the simplest approaches first, and trying other techniques as required to achieve the balance of the trade-offs that you seek. Here are the techniques, listed in order of estimated simplicity, from simplest to most thorough:

- "Restart with the -I option" on page 9-51

- "Replace Automatic Stubbing with Include Files" on page 9-51
- "Create _polyspace_stdstubs.c File with Required Includes" on page 9-52

  (Use when precision is important enough to justify extensive code preparation time)
- "Provide .c file Containing Prototype Function" on page 9-53

  (Use when you do not want to invest much time for code preparation time)
- "Ignore _polyspace_stdstubs.c" on page 9-54

If the problem persists after trying these solutions, contact MathWorks support.

Restart with the -I option

Generally you can best address stubbing errors by restarting the verification. Include the header file containing the prototype and the required definitions, as used during compilation for the target.

The least invasive way of including the header file containing the prototype is to use the `-I` option.

Replace Automatic Stubbing with Include Files

The Polyspace software provides a selection of files that contain stubs for most standard library functions. You can use those stubs in place of automatic stubbing.

For replacement of stubbing to work effectively, provide the include file for the function. In the following example, the standard library function is `strlen`. This example assumes that you have included `string.h`. Because the `string.h` file can differ between targets, there are no default include folders for Polyspace stub files.

If the compiler has implicit include files, manually specify those include files, as shown in this example.

```
(_polyspace_stdstubs.c located in <<results_dir>>/C-ALL/C-STUBS)

_polyspace_stdstubs.c
#if defined(_polyspace_strlen) || ... || defined(_polyspace_strtok)
#include <string.h>
size_t strlen(const char *s)
{
 size_t i=0;
```

```
 while (s[i] != 0)
  i++;
 return i;
}
#endif /* _polyspace_strlen */
```

If problems persist, try one of these solutions:

- "Create _polyspace_stdstubs.c File with Required Includes" on page 9-52
- "Provide .c file Containing Prototype Function" on page 9-53
- "Ignore _polyspace_stdstubs.c" on page 9-54

Create _polyspace_stdstubs.c File with Required Includes

1. Copy `<<results_dir>>/C-ALL/C-STUBS/ _polyspace_stdstubs.c` to the `sources` folder and rename it `polyspace_stubs.c`.

   This file contains the whole list of stubbed functions, user functions, and standard library functions. For example:

   ```
   #define _polyspace_strlen
   #define a_user_function
   ```

2. Find the problem function in the file. For example:

   ```
   #if defined(_polyspace_strlen) || ... || defined(_polyspace_strtok)
   #include <string.h>
    size_t strlen(const char *s)
    {
     size_t i=0;
     while (s[i] != 0)
      i++;
     return i;
    }
   #endif /* __polyspace_strlen */
   ```

   The verification requires you to include the `string.h` file that the application uses.

3. Provide the `string.h` file that contains the real prototype and type definitions for the stubbed function.

   Alternatively, extract the relevant part of that file for inclusion in the verification.

   For example, for `strlen`:

```
string.h
 // put it in the /homemade_include folder
 typedef int size_t;
 size_t strlen(const char *s);
```

4 Specify the path for the include files and relaunch Polyspace, using one of these commands:

```
polyspace-code-prover-nodesktop -I /homemade_include
```

or

```
polyspace-code-prover-nodesktop -I /our_target_include_path
```

Provide .c file Containing Prototype Function

1 Identify the function causing the problem (for example, `sprintf`).
2 Add a `.c` file to your verification containing the prototype for this function.
3 Restart the verification either from the Project Manager perspective or from the command line.

You can find other `__polyspace_no`*function_name* options in `_polyspace__stdstubs.c` files, such as:

```
__polyspace_no_vprintf
__polyspace_no_vsprintf
__polyspace_no_fprintf
__polyspace_no_fscanf
__polyspace_no_printf
__polyspace_no_scanf
__polyspace_no_sprintf
__polyspace_no_sscanf
__polyspace_no_fgetc
__polyspace_no_fgets
__polyspace_no_fputc
__polyspace_no_fputs
__polyspace_no_getc
```

Note: If you are considering defining multiple project generic `-D` options, using the `-include` option can provide a more efficient solution to this type of error. Refer to “Gather Compilation Options Efficiently”.

Ignore _polyspace_stdstubs.c

When all other troubleshooting approaches have failed, you can try ignoring `_polyspace_stdstubs.c`. To ignore `_polyspace_stdstubs.c`, but still see which standard library functions are in use:

1. Do one of the following:

   - Deactivate all standard stubs using `-D POLYSPACE_NO_STANDARD_STUBS` option. For example:

     ```
     polyspace-code-prover-nodesktop -D POLYSPACE_NO_STANDARD_STUBS
     ```
   - Deactivate all stubbed extensions to ANSI C standard by using `-D POLYSPACE_STRICT_ANSI_STANDARD_STUBS`. For example:

     ```
     polyspace-code-prover-nodesktop -D
     POLYSPACE_STRICT_ANSI_STANDARD_STUBS
     ```

   This approach presents a list of functions Polyspace software tries to stub. It also lists the standard functions in use (most probably without a prototype), and generates the following type of message:

   ```
   * Function strcpy may write to its arguments and may
   return parts of them. Does not model pointer effects.
   Returns an initialized value.

   Fatal error: function 'strcpy' has unknown prototype
   ```
2. Add an include file in the C file that uses your standard library function. If you restart Polyspace with the same options, the default behavior results for these stubs for this particular function.

Consider the example `size_t strcpy(char *s, const char *i)` stubbed to

- Write anything in `*s`
- Return any possible `size_t`

Automatic Stubbing Errors

In this section...

Three Types of Error Messages

The Polyspace software generates three different types of error messages during the automatic creation of stubs.

For more information about stubbing errors, see "Standard Library Function Stubbing Errors" on page 9-49.

Unknown Prototype Error

Message

```
Fatal error: function 'f' has unknown prototype
-------------------------
Error message explanation:
- "function has wrong prototype" means that either the function
 has no prototype or its prototype is not ANSI compliant.
- "task is undefined" means that a function has been declared
 to be a task but has no known body
```

Solution

Provide an ANSI-compliant prototype.

Parameter `-entry-points` Error

Message

```
*** Verifier found an error in parameter -entry-points: task "w"
must be a userdef function
------------------------------------------------------------- ---
---                       ---
```

```
--- Found some errors in launching command.        ---
--- Please consult rte-kernel -h to correct them      ---
--- and launch the verification again.           ---
---                      ---
------------------------------------------------------------ ---
```

Solution

A function or procedure declared to be an `-entry-points` cannot be an automatically stubbed function.

Reduce Verification Time

In this section...

Factors Affecting Verification Time

These factors affect how long it takes to run a verification:

- The size of the code
- The number of global variables
- The nesting depth of the variables (the more nested they are, the longer it takes)
- The depth of the call tree of the application
- The intrinsic complexity of the code, particularly with regards to pointer manipulation

Because many factors affect verification time, there is no precise formula for calculating verification duration. Instead, Polyspace software provides graphical and textual output to indicate how the verification is progressing.

Techniques to Improve Verification Performance

This section suggests methods to reduce the duration of a particular verification, with minimal compromise for the launch parameters or the precision of the results.

You can increase the size of a code sample for effective analysis by tuning the tool for that sample. Beyond that point, subdividing the code or choosing a lower precision level offers better results (`-O1`, `-O0`).

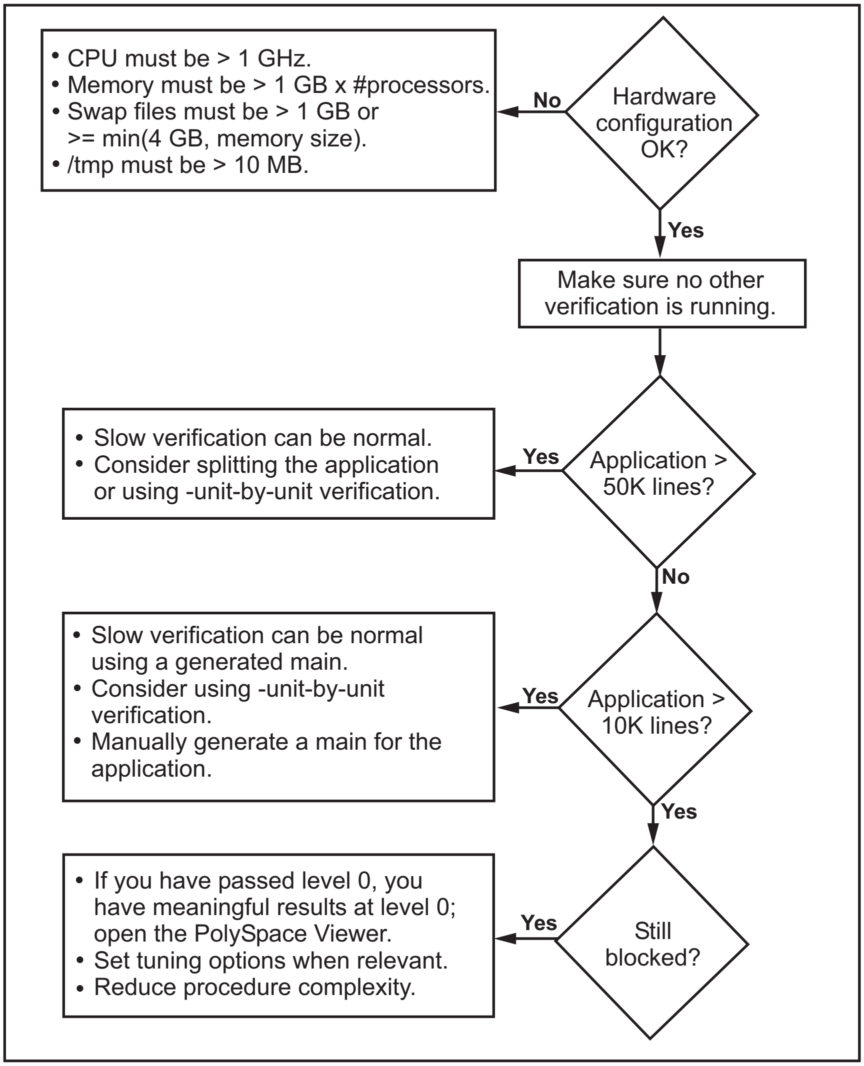
You can use several techniques to reduce the amount of time required for a verification, including

- “Errors From Disk Defragmentation and Antivirus Software” on page 9-10
- “Tune Polyspace Parameters” on page 9-60
- “Subdivide Code” on page 9-60
- “Reduce Procedure Complexity” on page 9-68
- “Reduce Task Complexity” on page 9-71
- “Reduce Variable Complexity” on page 9-71
- “Choose Lower Precision” on page 9-72

You can combine these techniques. See the following performance-tuning flow charts:

- “Standard Scaling Options Flow Chart” on page 9-59
- “Reduce Code Complexity” on page 9-59

Standard Scaling Options Flow Chart



Reduce Code Complexity

To reduce code complexity, try the following techniques, in the order listed:

- "Reduce Procedure Complexity" on page 9-68

- “Reduce Task Complexity” on page 9-71
- “Reduce Variable Complexity” on page 9-71

After you use any of these techniques, restart the verification.

Tune Polyspace Parameters

Impact of Parameter Settings

Compromise to balance the time required to perform a verification and the time required to review the results. Launching Polyspace verification with the following options reduces the time taken for verification. However, these parameter settings compromise the precision of the results. The less precise the results of the verification, the more time you can spend reviewing the results.

Recommended Parameter Tuning

Use the parameters in the sequence listed. If the first suggestion does not increase the speed of verification sufficiently, then introduce the second, and so on.

- Switch from `-O2` to a lower precision.
- Set the `-respect-types-in-globals` and `-respect-types-in-fields` options.
- Set the `-k-limiting` option to 2, then 1, or 0.
- Manually stub missing functions which write into their arguments.
- If some code uses some large arrays, use the `-no-fold` option.

For example:

```
polyspace-code-prover-nodesktop -O0 -respect-types-in-globals -k-
limiting 0
```

Subdivide Code

- “An Ideal Application Size” on page 9-61
- “Benefits of Subdividing Code” on page 9-61
- “Possible Issues with Subdividing Code” on page 9-61
- “Approach” on page 9-63

- “Select a Subset of Code” on page 9-64

An Ideal Application Size

People have used Polyspace software to analyze numerous applications with greater than 100,000 lines of code.

There is a trade-off between the time and resources required to analyze an application, and the resulting selectivity. The larger the project size, the broader the approximations Polyspace software makes. Broader approximations produce more oranges. Large applications can require you to spend much more time analyzing the results and your application.

These approximations enable Polyspace software to extend the range of project sizes it can manage, to perform the verification further, and to solve traditionally incomputable problems. Balance the benefits derived from verifying a whole large application against the loss of precision that results.

Benefits of Subdividing Code

Subdividing a large application into smaller subsets of code provides several benefits. You:

- Quickly isolate a meaningful subset
- Keep all functional modules
- Can maintain a high precision level (for example, level O2)
- Reduce the number of orange items
- Do not have to remove threads that affect shared data
- Reduce the code complexity considerably

Possible Issues with Subdividing Code

Subdividing code can lead to these problems:

- Orange checks can result from a lack of information regarding the relationship between modules, tasks, or variables.
- Orange checks can result from using too wide a range of values for stubbed functions.
- Some loss of precision; the verification consider all possible values for a variable.

When the Application is Incomplete

When the code consists of a small subset of a larger project, Polyspace software automatically stubs many procedures. Polyspace bases the stubbing on the specification or prototype of the missing functions. Polyspace verification assumes that all possible values for the parameter type are returnable.

Consider two 32-bit integers `a` and `b`, which are initialized with their full range due to missing functions. Here, `a*b` causes an overflow, because `a` and `b` can be equal to 2^31. Precise stubbing can reduce the number of incidences of these data set issue orange checks.

Now consider a procedure `f` that modifies its input parameters `a` and `b`. `f` passes both parameters by reference. Suppose `a` can be from 0 through 10, and `b` any value between -10 and 10. In an automatically stubbed function, the combination `a=10` and `b=10` is possible, even if it is not possible with the real function. This situation introduces orange checks in a code snippet such as `1/(a*b - 100)`, where the division would be orange.

- So, even with precise stubbing, verification of a small section of code can introduce extra orange checks. However, the net effect from reducing the complexity is to reduce the total number of orange checks.
- With default stubbing, the increase in the number of orange checks as the result of this phenomenon tends to be more pronounced.

Considering the Effects of Application Code Size

Polyspace can make approximations when computing the possible values of the variables, at any point in the program. Such an approximation use a superset of the actual possible values.

For instance, in a relatively small application, Polyspace software can retain detailed information about the data at a particular point in the code. For example, the variable `VAR` can take the values
{ –2 ; 1 ; 2 ; 10 ; 15 ; 16 ; 17 ; 25 }

If the code uses `VAR` to divide, the division is green (because 0 is not a possible value).

If the program is large, Polyspace software simplifies the internal data representation by using a less precise approximation, such as:

```
[-2 ; 2] U {10} U [15 ; 17] U {25}
```

Here, the same division appears as an orange check.

If the complexity of the internal data becomes even greater later in the verification, Polyspace can further simplify the VAR range to (for example):

```
[-2 ; 20]
```

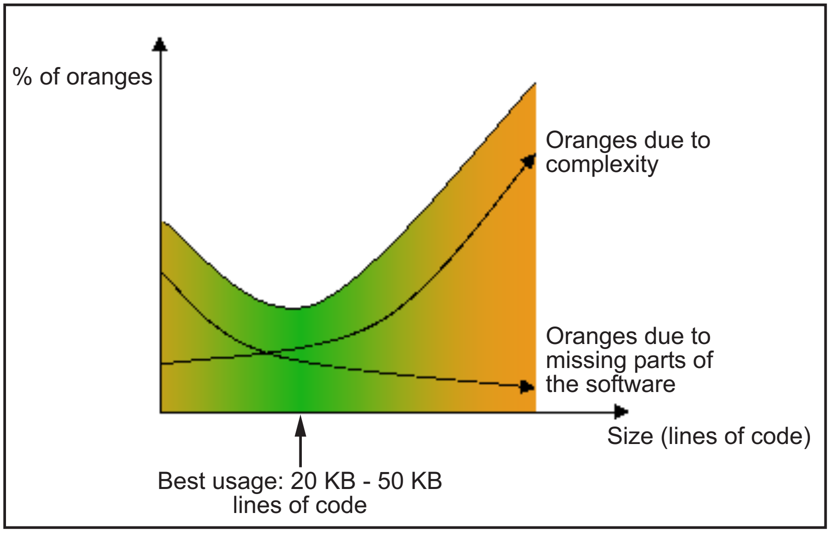
This phenomenon increases the number of orange warnings when the size of the program becomes large.

Approach

Begin with file-by-file verifications (when dealing with C language), package-by-package verifications (when dealing with Ada language), and class-by-class verifications (when dealing with C++ language).

The maximum application size is between 20,000 (for C++) and 50,000 lines of code (for C and Ada). For such applications of that size, approximations are not too significant. However, sometimes verification time is extensive.

Experience suggests that subdividing an application before verification normally has a beneficial impact on selectivity. The verification produces more red, green and gray checks, and fewer unproven orange checks. This subdivision approach makes bug detection more efficient.



A compromise between selectivity and size

Polyspace verification is most effective when you use it as early as possible in the development process, before any other form of testing.

When you analyze a small module (for example, a file, piece of code, or package) using Polyspace software, focus on the red and gray checks. orange unproven checks at this stage are interesting, because most of them deal with robustness of the application. The orange checks change to red, gray, or green as the project progresses and you integrate more modules.

In the integration process, code can become so large (50,000 lines of code or more). This amount of code can cause the verification to take an unreasonable amount of time. You have two options:

- Stop using Polyspace verification at this stage (you have gained many benefits already).
- Analyze subsets of the code.

Select a Subset of Code

Subdividing a project for verification takes considerably less verification time for the sum of the parts than for the whole project considered in one pass. Consider data flow when you subdivide the code.

Consider two distinct concepts:

- Function entry-points — Function entry-points refer to the Polyspace execution model, because they start concurrently, without assumptions regarding sequence or priority. They represent the beginning of your call tree.
- Data entry-points — Regard lines in the code that acquire data as data entry points.

Example 1

```
int complete_treatment_based_on_x(int input)
{
 thousand of line of computation...
}
```

Example 2

```
void main(void)
{
 int x;
```

```
 x = read_sensor();
 y = complete_treatment_based_on_x(x);
}
```

Example 3

```
#define REGISTER_1 (*(int *)0x2002002)
void main(void)
{
 x = REGISTER_1;
 y = complete_treatment_based_on_x(x);
}
```

In each case, the `x` variable is a data entry point and `y` is the consequence of such an entry point. `y` can be formatted data, due to a complex manipulation of `x`.

Because `x` is volatile, a probable consequence is that `y` contains all possible formatted data. You could remove the procedure `complete_treatment_based_on_x` completely, and let automatic stubbing work. The verification process considers `y` as potentially taking any value in the full range data.

```
//removed definition of complete_treatment_based_on_x
void main(void)
{
 x = ... // what ever
 y = complete_treatment_based_on_x(x); // now stubbed!
}
```

Typical Examples of Removable Components, According to the Logic of the Data

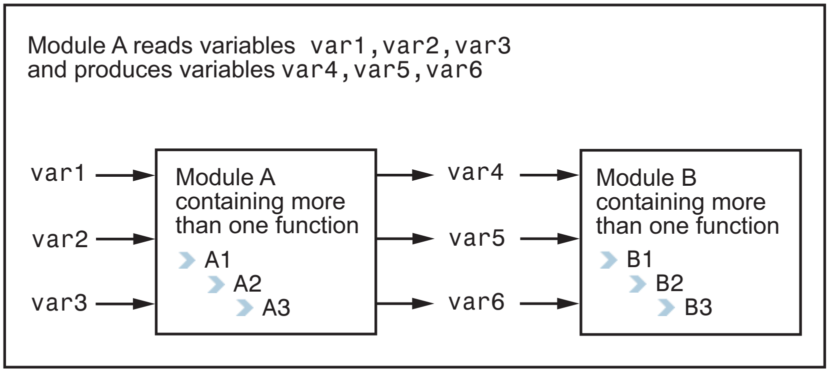
Here are some examples of removable components, based on the logic of the data:

- **Error management modules** often contain a large array of structures accessed through an API, but return only a Boolean value. Removing the API code and retaining the prototype causes the automatically generated stub to return a value in the range `[-2^31, 2^31-1]`, which includes 1 and 0. Polyspace considers the procedure able to return all possible values.
- **Buffer management for mailboxes coming from missing code** – Suppose an application reads a huge buffer of 1024 char. The application then uses the buffer to populate three small arrays of data, using a complicated algorithm before passing it to the main module. If the verification excludes the buffer, and initializes the arrays with random values instead, then the verification of the remaining code is just the same.

- Display modules

Subdivision According to Data Flow

Consider the following example.



In this application, `var1`, `var2`, and `var3` can vary between the following ranges:

`var1`	From 0 through 10
`var2`	From 1 through 100
`var3`	From –10 through 10

Module A consists of an algorithm that interpolates between `var1` and `var2`. That algorithm uses `var3` as an exponential factor, so when `var1` is equal to 0, the result in `var4` is also equal to 0.

As a result, `var4`, `var5`, and `var6` have the following specifications:

Ranges	`var4`
	`var5`
	`var6`
		Between –60 and 110
		From 0 through 12
		From 0 through 100

Properties	And a set of properties between variables	• If `var2` is equal to 0, then `var4 > var5 > 5`. • If `var3` is greater than 4, then `var4 < var5 < 12` • ...

Subdivision in accordance with data flow allows you to analyze modules A and B separately:

- A uses var1, var2, and var3, initialized respectively to [0;10], [1;100], and [-10;10].
- B uses var4, var5, and var6, initialized respectively to [-60;110], [0;12], and [-10;10].

The consequences are:

- A slight loss of precision on the B module verification, because now Polyspace considers all combinations for var4, var5, and var6. It includes all possible combinations, even those combinations that the module A verification restricts.

  For example, if the B module included the test

  ```
  If var2 is equal to 0, then var4 > var5 > 5
  ```

  then the dead code on any subsequent else clause is undetected.
- An in-depth investigation of the code is not required to isolate a meaningful subset. It means that a logical split is possible for an application, in accordance with the logic of the data.
- The results remain valid, because there is no requirement to remove, for example, a thread that changes shared data.
- The code is less complex.
- You can maintain the maximum precision level.

Typical examples of removable components:

- Error management modules. A function has_an_error_already_occurred can return TRUE or FALSE. Such a module can contain a large array of structures accessed through an API. Removing API code with the retention of the prototype results in the Polyspace verification producing a stub that returns [-2^31, 2^31-1]. That result clearly includes 1 and 0 (yes and no). The procedure has_an_error_already_occurred returns all possible values.
- Buffer management for mailboxes coming from missing code. Suppose the code reads a large buffer of 1024 char and then collates the data into three small arrays of data, using a complicated algorithm. It then gives this data to a main module for treatment. For the verification, Polyspace can remove the buffer and initialize the arrays with random values.

- Display modules.

Subdivide According to Real-Time Characteristics

Another way to split an application is to isolate files which contain only a subset of tasks, and to analyze each subset separately.

If a verification initiates using only a few tasks, Polyspace loses information regarding the interaction between variables.

Suppose an application involves tasks `T1` and `T2`, and variable `x`.

If `T1` modifies `x` and reads it at a particular moment, the values of `x` affect subsequent operations in `T2`.

For example, consider that `T1` can write either 10 or 12 into `x` and that `T2` can both write 15 into `x` and read the value of `x`. Two ways to achieve a sound standalone verification of `T2` are:

- You could declare `x` as volatile to take into account all possible executions. Otherwise, `x` takes only its initial value or `x` variable remains constant, and verification of `T2` is a subset of possible execution paths. You can get precise results, but it includes one scenario among all possible states for the variable `x`.
- You could initialize `x` to the whole possible range `[10;15]`, and then call the `T2` entry-point. Use this approach if `x` is calibration data.

Subdivide According to Files

This method is simple, but it can produce good results when you are trying to find defects in gray code.

Simply extract a subset of files and perform a verification using one of these approaches:

- Use entry points.
- Create a `main` that calls randomly functions that the subset of the code does not call.

Reduce Procedure Complexity

If the log file does not display any messages for several hours, you probably have a scaling issue. You can reduce the complexity of some of the procedures by cloning the calling context for specific procedures. One way to reduce complexity is to specify the -inline option on procedures whose names appear in the log file in one or both of two lists.

The -inline option creates clones of each specified procedure for each call to it. This option reduces the number of aliases in a procedure, and can improve precision in some situations.

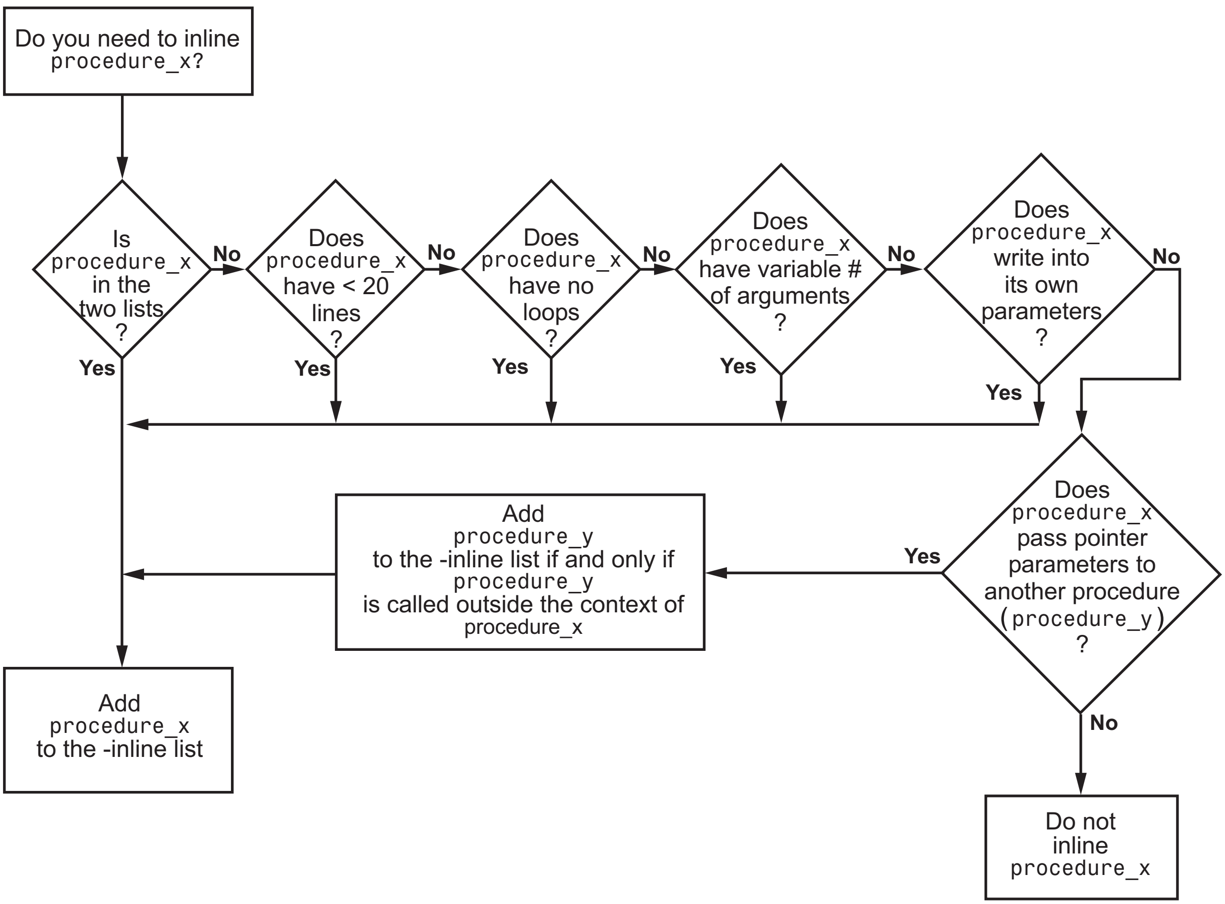
Suppose that the log file contains two lists that look like the following:

```
%%% BEGIN PRE%%%
* inlining procedure_1 could decrease the number of aliases of parameter #3 from 752
                                                                                 to 3
* inlining procedure_2 could decrease the number of aliases of parameter #3 from 2687
                                                                                 to 3
* inlining procedure_3 could decrease the number of aliases of parameter #4 from 1542
                                                                                 to 4
…
%%%END PRE%%%

%%% BEGIN PRE%%%
…
procedures that write the biggest sets of aliases: procedure_4  (2442),
                                                          procedure_2 (1120),
procedure_5 (500)
…
%%%END PRE%%%
```

Looking at this example log file, procedure_1 through procedure_5 are good candidates to be inlined.

Follow the steps on this flow chart to determine which procedure_*x* must be inlined, that is, for which procedure_*x* you need to specify the -inline option.



Here are three example situations:

- Using the preceding log file, inline `procedure_2` because it appears in both lists. In addition, if it has no loops, inline `procedure_5`.
- Inline procedures that have a variable number of arguments, such as `printf` and `sprintf`.
- In the following examples, consider whether each procedure, `procedure_x`, passes its pointer parameters to another procedure.

<table>
<tr><th colspan="3">Does this procedure pass pointer parameters?</th></tr>
<tr><th>Yes</th><th>No</th><th>No</th></tr>
<tr><td><pre>void procedure_x(int *p)
{
 procedure_y(p)
}</pre></td><td><pre>void procedure_x(int q)</pre></td><td><pre>void procedure_x(int *r)
{
 *r = 12
}</pre></td></tr>
</table>

Exercise caution when you inline procedures. Inlining duplicates code and can drastically increase the number of lines of code, resulting in increased computation time.

For example, suppose `procedure_2` has 30 lines of codes and is called 30 times; `procedure_5` has 100 lines of code and is called 50 times. The number of lines of code becomes more than 5000 lines, so computation time increases.

Reduce Task Complexity

If the code contains two or more tasks, and particularly if there are more than 10,000 alias reads, set the option **Reduce task complexity** (`-lightweight-thread-model`). This option reduces:

- Task complexity
- Verification time

However, using this option causes more oranges and a loss of precision on reads of shared variables through pointers.

Reduce Variable Complexity

Variable Characteristic	Action
The types are complex.	Set the `-k-limiting [0-2]` option. Begin with 0. Go up to 1, or 2 in order to gain precision.
There are large arrays	Set the `-no-fold` option.

Choose Lower Precision

The amount of simplification applied to the data representations depends on the required precision level (O0, O2), Polyspace software adjusts the level of simplification. For example:

- `-O0` — shorter computation time
- `-O2` — less orange warnings
- `-O3` — less orange warnings and longer computation time. Use this option for projects containing less than 1,000 lines of code.

Storage of Temporary Files

By default, Polyspace uses the standard `/tmp` or `C:\Temp` folder to store temporary files. If you do not have write permissions for your temporary folder, you can encounter the error, `Unable to create folder "C:\Temp\Polyspace\`*`foldername`*. There are two possible solutions to this error:

- Change the permissions of your standard temporary folder so you have full read and write privileges.
- Specify the option `-tmp-dir-in-results-dir`. Instead of the standard temporary folder, Polyspace uses a subfolder of the results folder. Using this option may affect processing speed if the results folder is mounted on a network drive. Use this option only when the temporary folder partition is not large enough and troubleshooting is required. You can specify `-tmp-dir-in-results-dir` through a line command or the **Advanced Settings** > **Other** field.

Reviewing Verification Results

Open Remote Verification Results

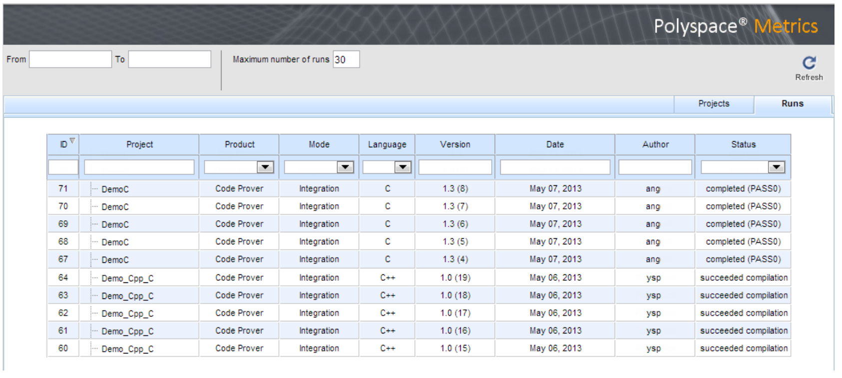
Use Polyspace Metrics to open results from a remote verification.

1 In the address bar of your Web browser, enter the following URL:

`protocol://ServerName:PortNumber`

- `protocol` is either `http` (default) or `https`.
- `ServerName` is the name or IP address of your Polyspace Metrics server.
- `PortNumber` is the Web server port number (default 8080).

For reference, save the Polyspace Metrics Web page as a bookmark.



2 Click the **Project** or **Version** cell of your verification.

The software downloads and opens the results in the Results Manager perspective of Polyspace Code Prover.

For more information, see:

- “Set Up Polyspace Metrics”
- “Results Manager Overview”

Download Remote Verification Results From Command Line

To download verification results from the command line, use the `polyspace-jobs-manager` command:

```
MATLAB_Install\polyspace\bin\polyspace-jobs-manager -download
-job Verification_ID -results-folder FolderPath
```

For more information, see “Manage Remote Analyses at the Command Line”.

After downloading results, use the Results Manager to view the results. See “Open Local Verification Results”.

Open Results of File-by-File Batch Verification

This example shows how to open the results of a file-by-file batch verification. When you run a file-by-file batch verification, the software submits each source file separately for verification. Polyspace Metrics displays these verifications using a tree structure.

ID	Project	Product	Mode	Language	Version	Date
5	Polyspace	Code Prover	Unit By Unit	C	1.0 (3)	May 21, 2013
5/1	example			C		
5/2	initialisations			C		
5/3	main			C		
5/4	single_file_analysis			C		
5/5	tasks1			C		
5/6	tasks2			C		

Before you view the results, you must run a file-by-file batch verification. For more information, see “Run File-by-File Batch Verification”.

1 Open your results in Polyspace Metrics. For more information, see “Open Remote Verification Results”.
2 Select the **Runs** tab.
3 To download and open results for all files in the project:
   a In the parent row, click the **Project** or **Version** cell.
   b Select the **Download all results sets** check box. Then click **OK**.
4 To download and open results for a specific file:
   a In the parent row, click the **Project** or **Version** cell.
   b In the Select the results set to review dialog box, from the **Results Set** drop-down list, select the results that you want to review. Then click **OK**.

Open Results of File-by-File Verification

This example shows how to open the results of a file-by-file verification performed in the user interface. For more information on running the verification, see “Run File-by-File Verification”. After verification, your results appear in the **Project Browser** under the **Result** node in your module.

1 To open result for each source file, double-click the corresponding result file under the **Result** node. The result file has the same name as the source file.

2 To see an overview of the verification:

   a Under the **Result** node, right-click the  icon.

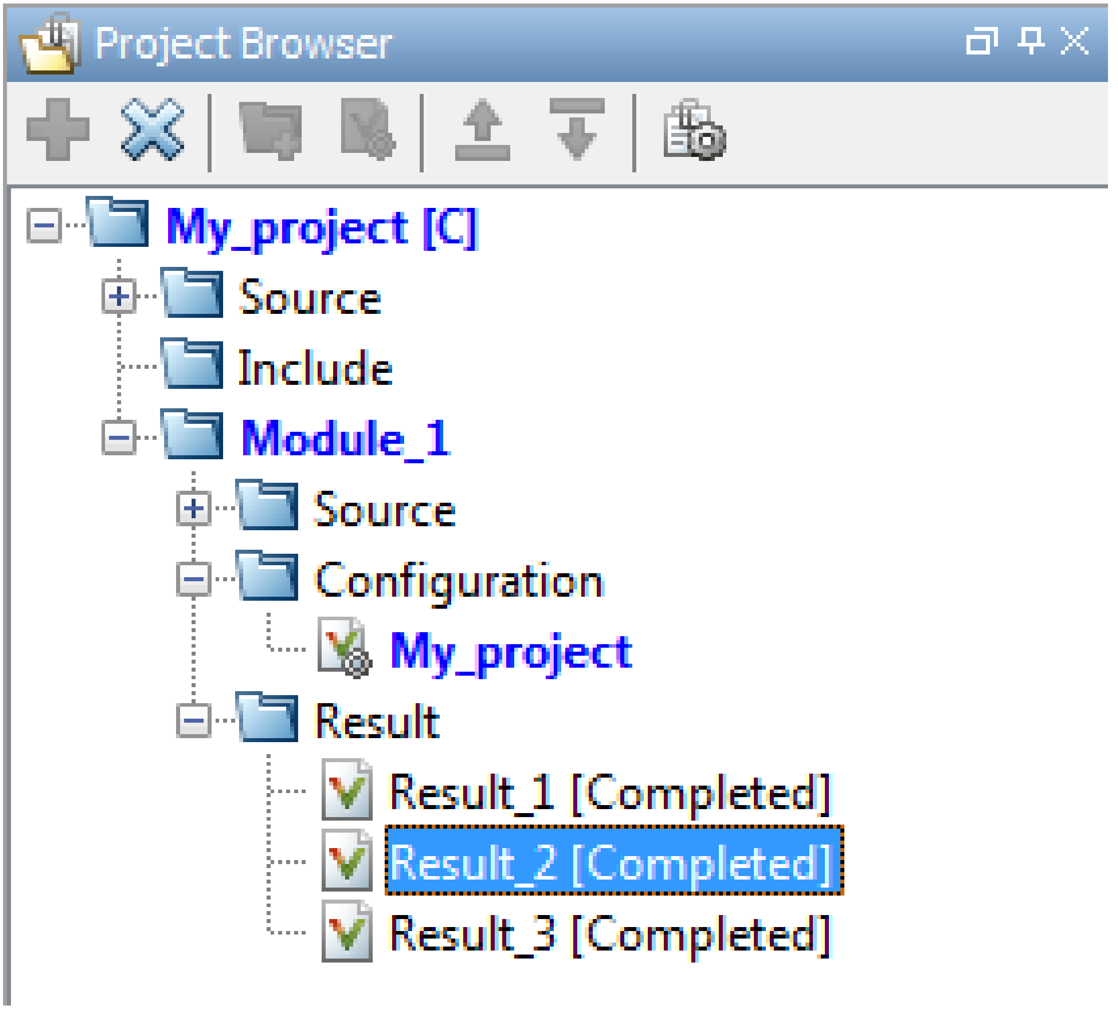
   b Select **Open Folder with File Manager**.

   Your result folder opens in your file explorer.

   c Open the `html` file `Synthesis` in the result folder.

Open Local Verification Results

1 In the Project Manager perspective, on the **Project Browser**, navigate to the results that you want to review.



2 Double-click the results file, for example, **Result_1**.

The software opens the verification results in the Results Manager perspective.

Alternatively:

1 On the Polyspace Code Prover toolbar, select **File** > **Open Result**.
2 In the Open Results dialog box, navigate to the results folder. For example:

   `My_project\Module_1\Result_1`
3 Select the results file, for example, `My_project.pscp`.
4 Click **Open**.

Search Results in Results Manager

This example shows how to search for occurrences of a variable or function name in the source code. Search for the variable or function name in the following situations:

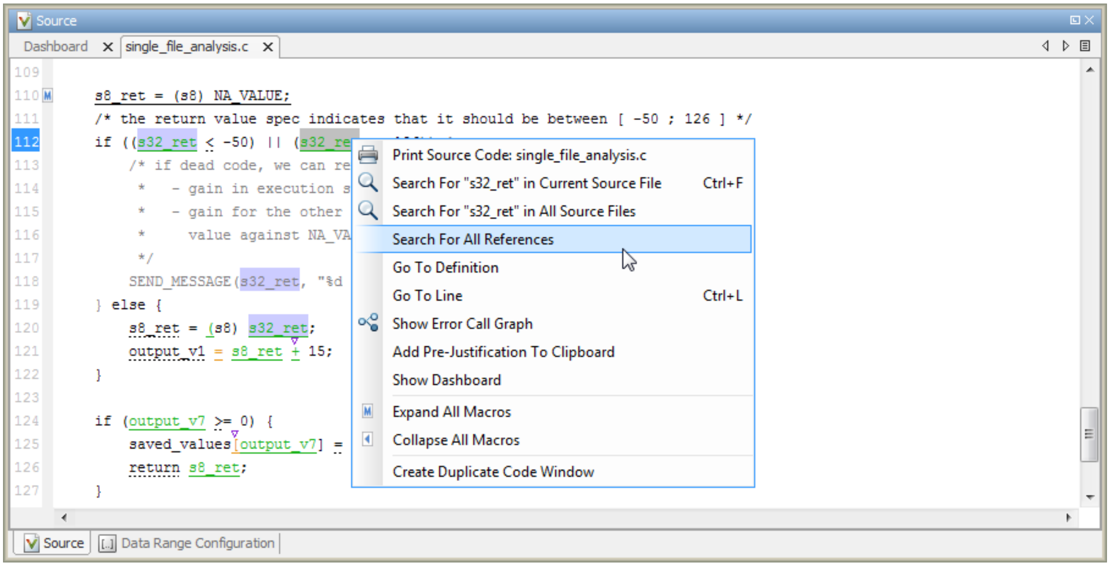
- A read/write operation on a variable causes a check. However, the check might be related to an instruction prior to this read/write operation.

  Selecting a check in the **Results Summary** pane displays the read/write operation only. On the **Source** pane, you can look in the source code for prior instructions containing the variable name. Instead, searching for the occurrences is an easier way to find and quickly navigate to them.

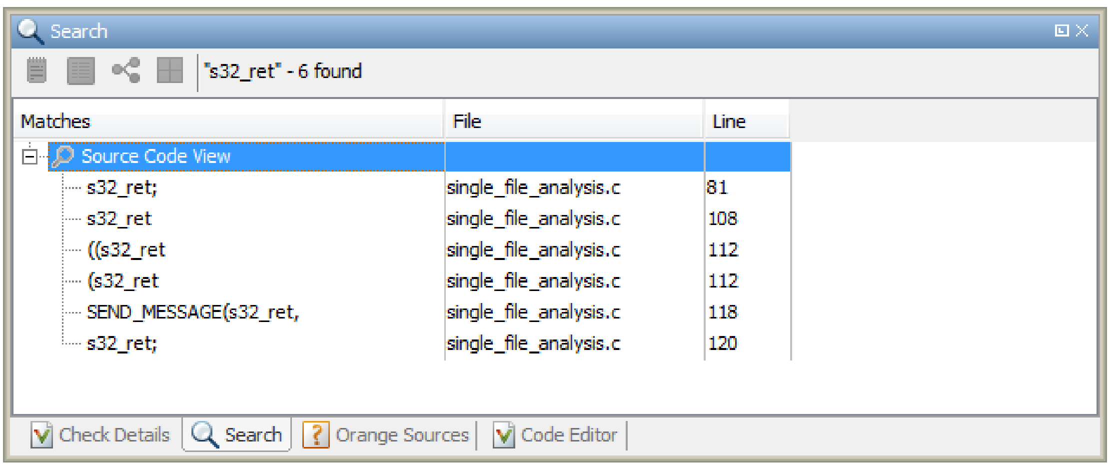
  For instance, consider the check, `Out of bounds array index`. Though an access operation on the array causes the check, it is useful to quickly navigate to the array declaration.
- A function call causes a check. However, the check might be related to an instruction in the function definition. Therefore, it is useful to quickly navigate to the function definition.

Search Variable Name

1 On the **Source** pane, right-click the variable name and select **Search For All References**.



The **Search** tab displays all occurrences of the variable name.



2 To navigate to a particular occurrence of the variable name in the source code, use the up and down arrow keys.

The **Source** pane displays the corresponding line of code.

3 If the variable is a global variable, use **Variable Access** pane. For more information, see “Variable Access”.

Search Function Name

1 On the **Source** pane, right-click the function name and select **Search For All References**.

The **Search** tab displays all occurrences of the function name.

2 To navigate to a particular occurrence of the function name in the source code, use the up and down arrow keys.

The **Source** pane displays the corresponding line of code.

3 To navigate from a function call to the function definition, right-click the function name and select **Go To Definition**.

Set Character Encoding Preferences

If the source files that you want to verify are created on an operating system that uses different character encoding than your current system (for example, when viewing files containing Japanese characters), you receive an error message when you view the source file or run certain macros.

The **Character encoding** option allows you to view source files created on an operating system that uses different character encoding than your current system.

To set the character encoding for a source file:

1. Select **Tools** > **Preferences**.
2. In the Polyspace Preferences dialog box, select the **Character encoding** tab.


Polyspace Preferences
Server Configuration
Project and Results Folder
Editors
Tools Menu
Review Configuration
Review Statuses
Miscellaneous
Character Encoding
Specifies the character encoding used by the operating system on which the source file was created.
This allows you to view source files created on an operating system that uses different character encoding than the current system.
Select the character encoding that you want to use.
Latin/Western European (ISO) (ISO-8859-1)
16-bits UCS Transformation Format, byte order identified by an optional byte-order mark (UTF-16)
16-bits Unicode (or UCS) Transformation Format, little-endian byte order with byte-order mark (x-UTF-16LE-BOM)
16-bits Unicode Transformation Format, big-endian byte order (UTF-16BE)
16-bits Unicode Transformation Format, little-endian byte order (UTF-16LE)
32-bits UCS Transformation Format, byte order identified by an optional byte-order mark (UTF-32)
32-bits Unicode (or UCS) Transformation Format, big-endian byte order with byte-order mark (X-UTF-32BE-BOM)
32-bits Unicode (or UCS) Transformation Format, little-endian byte order with byte-order mark (X-UTF-32LE-BOM)
32-bits Unicode Transformation Format, big-endian byte order (UTF-32BE)
32-bits Unicode Transformation Format, little-endian byte order (UTF-32LE)
8-bits UCS Transformation Format (UTF-8)
American Standard Code for Information Interchange (US-ASCII)
Arabic (IBM420)
Arabic (IBM864)
Arabic (Macintosh) (x-MacArabic)
Arabic (Windows) (windows-1256)
Arabic - Windows (x-IBM1046)
Austria, Germany (IBM273)
Baltic (IBM775)
Baltic (Windows) (windows-1257)
Canadian French (MS-DOS) (IBM863)
Catalan/Spain, Spanish Latin America (IBM284)
Chinese (AIX) (x-IBM1383)
Chinese (AIX) (x-IBM834)
Chinese (AIX) (x-IBM964)
Chinese (Hong Kong, Taiwan) (x-IBM950)
Chinese (OS/2) (x-IBM1381)
Chinese (Simplified) (GBK)
Chinese (Simplified) Host mixed with 1880 UDC, superset of 5031 (x-IBM935)
Chinese (Simplified) PRC standard (GB18030)
Chinese (Simplified), GB2312 in ISO 2022 CN form (x-ISO-2022-CN-GB)
Chinese (Traditional) (Big5)
Select current operating system character encoding: Western European (Windows) (windows-1252)
Note: You must restart Polyspace to use the new character encoding settings.
OK
Apply
Cancel

3. Select the character encoding used by the operating system on which the source file was created.
4. Click **OK**.
5. Close and restart the Polyspace verification environment to use the new character encoding settings.

Open Results for Generated Code

When opening results for automatically generated code, the software must know which code generator created the code, so that it can interpret comments and create back-to-source links in the Results Manager perspective.

If you start the verification from Simulink, the software automatically creates a file in the results folder called `code_generator_used.txt` to provide this information. Otherwise, you must provide this information manually.

To manually specify the code generator that created the code:

1. Open your results in the Results Manager perspective.
2. Select **Tools** > **Code Generator Support** > ***code_generator***

Manually Create the Code Generator Text File

To avoid specifying the code generator each time you open your results, you can manually create a file named `code_generator_used.txt` in your results folder. The software then automatically uses this file each time you open the results.

The format of this file is:

```
<Code generator>
MATLABROOT=<Path to MATLAB>
ModelVersion=<model name>:<model version>
```

`<Code generator>` can be either `RTWEmbeddedCoder` or `TargetLink`.

For example:

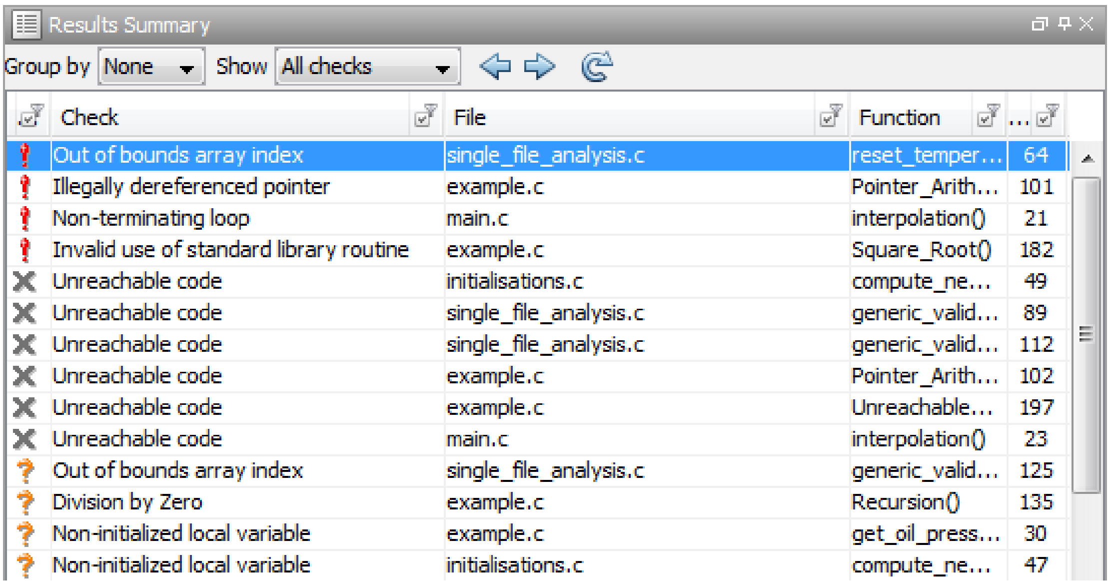
```
RTWEmbeddedCoder
MATLABROOT=C:\MATLAB\R2010b
ModelVersion=demo_ml:1.94
```

Review Results Progressively

This example shows how to review checks progressively using the Results Manager perspective.

Review Results

1 Select the first check on the **Results Summary** pane.



- The **Source** pane displays the source code for this check.
- The **Check Details** pane displays information about this check.

2 Review the check. For more information, see "Assign Review Status to Result".

3 Click the forward arrow  to go to the next check in the set. Review this check.

4 Continue to click the forward arrow until you have reviewed through all of the checks.

Track Review Progress

1 To see what percentage of checks you have reviewed, broken down by color and type:

   a. On the **Results Summary** pane, select **Group by** > **Family**.
   b. For each color and type, view the entries in the **Justified** column.
2. To see what percentage of checks you have reviewed, broken down by file and function:
   a. On the **Results Summary** pane, select **Group by** > **File**.
   b. For each file and function, view the entries in the **Justified** column.

Related Examples

- "Assign Review Status to Result"
- "View Call Sequence for Checks"

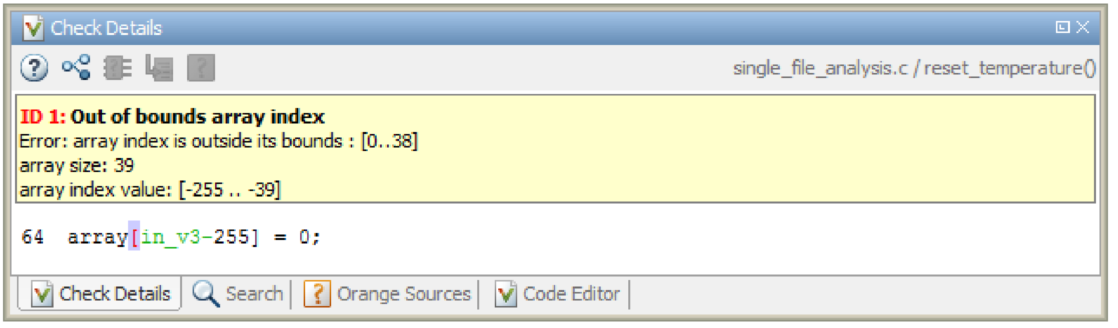
Assign Review Status to Result

This example shows how to review and comment checks using the Results Manager perspective. When reviewing checks, you can assign a status to checks, and enter comments to describe the results of your review. These actions help you to track the progress of your review and avoid reviewing the same check twice.

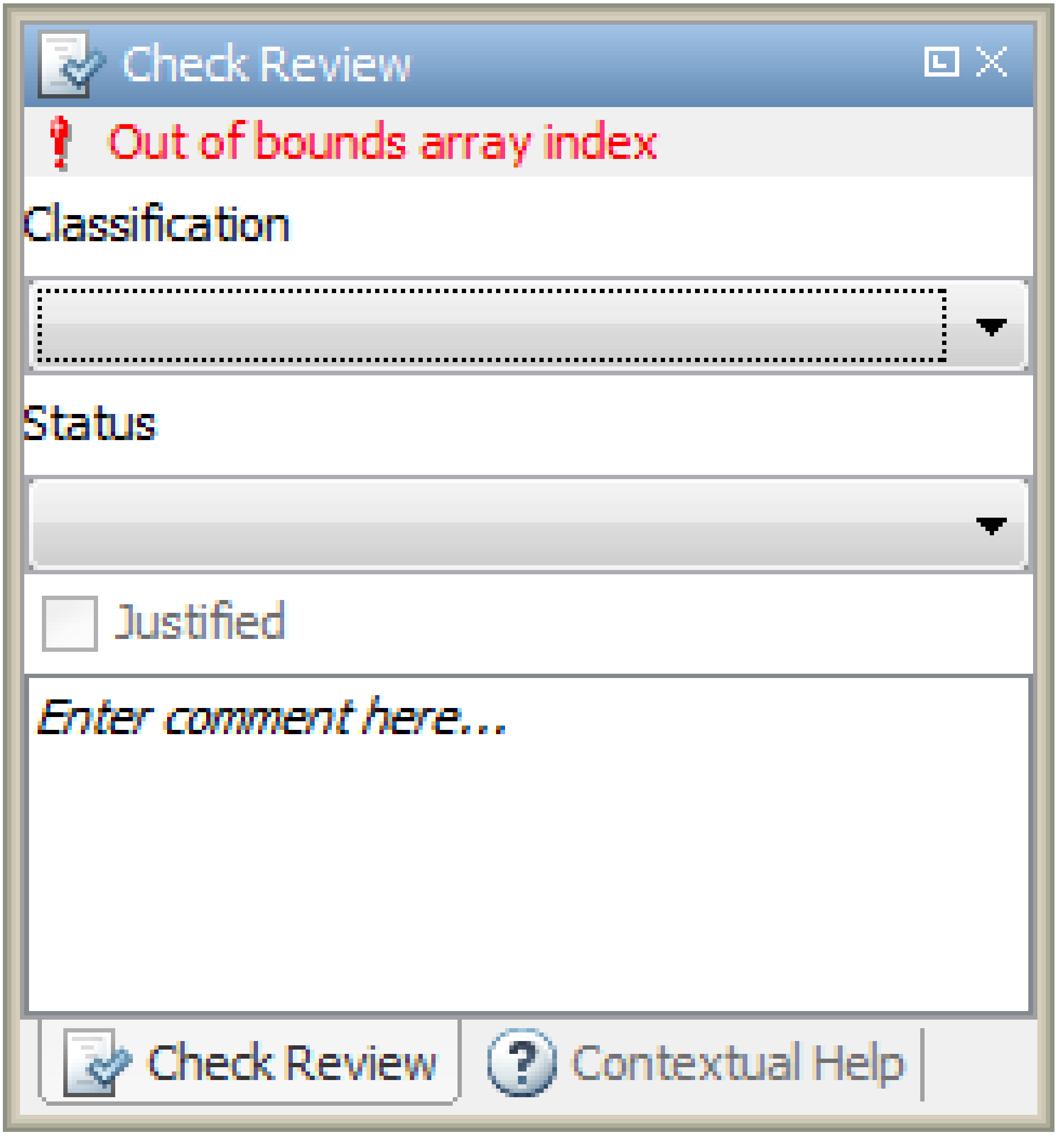
Review Individual Check

1 On the **Results Summary** pane, select the check that you want to review.

The **Check Details** pane displays information about the current check.



The **Check Review** pane displays fields where you can enter review information.



2 Select a **Classification** to describe the severity of the issue:

- `Unset`
- `High`
- `Medium`
- `Low`
- `Not a defect`

3 Select a **Status** to describe how you intend to address the issue:

- `Fix`
- `Improve`
- `Investigate`
- `Justify with annotations`
- `No action planned`
- `Other`
- `Restart with different options`
- `Undecided`

4 To justify the check, select one of the **Status** options, `Justify with annotations` or `No action planned`.

To view the percentage of checks justified per file and function:

a On the **Results Summary** pane, select **Group by** > **File**.

b View the entries on the **Justified** column.

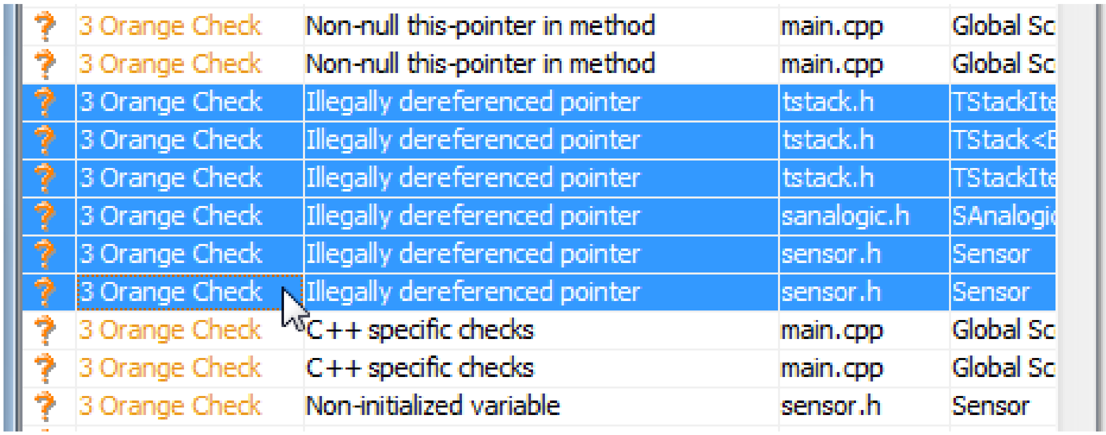
5 In the **Comment** field, enter remarks, for example, defect or justification information.

Note: You can also enter the review information through the **Classification**, **Status**, and **Comment** fields on the **Results Summary** pane.

Review Group of Checks

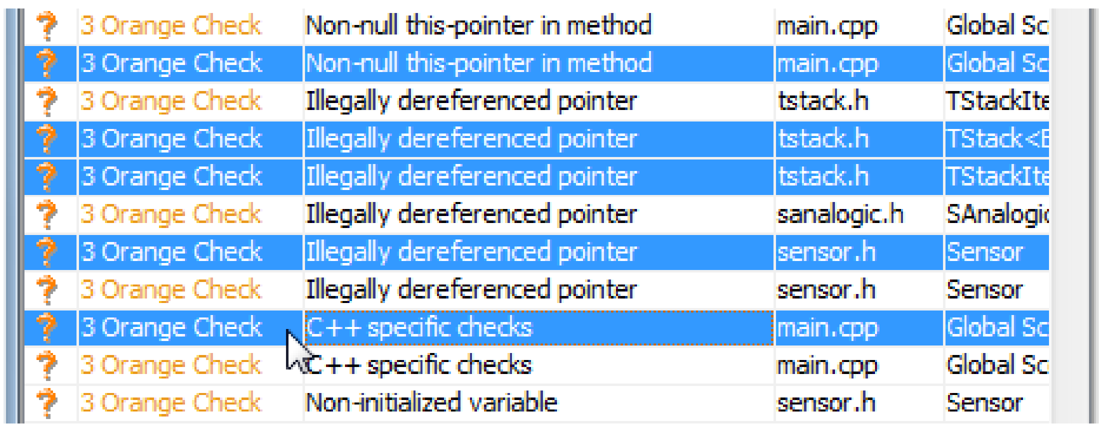
1 On the **Results Summary** pane, select a group of checks using one of the following methods:

- For contiguous checks, left-click the first check. Then **Shift**-left click the last check.



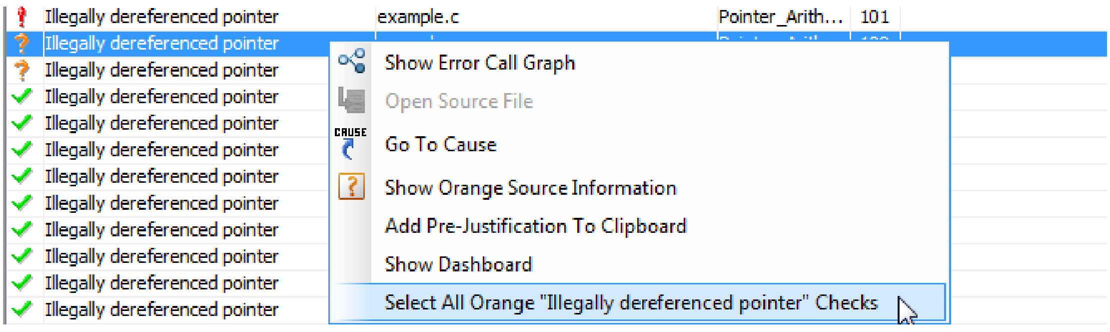
To group together checks belonging to a certain category, click the **Check** column header on the **Results Summary** pane.

- For non-contiguous checks, **Ctrl**-left click each check.



- For checks of a similar color and category, right-click one check. From the context menu, select **Select All *`Color Type`* Checks**

For instance, select **Select All Orange "Illegally dereferenced pointer" Checks**.



2 On the **Check Review** tab, enter the required information. The software applies this information to the selected checks.

Save Review Comments

After you have reviewed your results, save your comments with the verification results. Saving your comments makes them available the next time that you open the results file, allowing you to avoid reviewing the same check twice.

To save your review comments, select **File** > **Save**. Your comments are saved with the verification results.

Track Review Progress

1 To see what percentage of checks you have reviewed, broken down by color and type:

   a On the **Results Summary** pane, select **Group by** > **Family**.

   b For each color and type, view the entries in the **Justified** column.

2 To see what percentage of checks you have reviewed, broken down by file and function:

   a On the **Results Summary** pane, select **Group by** > **File**.

   b For each file and function, view the entries in the **Justified** column.

Related Examples

- “Organize Results Using Filters and Groups”

- “Customize Review Status”
- “Review Coding Rule Violations”

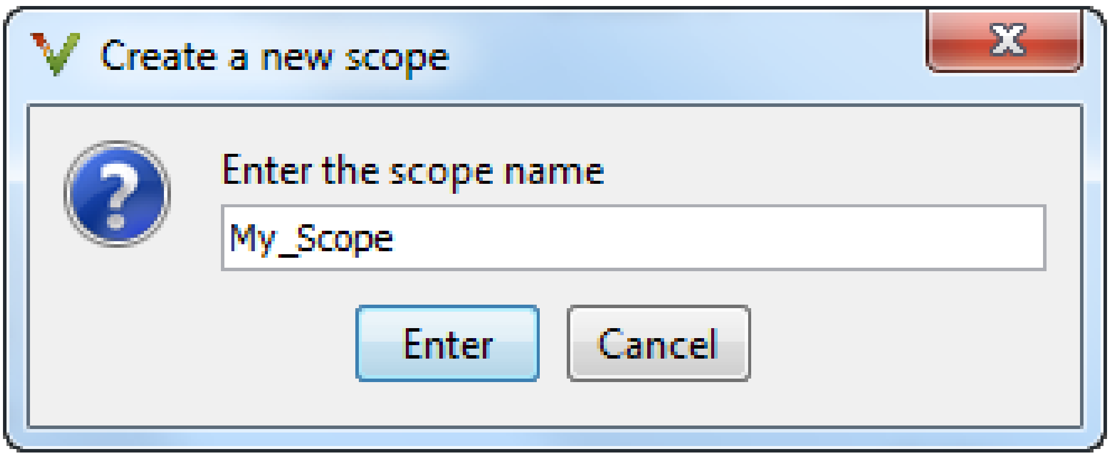
Organize Results Using Review Scopes

This example shows how to define and use a custom review scope to control the number and type of orange checks displayed on the **Results Summary** pane. Define a custom methodology to:

- Prioritize the orange checks that you review.
- Set standards that your team of developers must meet.

Define a Custom Scope

1. In the Polyspace user interface, select **Tools** > **Preferences**.
2. In the Polyspace Preferences dialog box, select the **Review Scope** tab.
3. From the drop-down list on this tab, select `Add a scope...`.
4. Enter a name for your scope in the Create a new scope dialog box. For this example, enter the name, `My_Scope`. Then, click **Enter**.

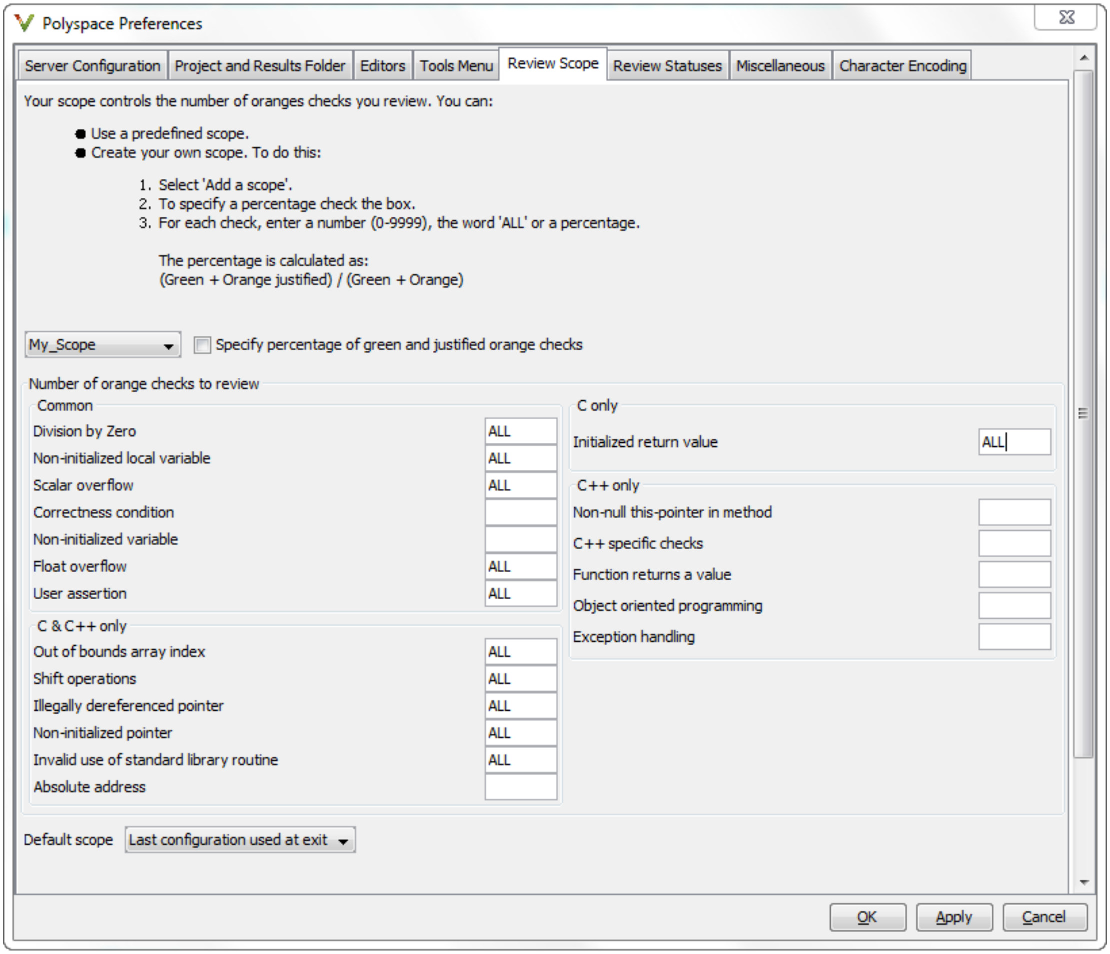


5. If you want to specify orange checks by percentage instead of number, select **Specify percentage of green and justified orange checks**.

   The percentage is calculated by:

```
(green checks + justified orange checks) x 100/(green checks + total orange checks)
```

6. Enter the total number of checks (or percentage of checks) to display for each type of check for your methodology. If you want to review all orange checks of a certain type, enter `ALL`.



In this example, ALL was entered for ZDV indicating that all **Division by Zero** orange checks must be displayed when you choose **Show** > **My_Scope** on the **Results Summary** pane.

Click **OK** to save the scope and close the dialog box.

Use Your Custom Scope

1 Open your verification results.

2 On the **Results Summary** pane, select **Show** > **My_Scope**.

The **Results Summary** pane displays orange checks according to the definition specified for **My_Scope**. For instance, it displays all **Division by Zero** orange checks.

Related Examples

- "Organize Check Review"
- "Organize Results Using Filters and Groups"

Organize Results Using Filters and Groups

This example shows how to filter and group checks on the **Results Summary** pane. To organize your review of checks, use filters and groups when you want to:

- Review certain categories of checks in preference to others. For instance, you first want to address checks resulting from **Out of bounds array index**.
- Not address the full set of coding rule violations detected by the coding rules checker.
- Not review checks you have already justified.

  Typically, in your second or later rounds of review, you would have some checks already justified.
- Review only those checks that you have already assigned a certain status. For instance, you want to review only those checks to which you have assigned the status, `Investigate`.
- Review all checks in the body of a particular file or function. Because of continuity of code, reviewing these checks together can help you organize your review process.

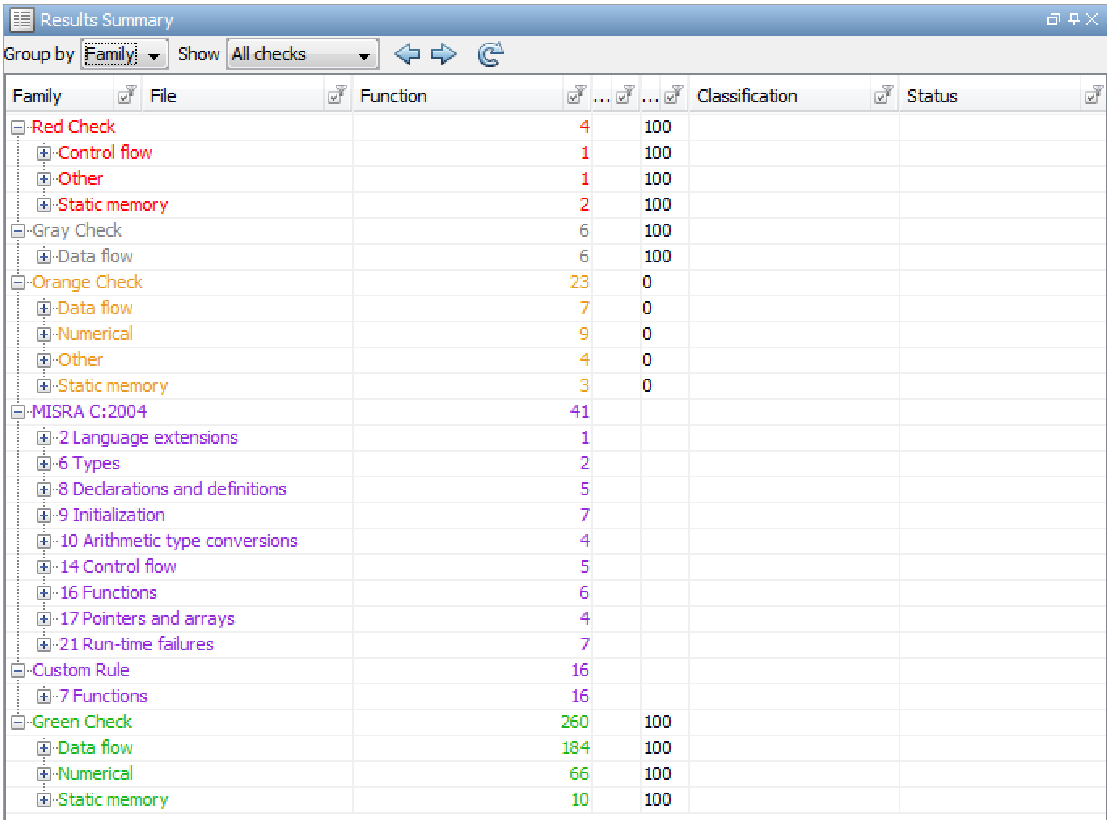
  You can also review checks in a file if you have written the code for that file only and not the entire set of source files used for verification.
- Not review the checks in automatically generated functions.
- C++ only: Review all checks dealing with a class definition.

Review Checks in a Given Category

1. To view red **Out of bounds array index** checks:

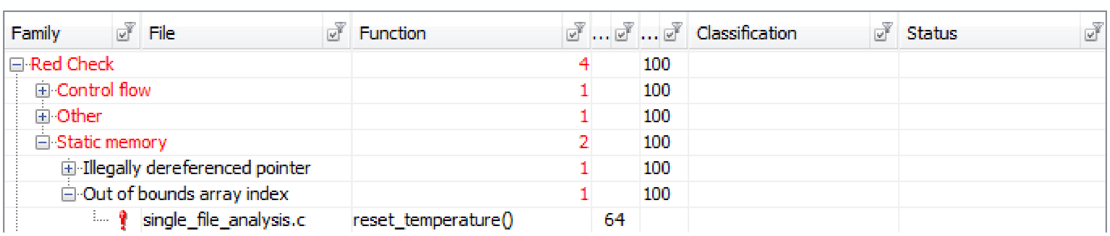
   a. On the **Results Summary** pane, select **Group by** > **Family**.

      The checks are grouped by type of check.



b Under the category **Red Check**, expand the subcategory **Static memory**.

You see the subcategory **Out of bounds array index**.



Expand **Out of bounds array index** to view all red checks of this kind.

To see further information about a check, select it. The information appears on the **Check Details** pane.

2 To view orange **Out of bounds array index** checks, repeat the previous steps for the subcategory **Static memory** under the category **Orange Check**.

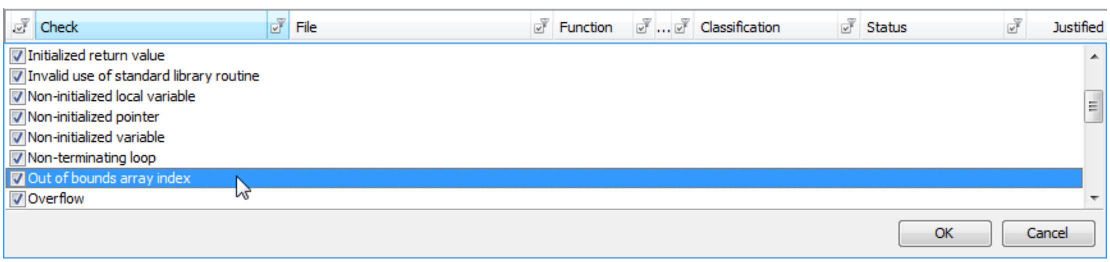
3 To view only the checks resulting from the error, **Out of bounds array index**:

a On the **Results Summary** pane, select **Group by** > **None**.

b Place your cursor on the **Check** column head.

c Click the filter icon.

A context menu lists the filter options available.



d Clear the **All** check box.

e Scroll down to the **Out of bounds array index** check box and select it. Click **OK**.

The **Results Summary** pane displays only the checks resulting from the **Out of bounds array index** error.

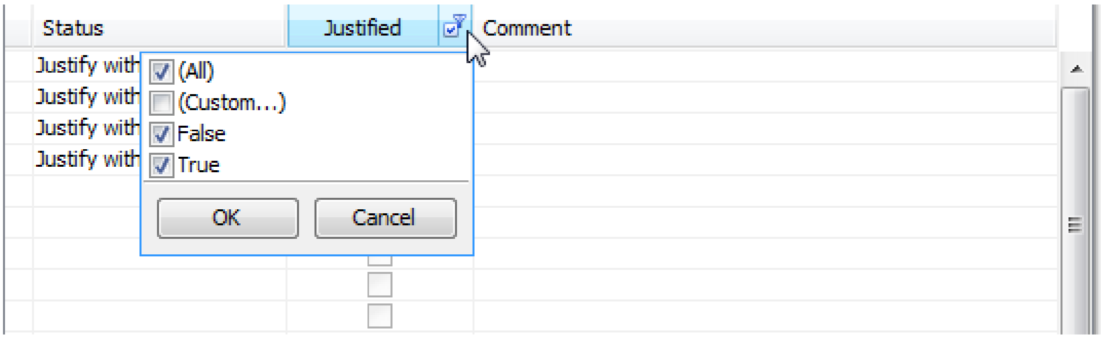
Review Checks Not Justified

To review only the checks that you have not justified:

1 On the **Results Summary** pane, place your cursor on the **Justified** column head.

2 Click the filter icon.

A context menu lists the filter options available.



3 Clear the **True** check box. Click **OK**.

The **Results Summary** pane displays only the checks that you have not justified.

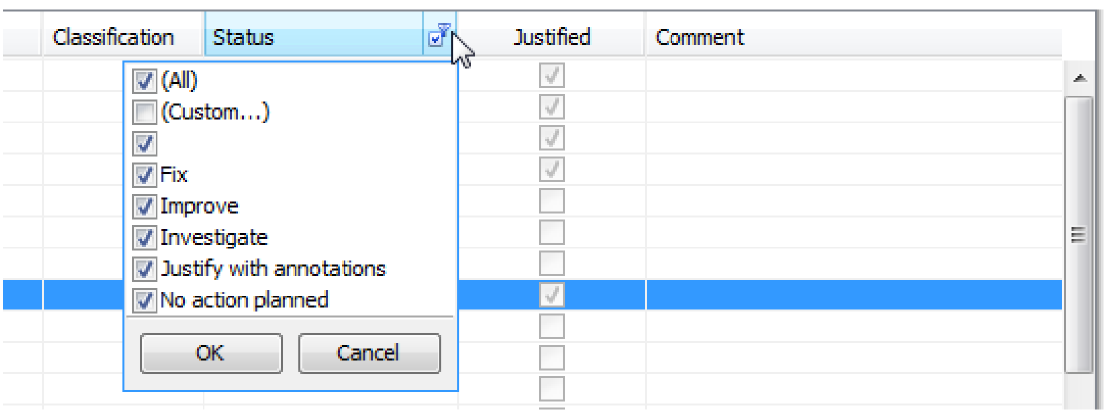
Review Checks with Given Status

To review only the checks with `Investigate` status:

1 On the **Results Summary** pane, place your cursor on the **Status** column head.

2 Click the filter icon.

A context menu lists the filter options available.



3 Clear the **All** check box.

4 Select the **Investigate** check box. Click **OK**.

The **Results Summary** pane displays only the checks with the `Investigate` status.

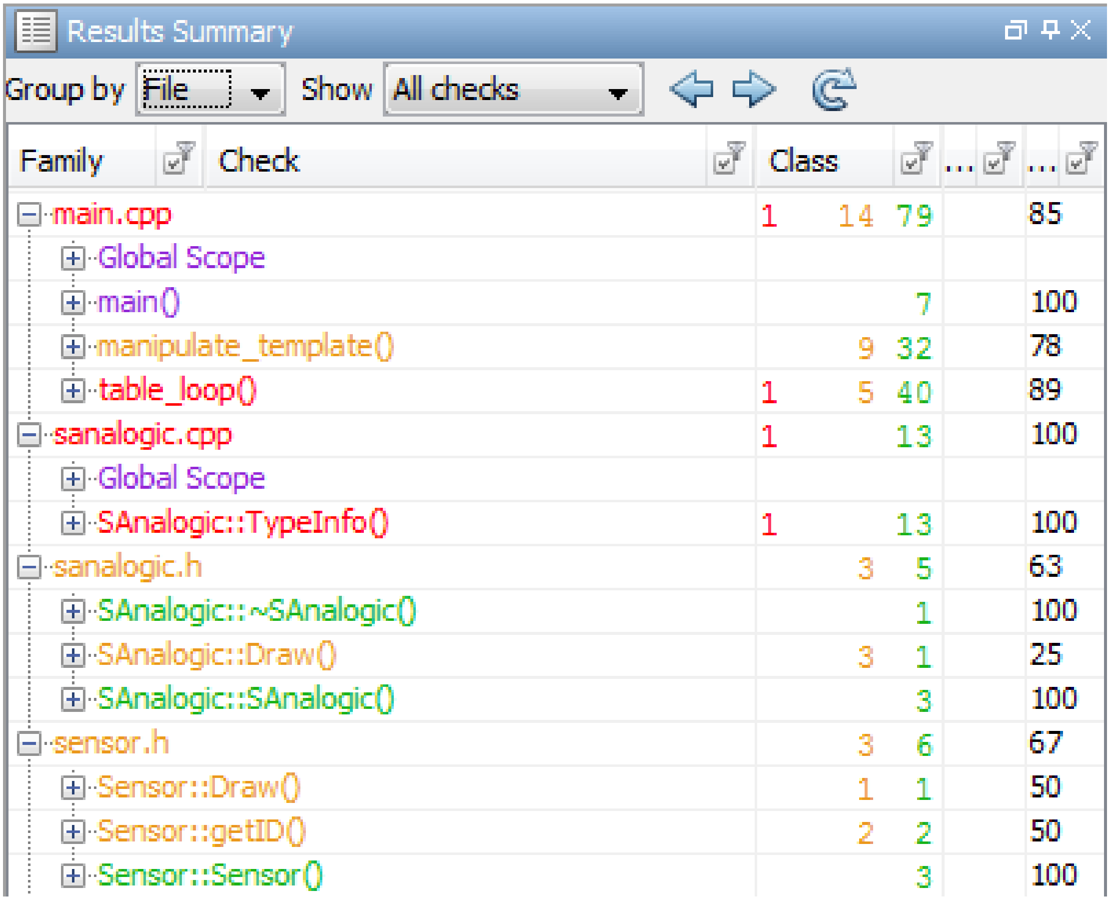
Review All Checks in a File

1 To review the checks in the file, `tasks.cpp`:

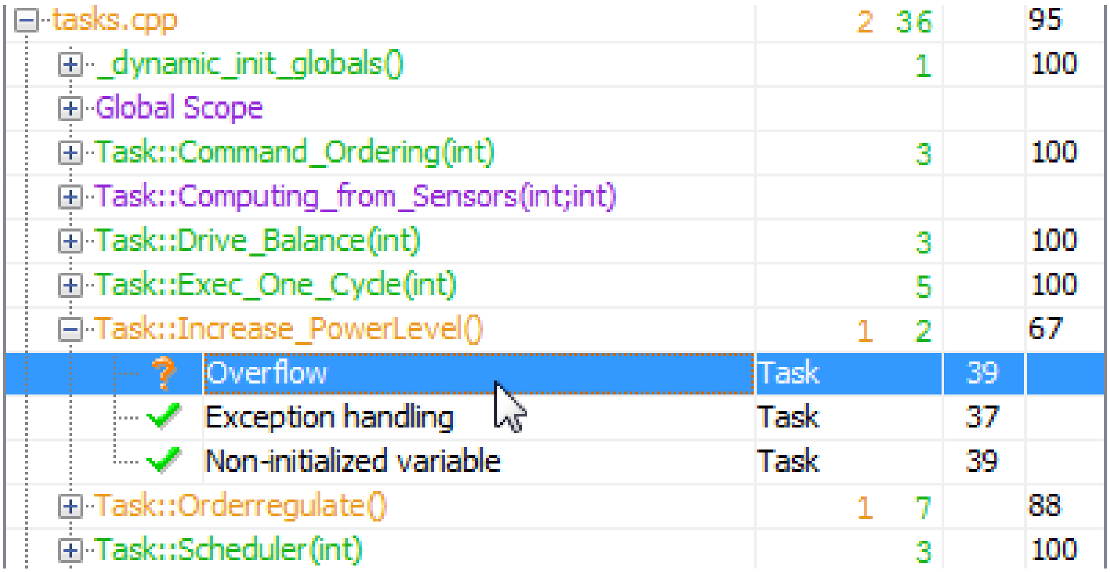
a On the **Results Summary** pane, select **Group by** > **File**.

The checks displayed are grouped by files. The file names are sorted alphabetically. Within each file name, the checks are grouped by functions, sorted alphabetically. Each file or function is colored by the most severe check that occurs. The severity decreases in this order:

- Red
- Gray
- Orange
- Purple
- Green



b To view the checks in `tasks.cpp`, expand any function name under the category, **tasks.cpp**.



To view further information on a check, select the check. The information on the check appears on the **Check Details** pane.

2 To view only the checks in `tasks.cpp`:

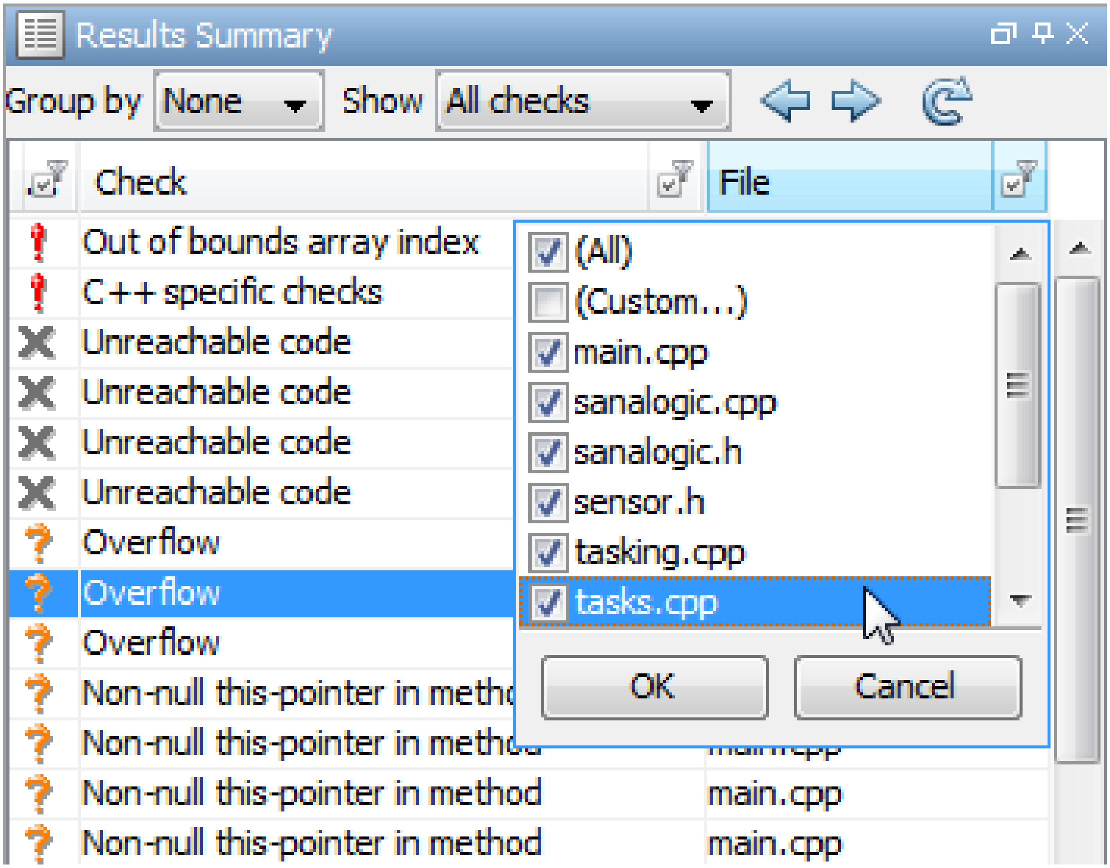
a On the **Results Summary** pane, select **Group by** > **None**.

The **Results Summary** pane displays all checks without any grouping.

b Place your cursor on the **File** column head.

c Click the filter icon.

A context menu lists the filter options available.



3 Clear the **All** check box.

4 Select the **tasks.cpp** check box. Click **OK**.

The **Results Summary** pane displays only the checks in `tasks.cpp`.

Tip If you apply a filter on a column on the **Results Summary** pane, the column header displays the number of rows suppressed.

Related Examples

- "Filter and Group Coding Rule Violations"

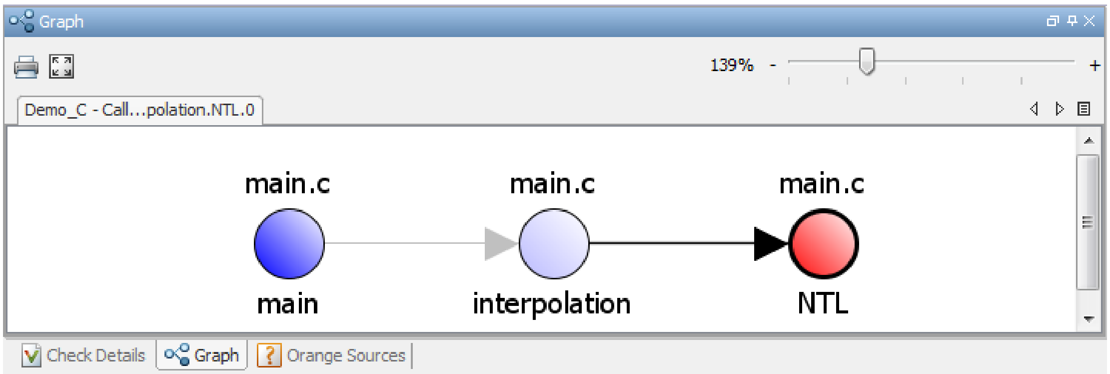
View Call Sequence for Checks

This example shows how to display the call sequence that leads to the code line associated with a check.

1 On the **Results Summary** pane, select the check that you want to review.

2 On the **Check Details** pane, click the Show error call graph button, .

A **Graph** tab appears, displaying the call graph.



3 Select a node to navigate to the procedure definition in the source code.

The **Source** pane displays the procedure definition.

4 Select the terminal node to navigate back to the code line associated with the check.

Related Examples

- "View Call Tree for Functions"
- "View Access Graph for Global Variables"

View Call Tree for Functions

In this section...

The call tree (or call graph) shows the calling relationship between functions (and tasks) in a program. From the call tree, for each function or task, `foo`, you can see its:

- Callers: functions and tasks calling `foo`.
- Callees: functions and tasks called by `foo`.

Sometimes, an error in a function might be related to an instruction in its callers or callees. Therefore, to review errors quickly, it is useful to:

- View all callers and callees of a function without navigating in the source code. The callers and callees are listed even for indirect calls through function pointers.
- Navigate quickly between a function, and its callers and callees.
- Verify dataflow for certification purposes. For more information, see "Dataflow Verification".

You can perform these tasks from the **Call Hierarchy** pane in the Results Manager perspective.

For a complete description of the **Call Hierarchy** pane, see "Call Hierarchy".

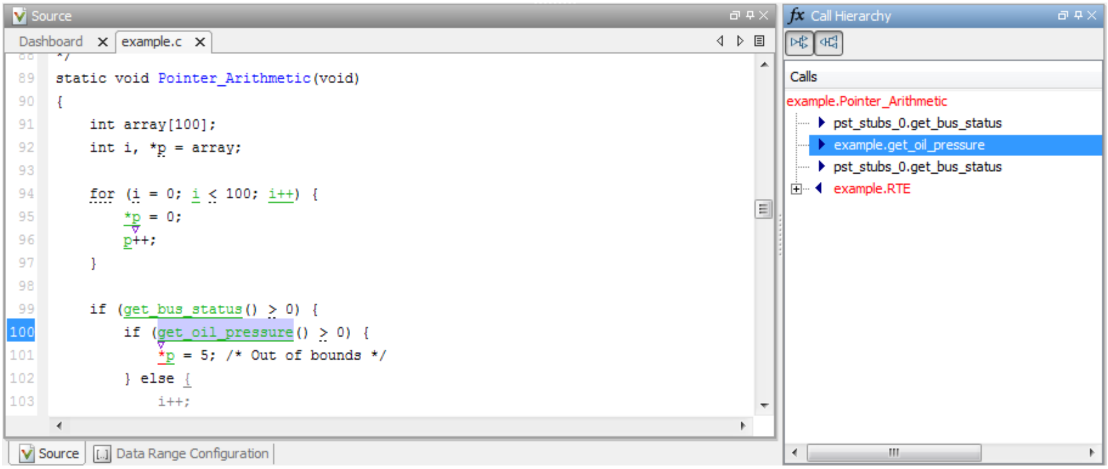
Note: If you do not see the **Call Hierarchy** pane in the Results Manager perspective, select **Window** > **Show/Hide View** > **Call Hierarchy**.

View Callers and Callees of a Function

You can view all callers and callees of a function on the **Call Hierarchy** pane.

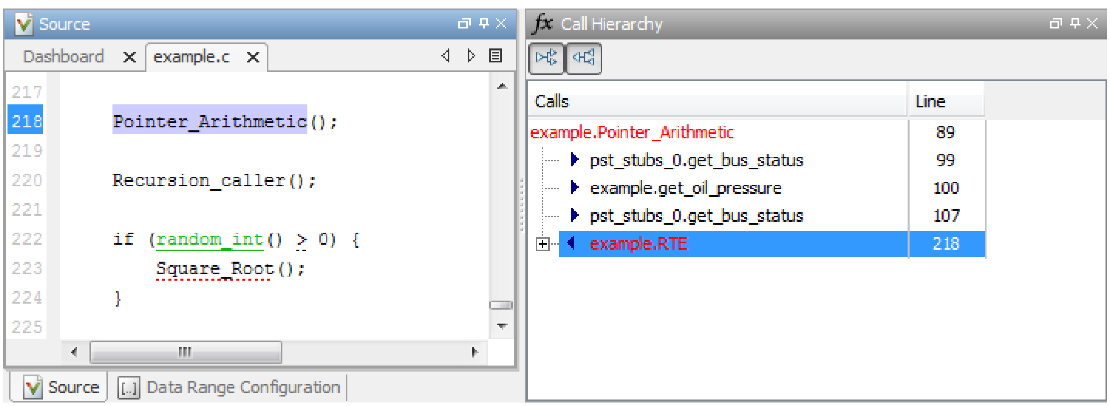
1. On the **Results Summary** pane or on the **Source** pane, select a check. The function containing the check appears on the **Call Hierarchy** pane.
2. On the **Call Hierarchy** pane, select a callee of the function. The callees are listed below the function name and marked by ▶ (functions) or ||▶ (tasks).

On the **Source** pane, the current line shows where the callee is called.



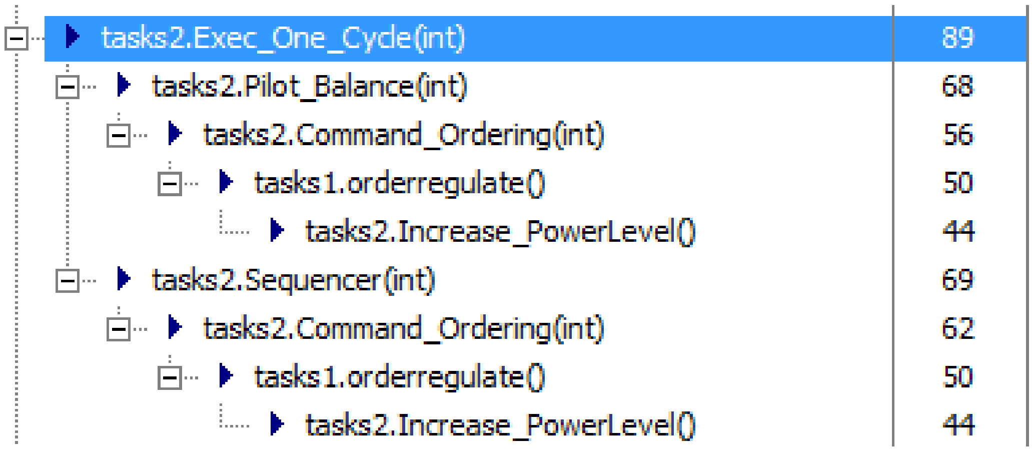
3 Select a caller name. These are listed below the function name and marked by (functions) or (tasks).

In the **Source** pane, the current line shows where the caller calls the function.



4 View all branches of a callee by progressively clicking ⊞ next to the callee name.

This figure displays the callee, `Exec_One_Cycle`, defined in the file, `tasks2.c`, with all branches shown.



5 View all branches ending with the caller by progressively clicking ⊞ next to the caller name.

This figure displays the caller, `Tserver`, defined in the file, `tasks1.c` with all branches shown.

Tip Instead of progressively viewing the branches by clicking ⊞, you can expand all caller/callee names at once. Right-click anywhere in the **Call Hierarchy** pane. From the context menu, select **Expand All Nodes**. You can collapse all caller/callee names by right-clicking anywhere in the **Call Hierarchy** pane and selecting **Collapse All Nodes**.

Navigate Call Tree

To navigate between a function and its callers and callees in the source code:

1 Select a check contained in the function from the **Results Summary** pane. The **Call Hierarchy** pane shows the function.

2 To navigate to a callee in the source code, double-click the callee name. These names are listed below the function name and marked by ▶ (functions) or ||▶ (tasks). Alternatively, right-click the callee name and from the context menu, select **Go To Definition**.

   The **Call Hierarchy** pane now shows the callee. In the **Source** pane, the current line shows the beginning of the callee function definition.

3 To navigate to a caller, double-click the caller name. These names are listed below the function name and marked by ◀ (functions) or ◀|| (tasks). Alternatively, right-click the caller name and from the context menu, select **Go To Definition**.

   The **Call Hierarchy** pane now shows the caller. In the **Source** pane, the current line shows the beginning of the caller function definition.

Related Examples

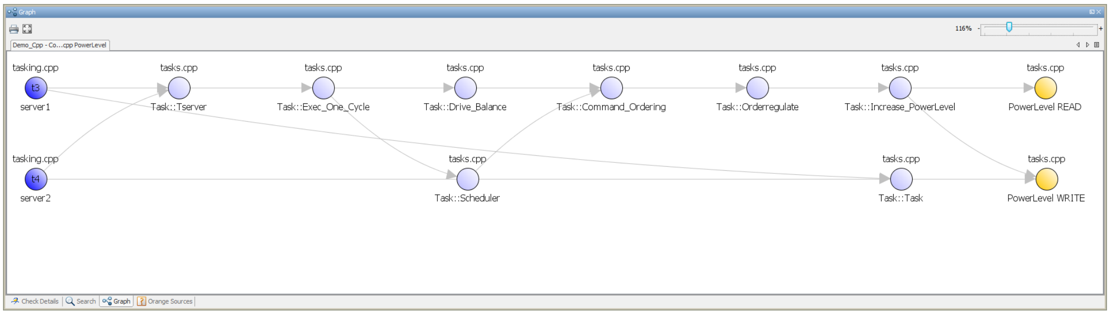
- "View Call Sequence for Checks"
- "View Access Graph for Global Variables"

View Access Graph for Global Variables

This example shows how to display the access sequence for a read or write operation on a global variable in the code.

1. On the **Variable Access** pane, select the variable that you want to view.
2. On the **Variable Access** pane toolbar, click the Show Access Graph button .

   A window displays the access graph.

   The access graph displays the function call sequence leading to read and write operations on the variable. Each node of the graph represents a function.
3. On the graph, click a node to navigate to the corresponding function on the **Source** pane.

   - The **Source** pane displays the function definition.
   - The **Call Hierarchy** pane displays the call tree of the function.

Related Examples

- "View Call Sequence for Checks"
- "View Call Tree for Functions"

More About

- "Variable Access"

Customize Review Status

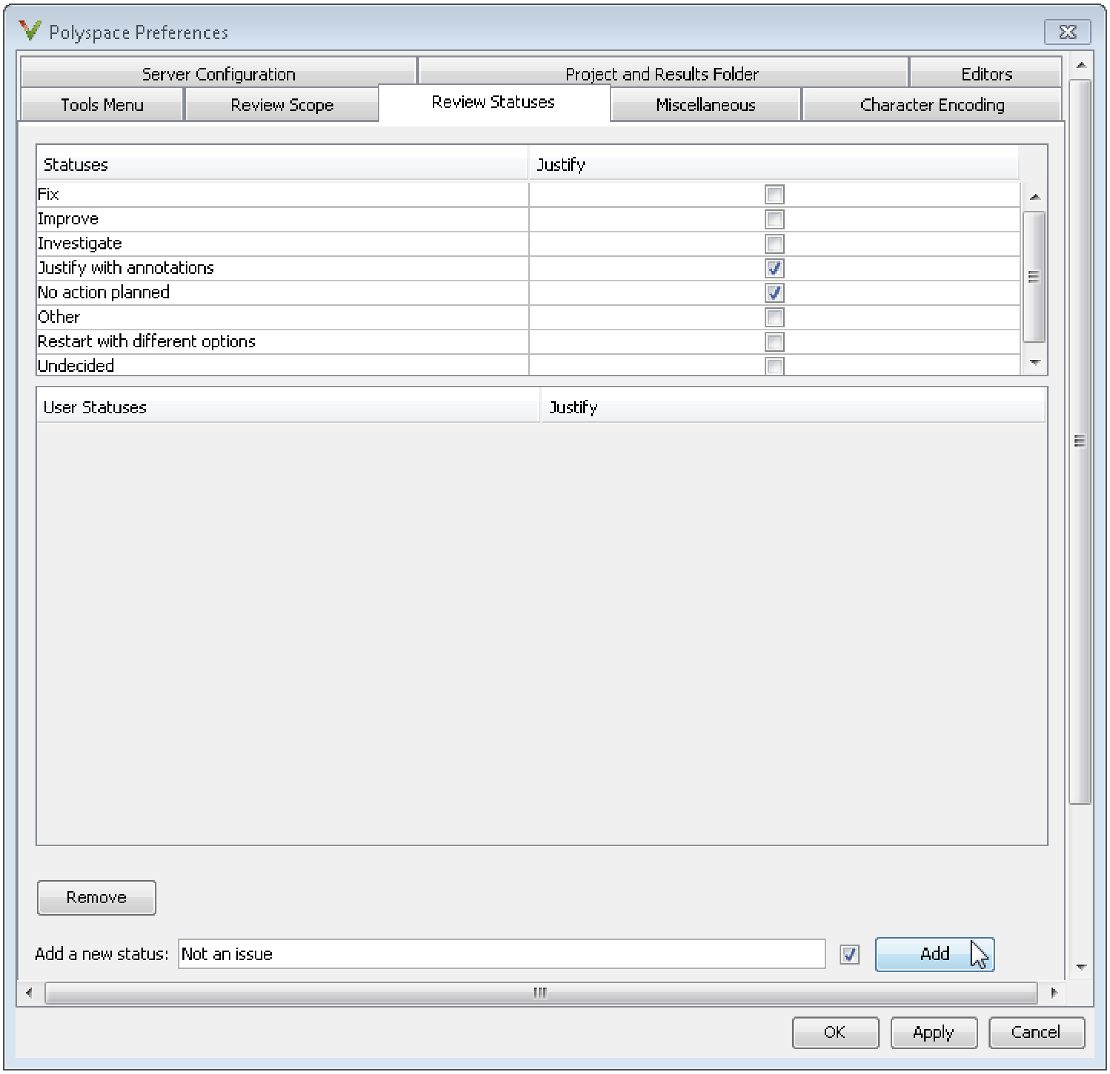
This example shows how to customize the statuses you assign on the **Results Summary** or **Check Review** pane.

Define Custom Status

1 Select **Tools** > **Preferences**.

2 Select the **Review Statuses** tab.

3 Enter your new status in the **Add a new status** field and click **Add**.



The new status appears in the **User Statuses** list.

4 Click **OK** to save your changes and close the dialog box.

When reviewing checks, you can select the new status from the **Status** drop-down list on the:

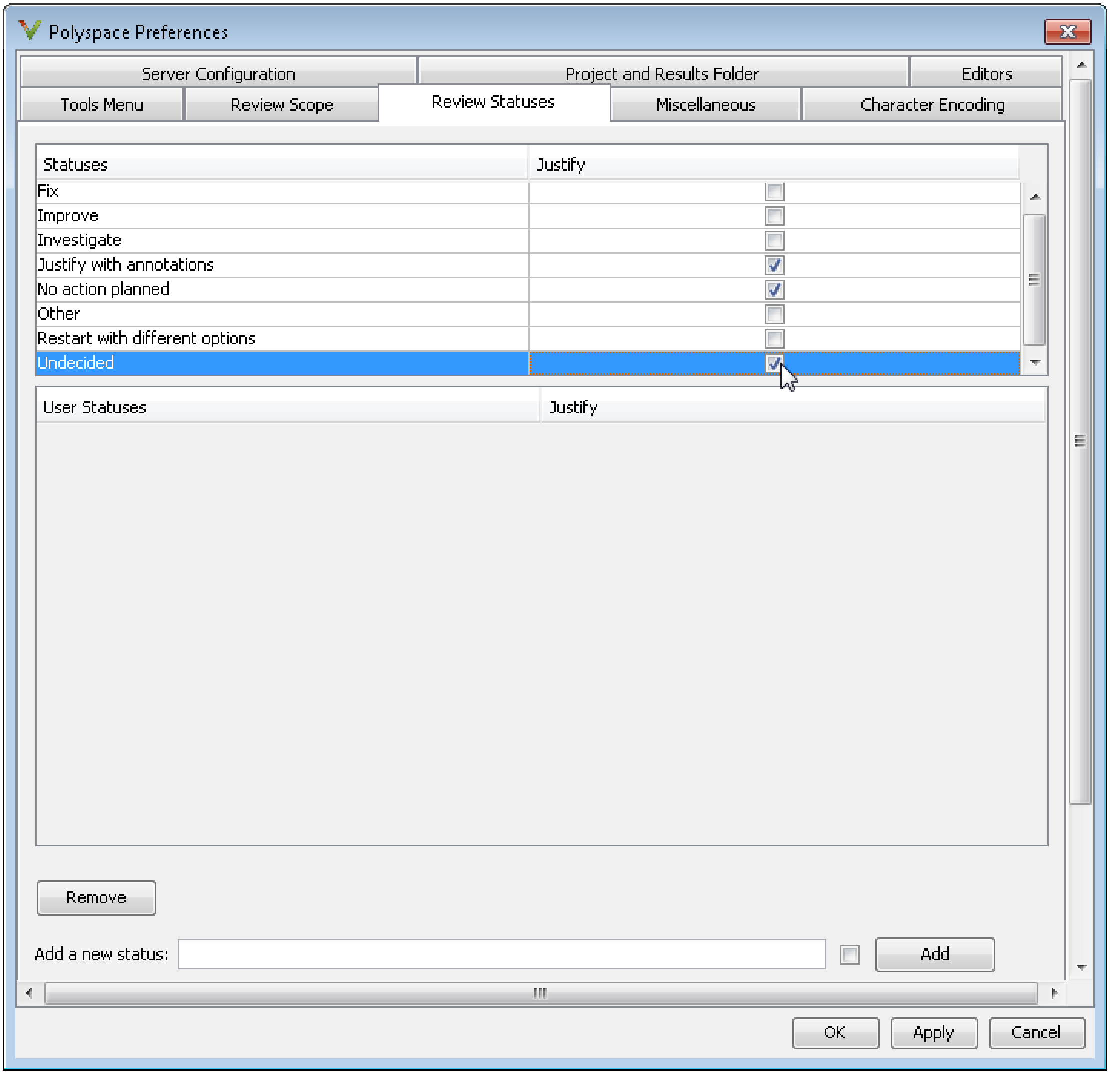
- **Check Review** pane.
- **Results Summary** pane.

Add Justification to Existing Status

By default, a check is automatically justified if you assign the status, `Justify with annotations` or `No action planned`. However, you can change this default setting so that a check is justified when you assign one of the other existing statuses.

To add justification to existing status `Improve`:

1. Select **Tools** > **Preferences**.
2. Select the **Review Statuses** tab. For the `Improve` status, select the check box in the **Justify** column. Click **OK**.


Polyspace Preferences
Server Configuration
Project and Results Folder
Editors
Tools Menu
Review Scope
Review Statuses
Miscellaneous
Character Encoding
Statuses
Justify
Fix
Improve
Investigate
Justify with annotations
No action planned
Other
Restart with different options
Undecided
User Statuses
Justify
Remove
Add a new status:
Add
OK
Apply
Cancel

If you assign the `Improve` status to a check on the **Check Review** or **Results Summary** pane, the check gets automatically justified.

Related Examples

- "Assign Review Status to Result"

Use Range Information in Results Manager

This example shows how to use the variable range information available in the Results Manager.

View Range Information

1 On the **Source** pane, place your cursor over an operator or variable. A tooltip message displays the range information, if it is available. To retain the tooltip even when you move the cursor away, press **F2**.

   The displayed range information represents a superset of dynamic values, which the software computes using static methods.

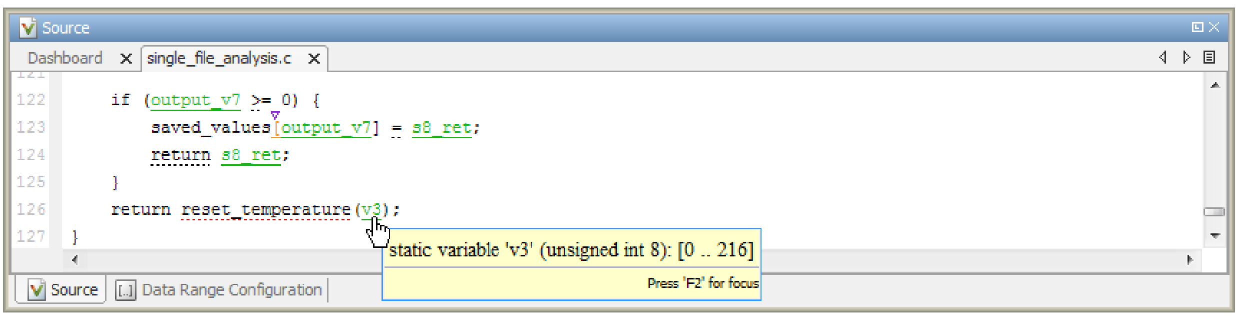
2 On the **Source** pane, select a check to display the error or warning message along with range information on the **Check Details** pane.

Interpret Range Information

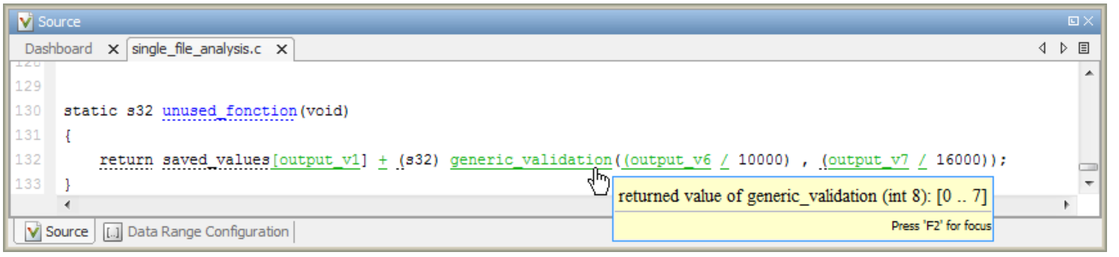
The software uses the following syntax to display range information of variables:

```
name (data_type) : [min1 .. max1] or [min2 .. max2] or [min3 .. max3] or exact value
```

The following are examples of range information displayed in tooltips on the **Source** pane:

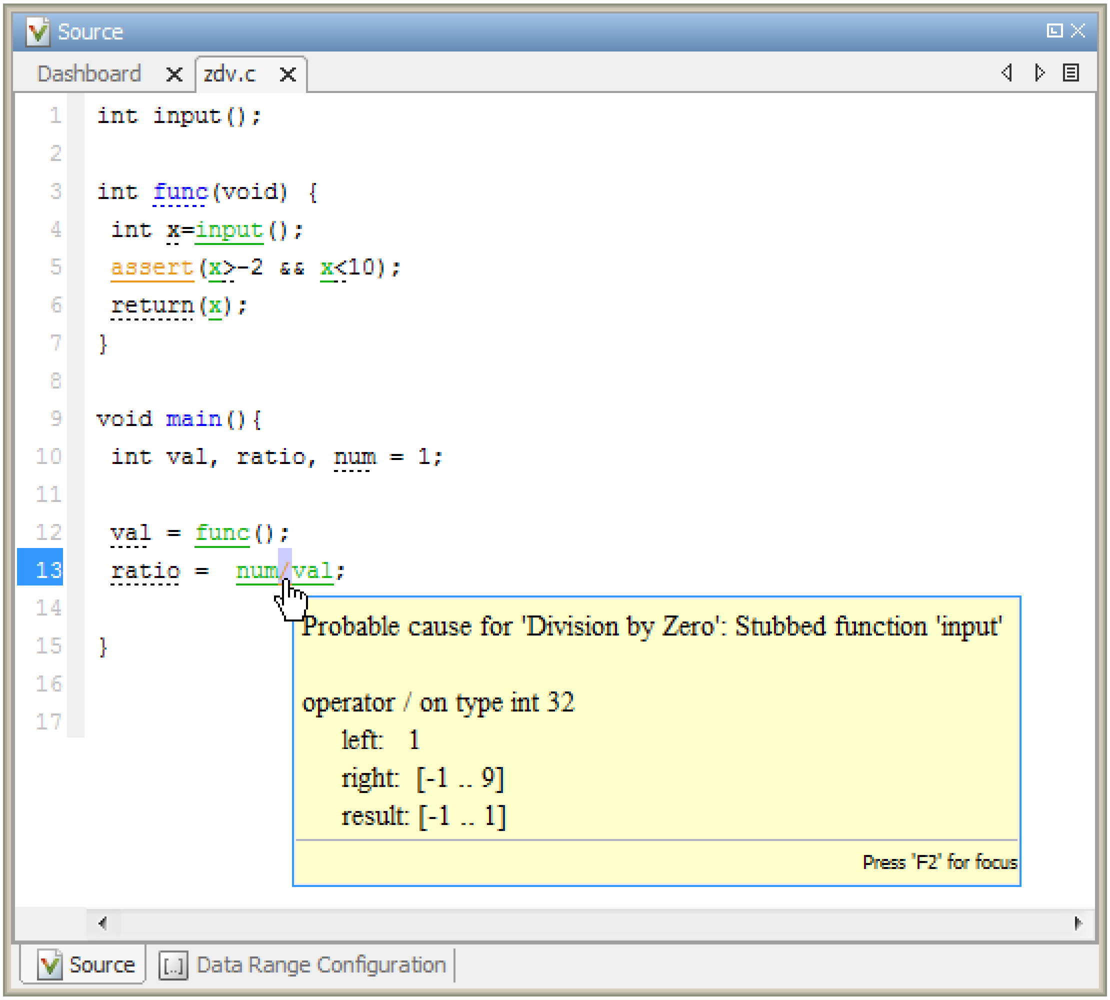


The tooltip message indicates that the variable `v3` is a 32-bit integer with value between 0 and 216..

• 

The tooltip message indicates that the returned value of the function `generic_validation` is an 8-bit integer that has values between 0 and 7.

•



The tooltip message for the division operator / indicates that the:

- The division is performed on 32-bit integers.
- The **left** operand or dividend has value 1.
- The **right** operand or divisor has value between -1 and 9.
- The **result** has value between -1 and 1.

- There is a possible **Division by Zero** error and the error arises because the function `input` is stubbed.

Related Examples

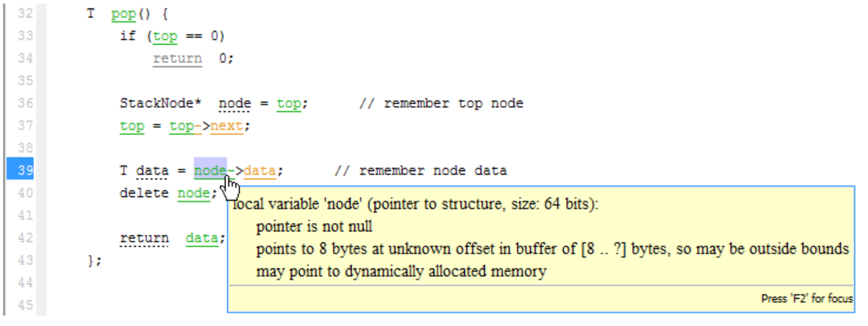
- "Review Orange Check"
- "View Pointer Information in Results Manager"

View Pointer Information in Results Manager

This example shows how to view information about pointers to variables or functions in the Results Manager.

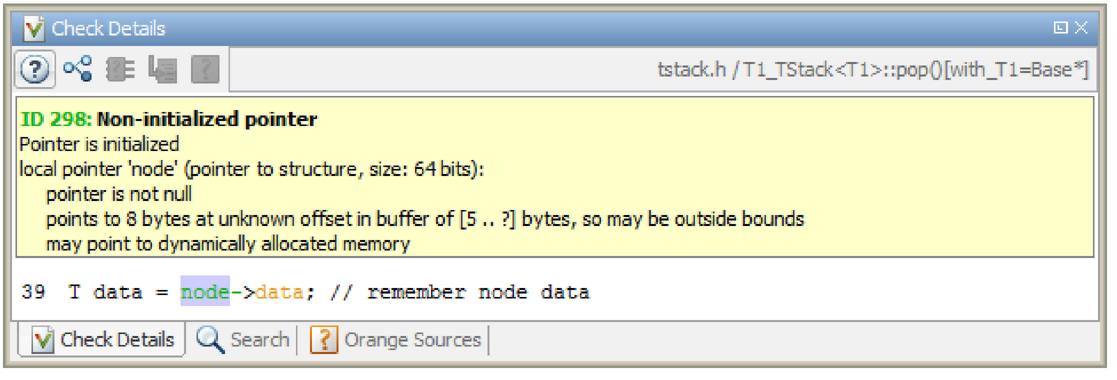
View Pointer Information on Source Pane

Place your cursor over a check related to a pointer variable or dereference character ([, ->, *). A tooltip message displays pointer information. To retain the tooltip even when you move the cursor away, press **F2**.



View Pointer Information on Check Details Pane

Click a check related to a pointer variable or dereference character. Further information about the check appears on the **Check Details** pane.



Related Examples

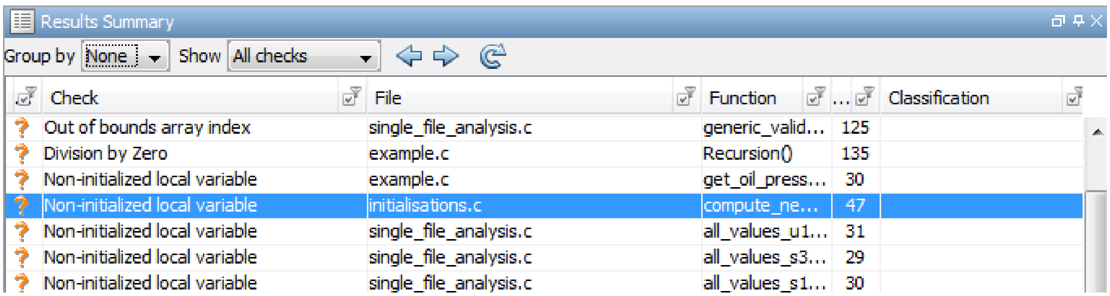
- "Use Range Information in Results Manager"

View Probable Cause for Checks

This example shows how to view the code sequence that is probably causing the check. In some cases, on the **Check Details** pane, the software outlines the subset of code causing the check.

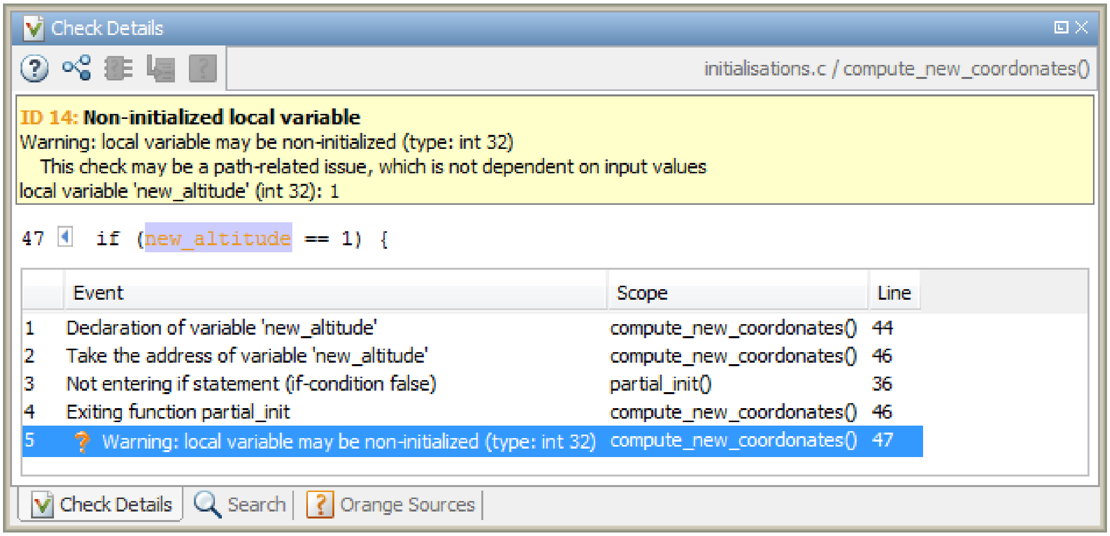
View Code Sequence Causing Check

1 On the **Results Summary** pane, select a check.



In this example, the check `Non-initialized local variable` on line 47 is selected.

2 On the **Check Details** pane, view the code sequence causing the check.



Each statement of the sequence contains a line number and a comment. You can use the information to understand and rectify your code.

3 To navigate to a statement in the code sequence, on the **Check Details** pane, click the statement. The **Source** pane displays the relevant code.

4 To navigate to the probable cause of the check, on the **Results Summary** pane, right-click the check. From the context menu, select **Go To Cause**.

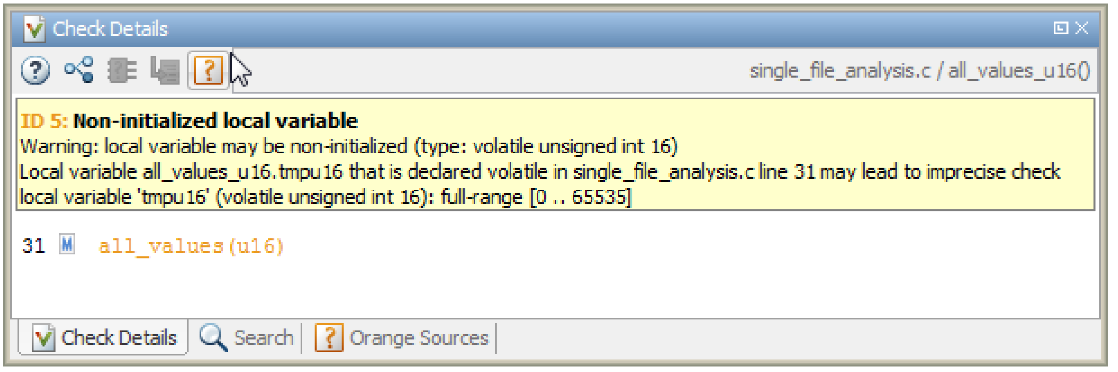
View Input Variables or Functions Causing Check

For orange checks caused by input, when the code sequence is not available, the software provides more information on input variables or functions causing the check. To view this information:

1 On the **Results Summary** pane, select the check.

   Further information on the check appears on the **Check Details** pane.

2 On the **Check Details** pane, select the  icon.



Information on source variables or functions causing the orange check appears on the **Orange Sources** tab in the **Check Details** pane.

Check Colors

Polyspace software presents verification results as colored entries in the source code. There are four main colors in the results:

- **Red** – Indicates code that is proven to contain a certain error on all execution paths.
- **Gray** – Indicates unreachable code. Polyspace assigns a lighter gray color to code deactivated due to conditional compilation, for instance in `#ifdef` statements.
- **Orange** – Indicates code that can contain an error on certain execution paths. For more information, see "Sources of Orange Checks".
- **Green** – Indicates code that is proven to not contain a certain error on all execution paths.

Polyspace considers that all execution paths that contain a run-time error terminate at the location of the error. Therefore:

- Following a red check, Polyspace does not analyze the remaining code in the same scope as the check.
- Following an orange check, Polyspace analyzes the remaining code. But it considers only the subset of execution paths that did not contain the run-time error.

More About

- "Source Code Colors"

Source Code Colors

Polyspace uses the following color scheme for displaying code on the **Source** pane.

- For every check on the **Results Summary** pane, Polyspace assigns the check color to the corresponding section of code.
  - For lines containing macros, if the macro is collapsed, then Polyspace colors the entire line with the color of the most severe check on the line. The severity decreases in this order: red, gray, orange, green.

    If there is no check in a line containing a macro, Polyspace underlines the line in black when the macro is collapsed.
  - For all other lines, Polyspace colors only the keyword or identifier associated with the check.
- For every coding rule violation on the **Results Summary** pane, Polyspace assigns to the corresponding keyword or identifier:
  - A ▽ symbol if the coding rule is a predefined rule. The predefined rules available are MISRA C, MISRA AC AGC, MISRA C++, or JSF C++.
  - A ▼ symbol if the coding rule is a custom rule.
- If a tooltip is available for a keyword or identifier on the **Source** pane, Polyspace:
  - Uses solid underlining for the keyword or identifier if it is associated with a check.
  - Uses dashed underlining for the keyword or identifier if it is not associated with a check.
- When a function is defined, Polyspace colors the function name in blue.
- Polyspace assigns a lighter shade of gray to code deactivated due to conditional compilation. Such code occurs, for instance, in `#ifdef` statements where the macro for a branch is not defined. This code has no effecton the verification.

More About

- “Check Colors”
- “Source”

Results Manager Overview

The Results Manager perspective has the following panes below the toolbar:

Pane	Function
“Results Summary”	List of checks (diagnostics) for each file and function in the project
“Dashboard”	• Graphical view of code coverage and check distribution • Top five orange checks (likely errors in unproven code) and purple checks (coding rule violations)
“Source”	Source code for a selected check in the procedural entities view
“Check Details”	Details about the selected check
“Check Review”	Review information about selected check
“Variable Access”	Information about global variables declared in the source code
“Call Hierarchy”	Tree structure of function calls

You can resize or hide these sections.

Results Summary

The **Results Summary** pane lists all checks along with their attributes. To organize your check review, from the drop-down list on this pane, select one of the following options:

- **Group by** > **None**: Lists all checks without any grouping. The checks are sorted in the following order:
  - **Red** – Indicates code that is proven to contain a certain error on all execution paths.
  - **Gray** – Indicates unreachable code.
  - **Orange** – Indicates code that can contain an error on certain execution paths. For more information, see “Sources of Orange Checks”.
  - **Green** – Indicates code that is proven to not contain a certain error on all execution paths.
  - **Purple** – Indicates code that contain a coding rule violation.
- **Group by** > **Family**: Lists all checks grouped by color. Within each color, the checks are grouped by category. For more information on the checks covered by a category, see the check reference pages.
- **Group by** > **Class**: Lists all checks grouped by class. Within each class, the checks are grouped by method. The first group, **Global Scope**, lists all checks not occurring in a class definition.

  This option is available for `C++` code only.
- **Group by** > **File**: Lists all checks grouped by file. Within each file, the checks are grouped by function.

For each check, the **Results Summary** pane contains the check attributes, listed in columns:

Attribute	Description
Family	Group to which the check belongs. For instance, if you choose the grouping `Checks by File/Function`, this column contains the name of the file and function containing the check.

Attribute	Description
ID	Unique identification number of the check. In the default view on the **Results Summary** pane, the checks appear sorted by this number.
Type	Check color
Category	Category of the check. For more information on the checks covered by a category, see the check reference pages.
Check	Description of the error
Information	For run-time errors, this attribute indicates whether the check is related to path or bounded input values. For coding rule violations, this attribute indicates whether the rule is `Required`.
File	File containing the instruction where the check occurs
Class	Class containing the instruction where the check occurs. If the check is not inside a class definition, then this column contains the entry, `Global Scope`.
Function	Function containing the instruction where the check occurs. If the function is a method of a class, it appears in the format *`class_name`*`::`*`function_name`*.
Line	Line number of the instruction where the check occurs.
Col	Column number of the instruction where the check occurs. The column number is the number of characters from the beginning of the line.

Attribute	Description
%	Percentage of checks that are not orange. This column is most useful when you choose the grouping `Checks by File/Function`. The entry in this column against a file or function indicates the percentage of checks in the file or function that are not orange.
Classification	Level of severity you have assigned to the check. The possible levels are: • `Unset` • `High` • `Medium` • `Low` • `Not a defect`
Status	Review status you have assigned to the check. The possible statuses are: • `Fix` • `Improve` • `Investigate` • `Justify with annotations` • `No action planned` • `Other` • `Restart with different options`
Justified	Check boxes showing whether you have justified the checks
Comments	Comments you have entered about the check

To show or hide any of the columns, right-click anywhere on the column titles. From the context menu, select or clear the title of the column that you want to show or hide.

Using this pane, you can:

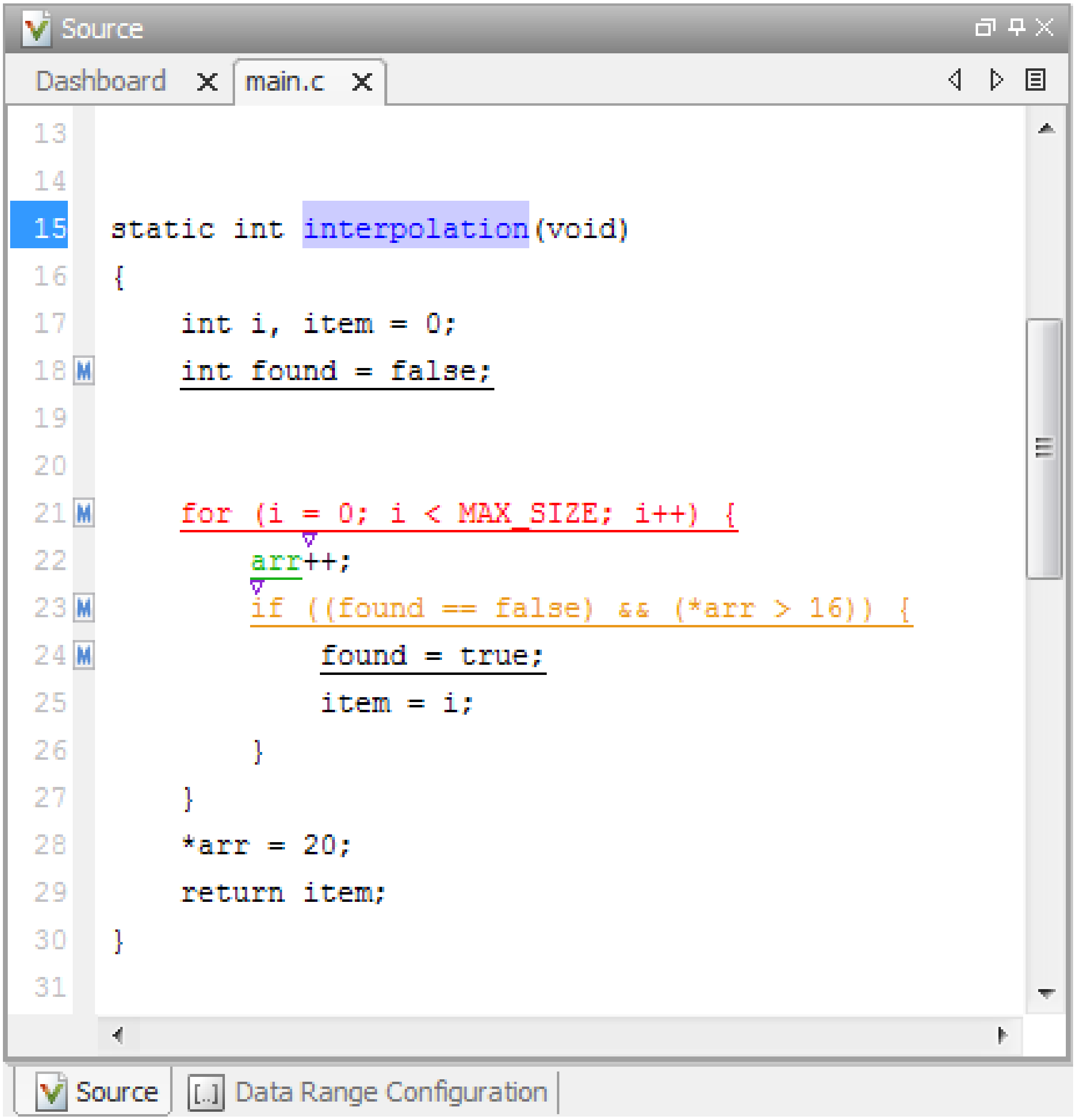
- Navigate through the checks. For more information, see “Assign Review Status to Result”.
- Organize your check review using filters on the columns. For more information, see “Organize Results Using Filters and Groups”.

Source

In this section...

Source

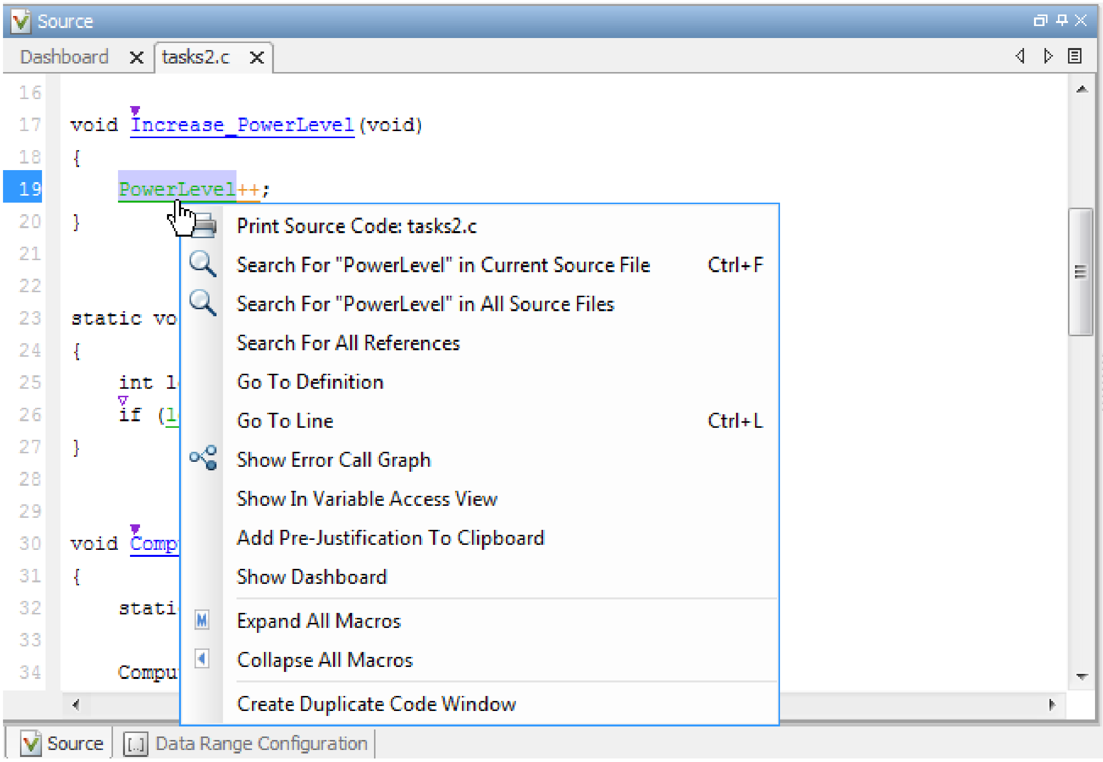
The **Source** pane shows the source code with colored checks highlighted.



On the **Source** pane, you can:

Examine Source Code

On the **Source** pane, if you right-click a text string, the context menu provides options to examine your code. For example, right-click the global variable `PowerLevel`:



Use the following options to examine and navigate through your code:

- **Search "PowerLevel" in Current Source** — List occurrences of the string within the current source file in the **Search** pane.
- **Search "PowerLevel" in All Source Files** — List occurrences of the string within all source files in the **Search** pane.

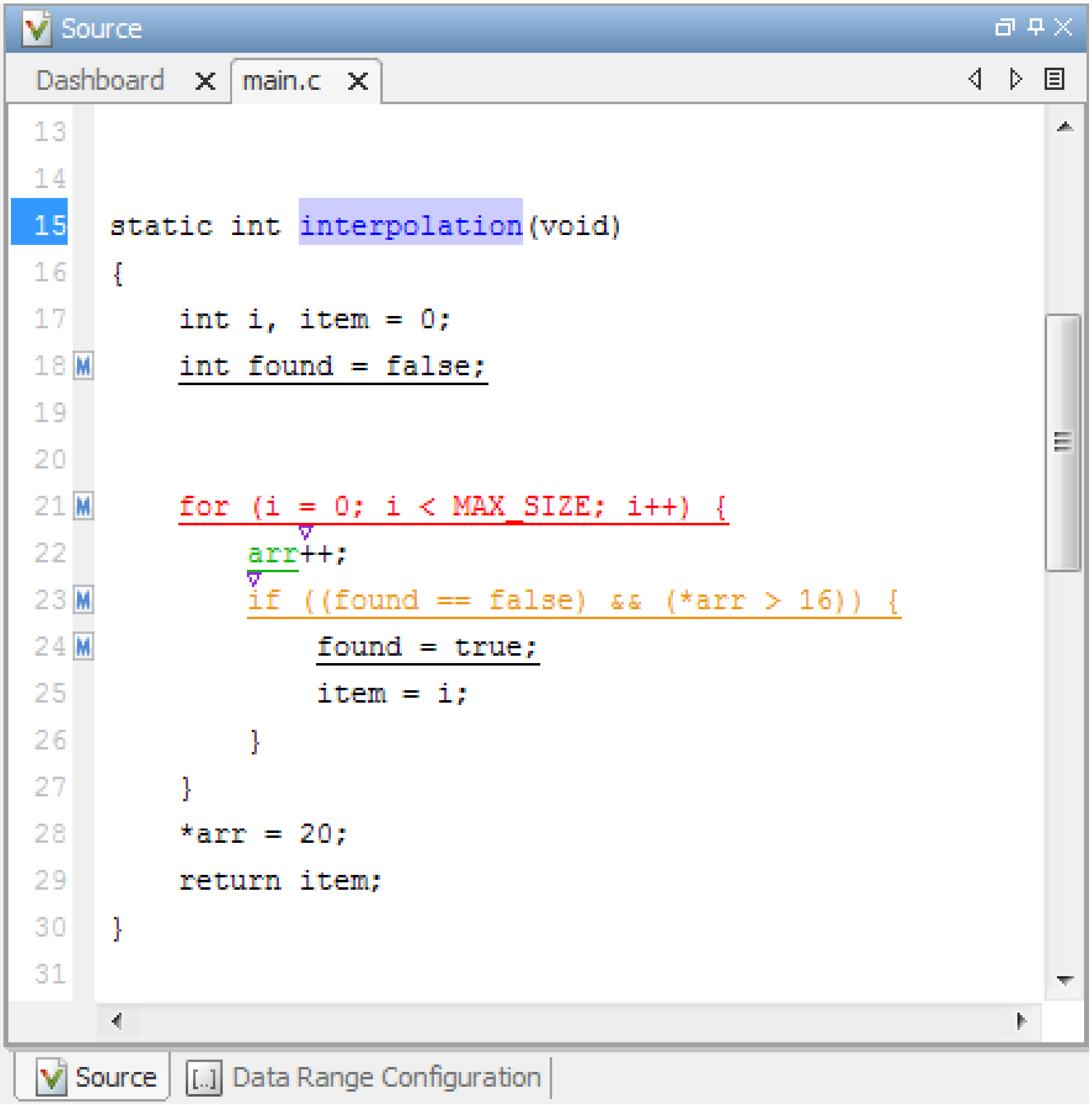
- **Search For All References** — List all references in the **Search** pane. The software supports this feature for global and local variables, functions, types, and classes.
- **Go to Definition** — Go to the line of code that contains the definition of `PowerLevel`. The software supports this feature for global and local variables, functions, types, and classes.
- **Go To Line** — Open the Go to line dialog box. If you specify a line number and click **Enter**, the software displays the specified line of code.
- **Expand All Macros** or **Collapse All Macros** — Display or hide the content of macros in current source file.

View Variable Range

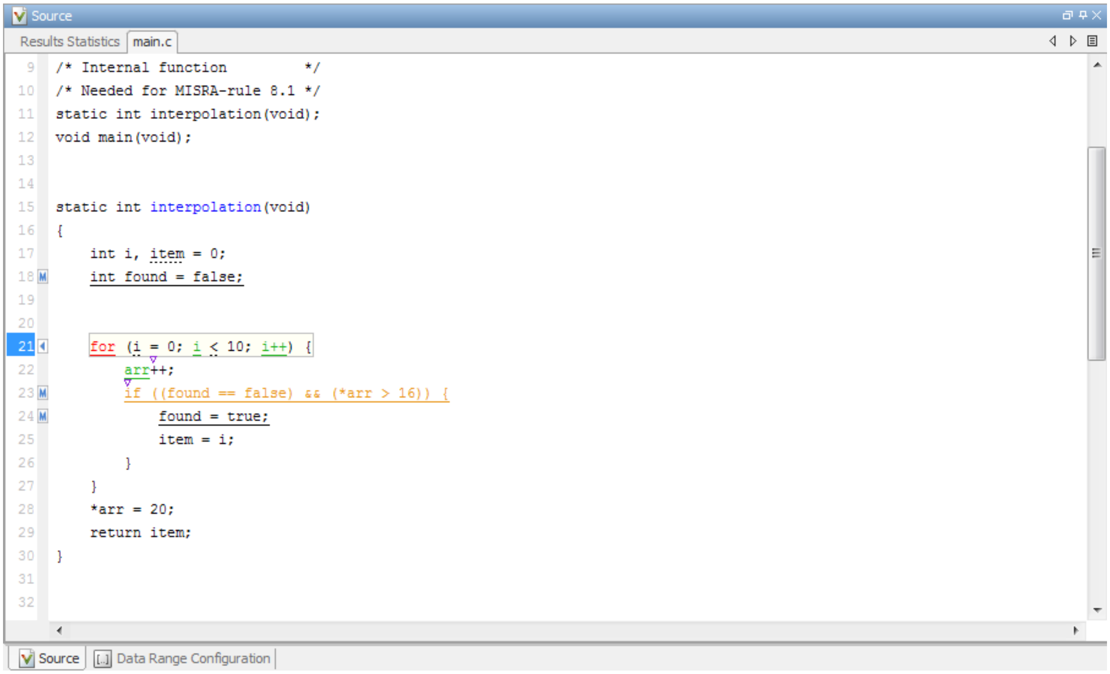
Place your cursor over a check to view range information for variables, operands, function parameters, and return values. For more information, see "Use Range Information in Results Manager"

Expand Macros

You can view the contents of source code macros in the source code view. A code information bar displays `M` icons that identify source code lines with macros.



When you click a line with this icon, the software displays the contents of macros on that line.



To display the normal source code again, click the line away from the shaded region, for example, on the arrow icon.

To display or hide the content of *all* macros:

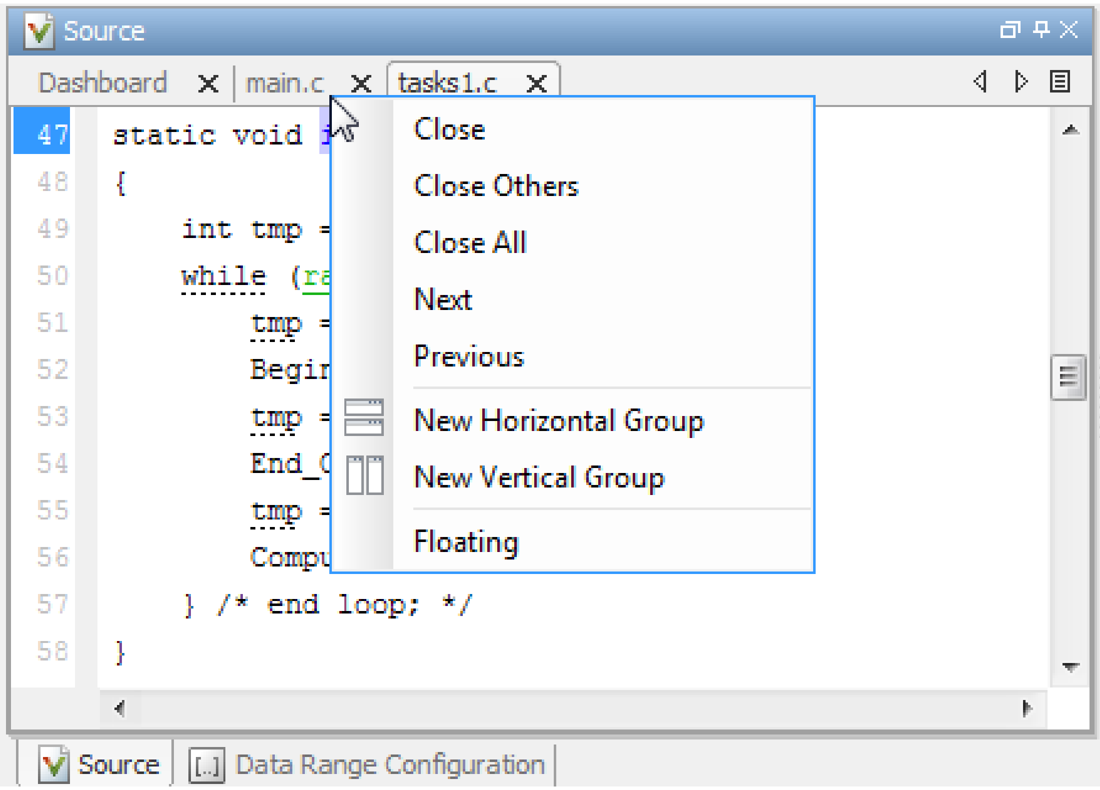
1. Right-click any point within the source code view.
2. From the context menu, select either **Expand All Macros** or **Collapse All Macros**.

Note: The **Check Details** pane also allows you to view the contents of a macro if the check you select lies within a macro.

Manage Multiple Files

You can view multiple source files in the **Source** pane as separate tabs.

On the **Source** pane toolbar, right-click a view.



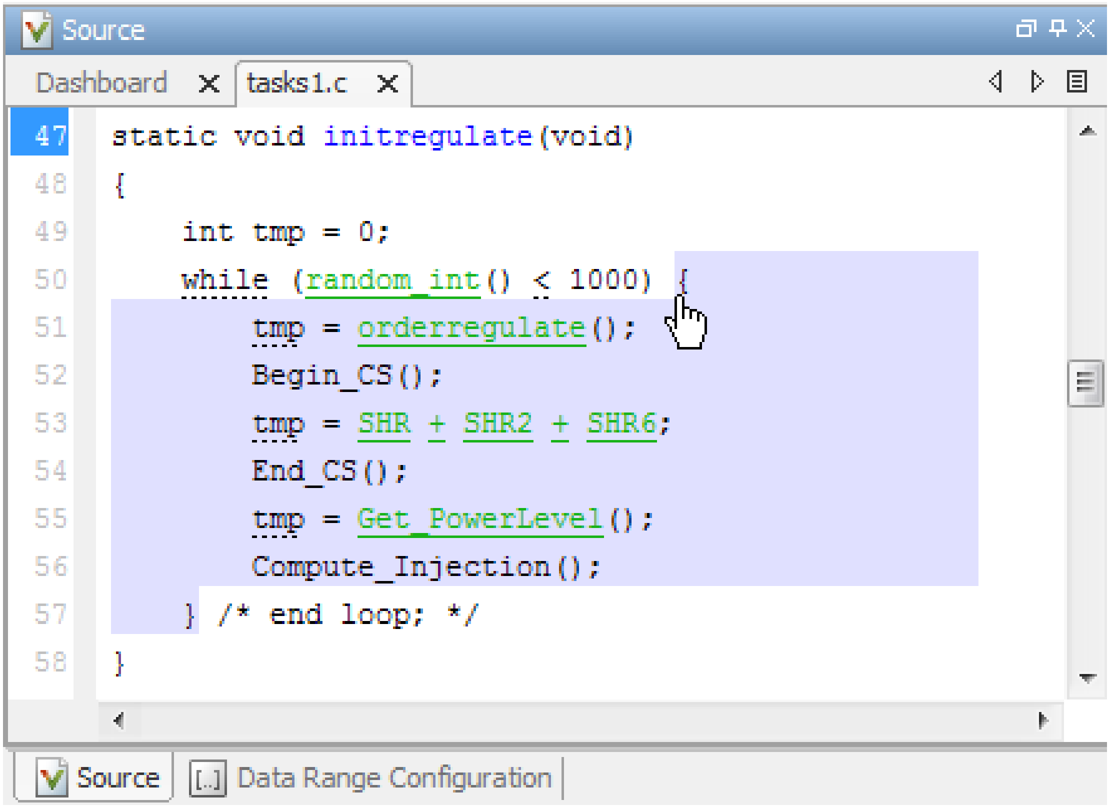
From the **Source** pane context menu, you can:

- **Close** – Close the currently selected source file. You can also use the x button to close the tabs.
- **Close Others** – Close all source files except the currently selected file.
- **Close All** – Close all source files.
- **Next** – Display the next view.
- **Previous** – Display the previous view.
- **New Horizontal Group** – Split the **Source** pane horizontally to display the selected source file below another file.

- **New Vertical Group** – Split the **Source** pane vertically to display the selected source file side-by-side with another file.
- **Floating** – Display the current source file in a new window, outside the **Source** pane.

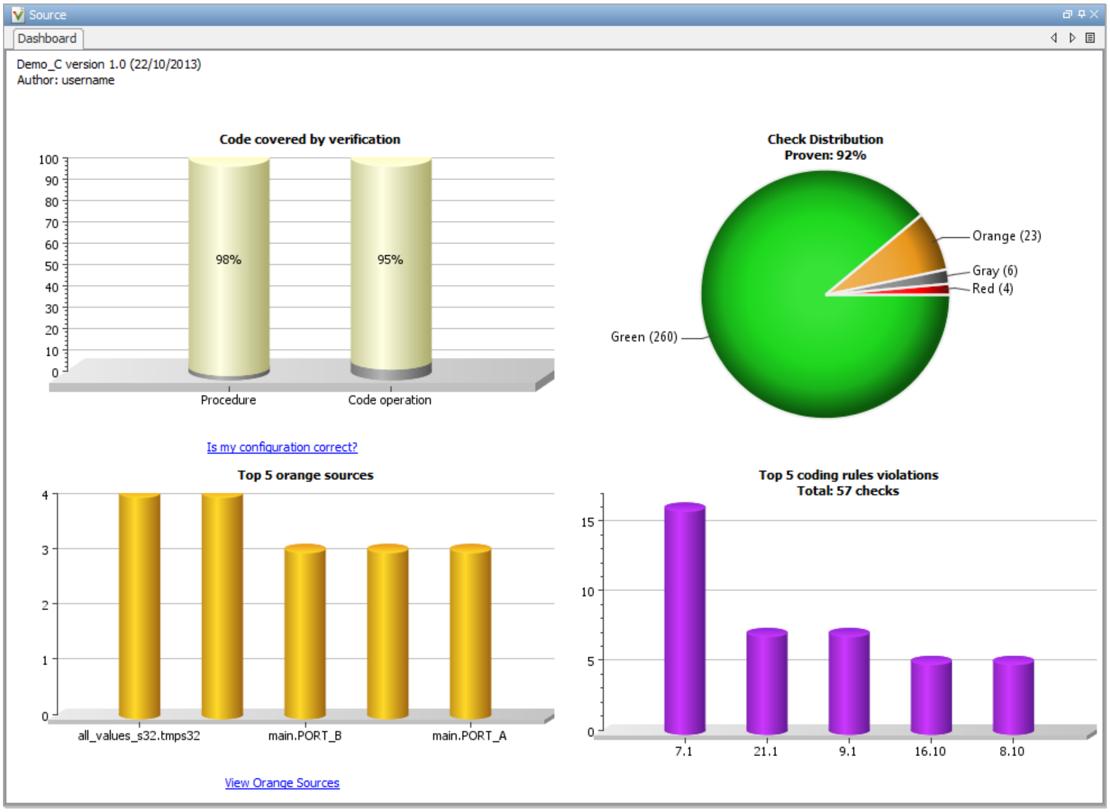
View Code Block

On the **Source** pane, to highlight a block of code, click either its opening or closing brace.



Dashboard

The **Dashboard** tab on the **Source** pane provides statistics on the verification results in a graphical format.



In the Results Manager perspective, this tab is displayed by default when you open a results file with extension `.pscp`. On this tab, you can view four graphs and charts:

- **Code covered by verification**

  This column graph displays:

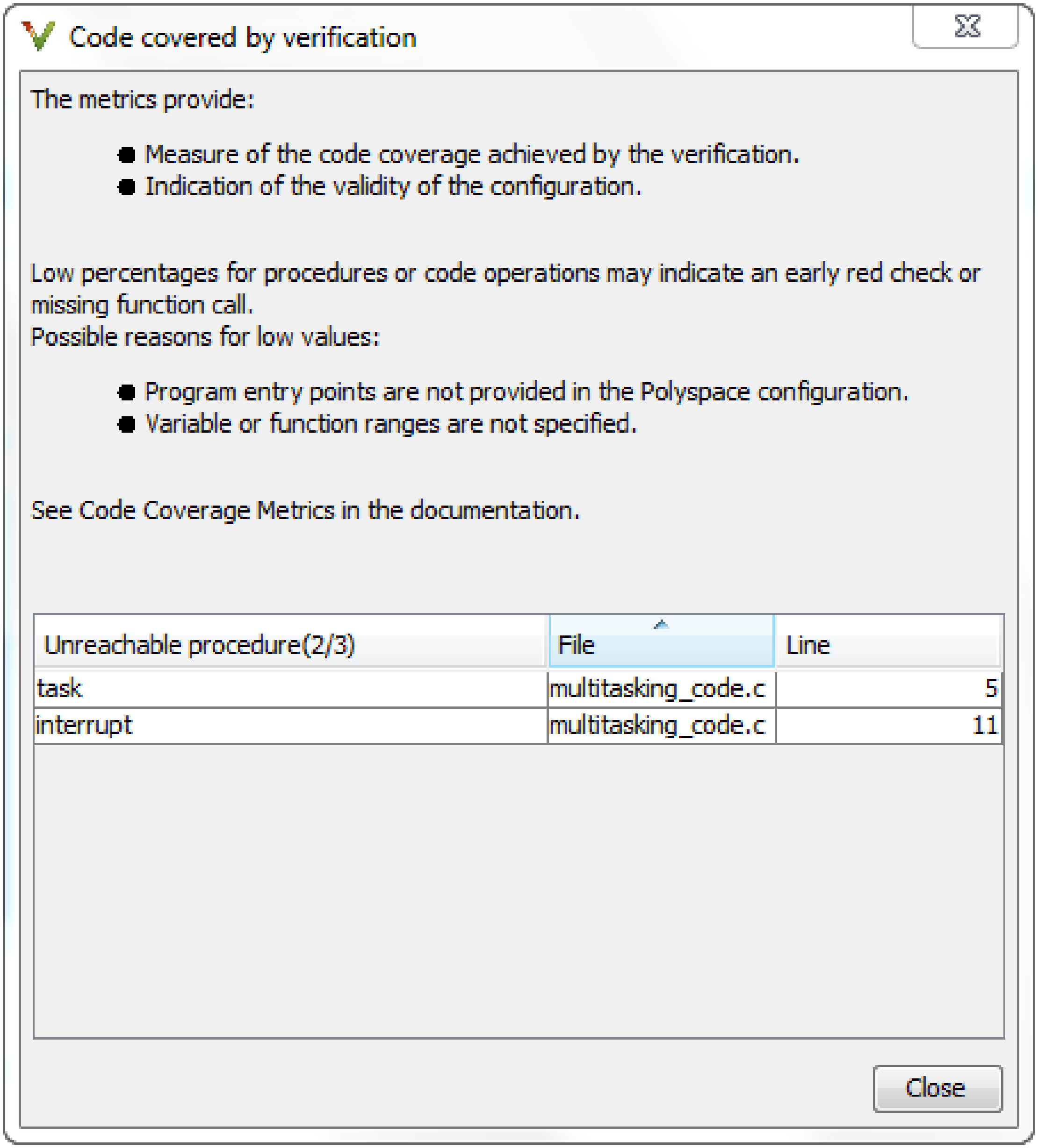
  - The percentage of procedures covered by verification. You can see this percentage in the `Procedure` column.

- The percentage of elementary operations in executable procedures covered by verification. You can see this percentage in the `Code operation` column.

These percentages provide a measure of:

- Code coverage achieved by the Polyspace verification.
- Validity of your Polyspace configuration.

Click the column graph to open the Code covered by verification window.


Code covered by verification
The metrics provide:
Measure of the code coverage achieved by the verification.
Indication of the validity of the configuration.
Low percentages for procedures or code operations may indicate an early red check or missing function call.
Possible reasons for low values:
Program entry points are not provided in the Polyspace configuration.
Variable or function ranges are not specified.
See Code Coverage Metrics in the documentation.
Unreachable procedure(2/3)
File
Line
task
multitasking_code.c
5
interrupt
multitasking_code.c
11
Close

This window contains:

- The fraction of procedures that are unreachable in the format, *`Number of unreachable procedures/Total number of procedures`*.
- A list of unreachable procedures along with the file and line number where they are defined. Selecting a procedure displays the procedure definition in the **Source** pane.

A low coverage can indicate an early red check or missing function call. Consider the following code:

```
1  void coverage_eg(void)
2  {
3    int x;
4
5    x = 1 / x;
6    x = x + 1;
7    propagate();
8  }
```

Verification generates only one red NIVL check, for a read operation on the variable `x` — see line 5. The software does not display checks for these elementary operations:

- On line 5, for the division operation, a ZDV check.
- On line 5, for the division operation, an OVFL check.
- On line 6, for the addition operation, an OVFL check.
- On line 6, for another read operation on `x`, an NIVL check.

As the software displays only one out of the five operation checks for the code, the percentage of elementary operations covered is 1/5 or 20%. The software does not take into account the checks inside the unreachable function `propagate()`.

Check distribution

This pie chart displays the number of checks of each color. For a description of the check colors, see “Check Colors”.

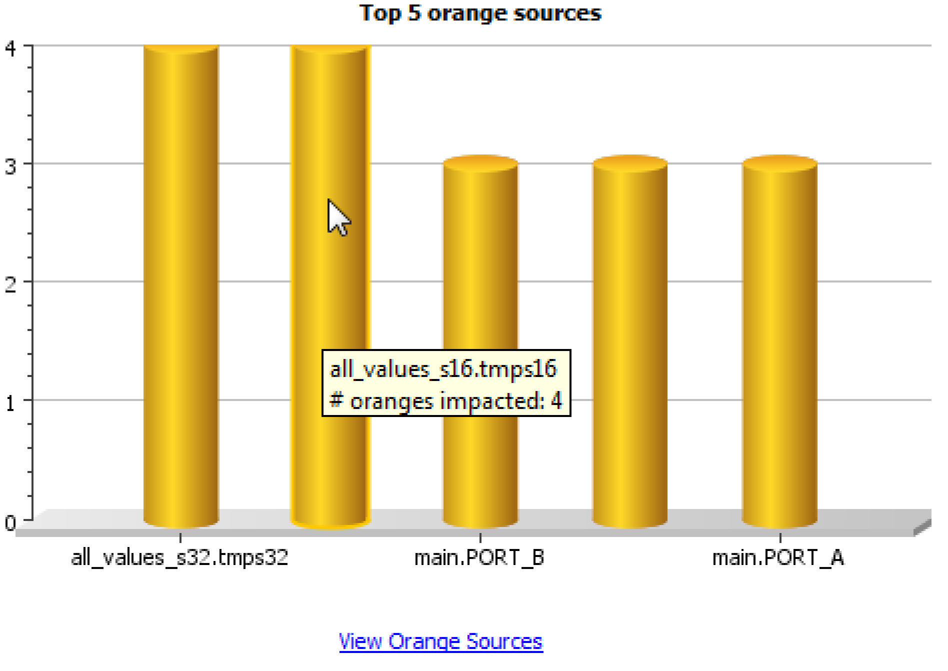
Using this pie chart, you can obtain an estimate of:

- The number of checks to review.
- The selectivity of your verification — the fraction of checks that are not orange.

Top 5 orange sources

An orange source is a variable or function that leads to an orange check. This column graph displays five orange sources affecting the most number of checks.

Each column represents an orange source. The columns are arranged in the order of number of checks affected. The height of the column indicates the number of checks affected by the corresponding orange source. Place your cursor on a column to open a tooltip showing the source name and the number of checks affected by the source.



Using this chart, you can:

- View the five sources affecting the most number of checks. Select a column to view further details of the corresponding orange source in the **Orange Sources** pane.
- Prioritize your review of orange checks. If there are sources affecting a large number of orange checks, using this chart can quickly improve the selectivity of your verification.

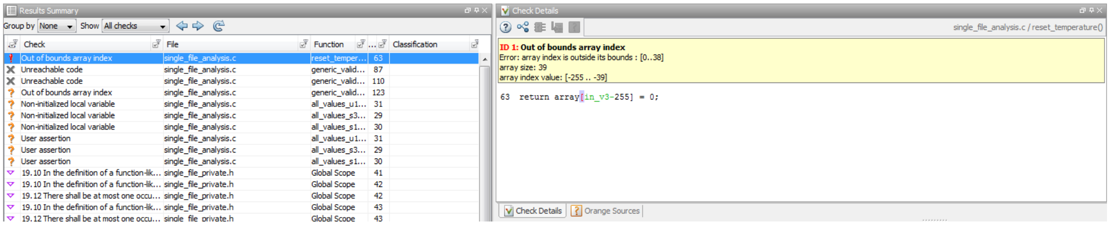
Top 5 coding rule violations

This column graph displays the five most violated coding rules. Each column represents a coding rule and is indexed by the rule number. The height of the column indicates the number of violations of the coding rule represented by that column.

For a list of supported coding rules, see “Supported MISRA C:2004 Rules”, “Supported MISRA C++ Coding Rules” and “Supported JSF C++ Coding Rules”.

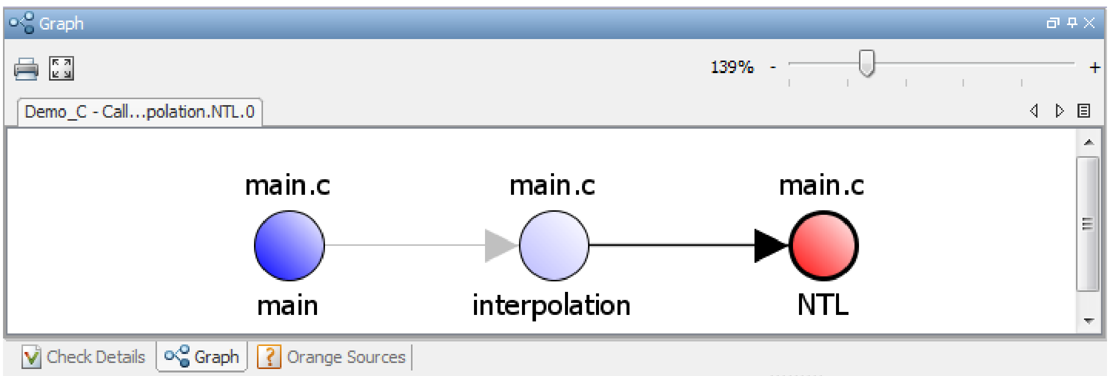
Check Details

On the **Results Summary** pane, if you click a check, you see additional information on the **Check Details** pane.



Error Call Graph

Click the **Show error call graph** icon,  in the **Check Details** pane toolbar to display the call sequence that leads to the code associated with a check.

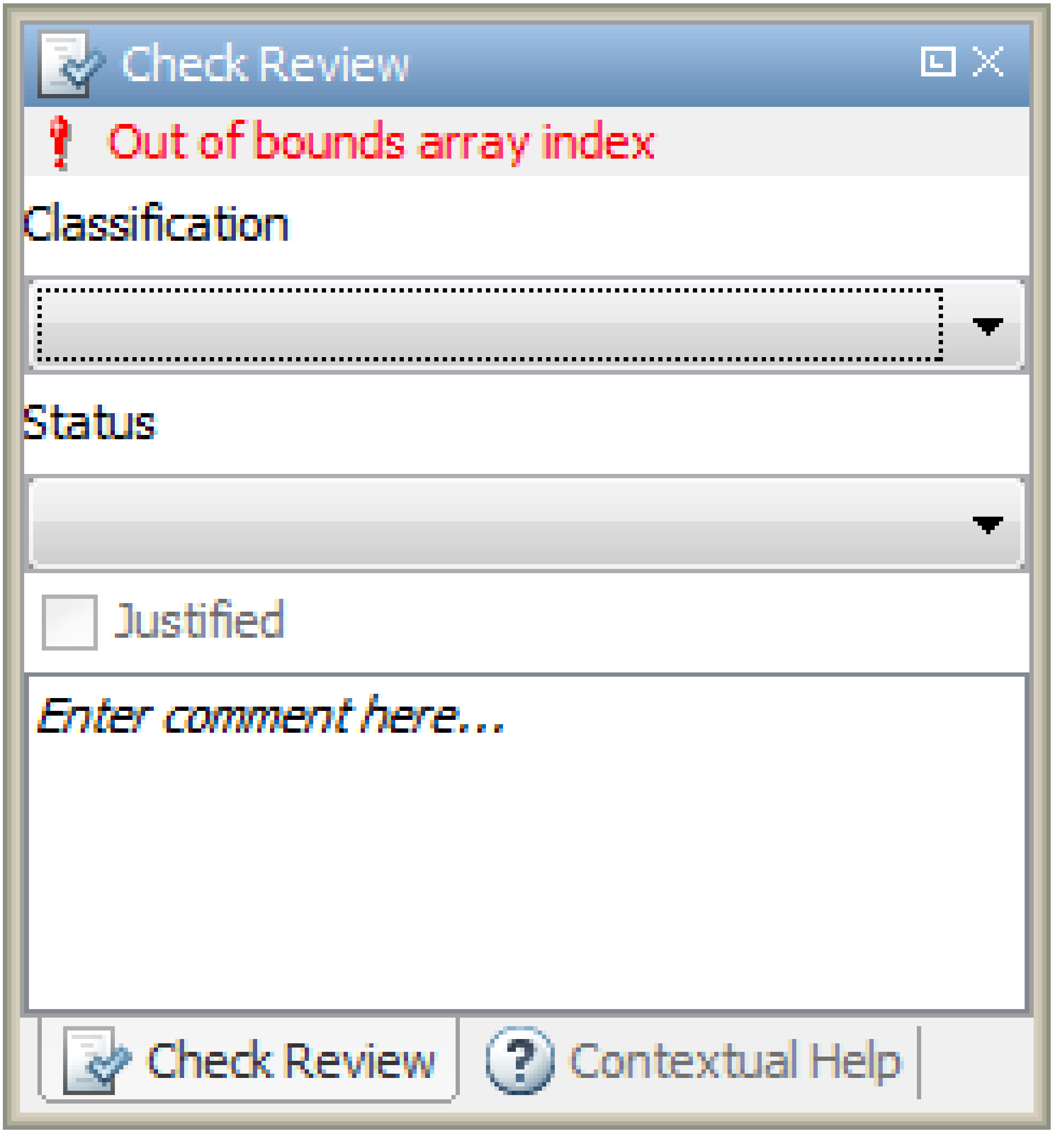


For more information, see "View Call Sequence for Checks".

Check Review

Check Review

When reviewing checks, use the **Check Review** tab to assign a **Classification** and **Status** to each check. You can also enter comments to describe the results of your review. This action helps you track the progress of your review and avoid reviewing the same check twice.



For more information, see “Assign Review Status to Result”.

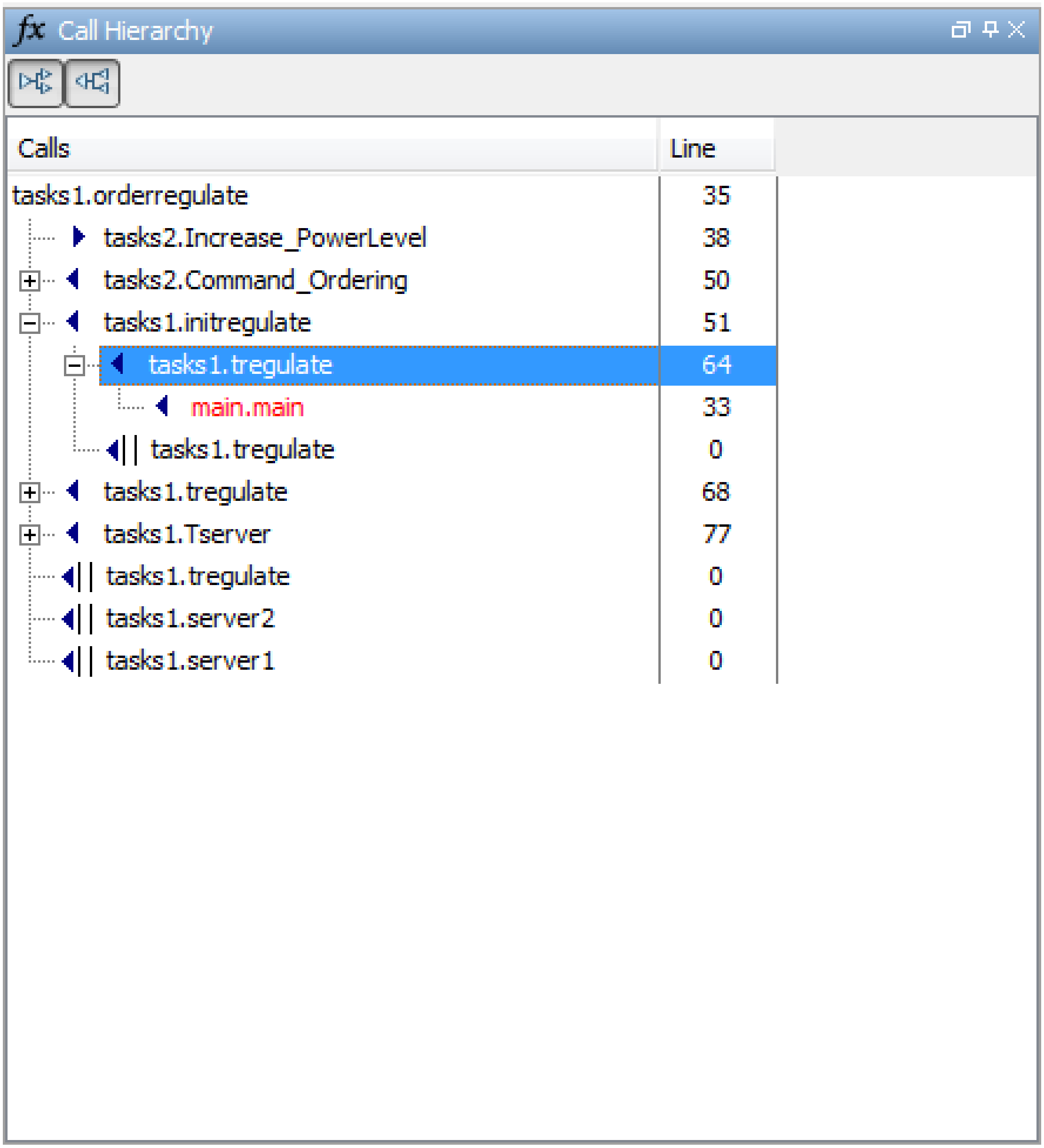
Call Hierarchy

The **Call Hierarchy** pane displays the call tree of functions in the source code.

For each function,`foo`, the **Call Hierarchy** pane lists the functions and tasks that call `foo` (callers) and those called by `foo` (callees). The callers are indicated by (functions), or (tasks). The callees are indicated by (functions) or (tasks). The **Call Hierarchy** pane lists both direct function calls and indirect calls through function pointers.

For more information, see “View Call Tree for Functions”.

In the following example, the **Call Hierarchy** pane displays the function, `orderregulate`, in the file, `tasks1.c`. It also displays the callers and the callees of `orderregulate`.


Call Hierarchy
Calls
Line
tasks1.orderregulate
35
tasks2.Increase_PowerLevel
38
tasks2.Command_Ordering
50
tasks1.initregulate
51
tasks1.tregulate
64
main.main
33
tasks1.tregulate
0
tasks1.tregulate
68
tasks1.Tserver
77
tasks1.tregulate
0
tasks1.server2
0
tasks1.server1
0

Depending on the name, the corresponding line number in the **Call Hierarchy** pane refers to a different line in the source code:

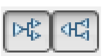
- For the function name, the line number refers to the beginning of the function definition. In the preceding example, the definition of `tasks1.orderregulate` begins on line 35.
- For a callee name, the number refers to the line where the callee is called. In the preceding example, callee, `tasks2.Increase_PowerLevel`, is called by `tasks1.orderregulate` on line 38.
- For a caller name, the number refers to the line where the caller calls the function. In the preceding example, caller, `tasks2.Command_Ordering`, calls `tasks1.orderregulate` on line 50.

Tip Select a caller or callee name to navigate to the function call in the source code.

You can perform the following actions from the **Call Hierarchy** pane:

- ## Show/Hide Callers and Callees

  Customize the view to display callers only or callees only. Show or hide callers and callees by clicking this button

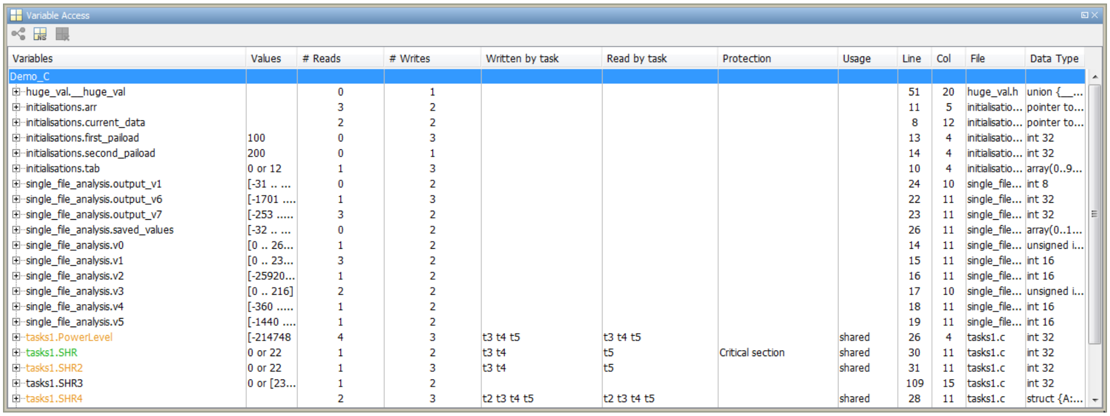
  

- ## Go to Caller/Callee Definition

  Go directly to the definition of a caller or callee in the source code. Right-click the name of the caller or callee and select **Go to definition**. For more information, see “Navigate Call Tree”.

Variable Access

The **Variable Access** pane displays global variables. For each global variable, the pane lists all functions and tasks performing read/write access on the variables, along with their attributes, such as values, read/write accesses and shared usage.



Variable Access

Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Line	Col	File	Data Type
Demo_C											
huge_val.__huge_val		0	1					51	20	huge_val.h	union {__...
initialisations.arr		3	2					11	5	initialisatio...	pointer to...
initialisations.current_data		2	2					8	12	initialisatio...	pointer to...
initialisations.first_paiload	100	0	3					13	4	initialisatio...	int 32
initialisations.second_paiload	200	0	1					14	4	initialisatio...	int 32
initialisations.tab	0 or 12	1	3					10	4	initialisatio...	array(0..9...
single_file_analysis.output_v1	[-31	0	2					24	10	single_file...	int 8
single_file_analysis.output_v6	[-1701	1	3					22	11	single_file...	int 32
single_file_analysis.output_v7	[-253	3	2					23	11	single_file...	int 32
single_file_analysis.saved_values	[-32	0	2					26	11	single_file...	array(0..1...
single_file_analysis.v0	[0 .. 26...	1	2					14	11	single_file...	unsigned i...
single_file_analysis.v1	[0 .. 23...	3	2					15	11	single_file...	int 16
single_file_analysis.v2	[-25920...	1	2					16	11	single_file...	int 16
single_file_analysis.v3	[0 .. 216]	2	2					17	10	single_file...	unsigned i...
single_file_analysis.v4	[-360	1	2					18	11	single_file...	int 16
single_file_analysis.v5	[-1440	1	2					19	11	single_file...	int 16
tasks1.PowerLevel	[-214748	4	3	t3 t4 t5	t3 t4 t5		shared	26	4	tasks1.c	int 32
tasks1.SHR	0 or 22	1	2	t3 t4	t5	Critical section	shared	30	11	tasks1.c	int 32
tasks1.SHR2	0 or 22	1	3	t3 t4	t5		shared	31	11	tasks1.c	int 32
tasks1.SHR3	0 or [23...	1	2					109	15	tasks1.c	int 32
tasks1.SHR4		2	3	t2 t3 t4 t5	t2 t3 t4 t5		shared	28	11	tasks1.c	struct {A:...

For each variable and each read/write access, the **Variable Access** pane contains the relevant attributes. For the variables, the various attributes are listed in this table.

Attribute	Description
Variables	Name of Variable, *`File_Name.Variable_Name`* *`File_Name`*: Name of file where variable is declared
Values	Value (or range of values) of variable
# Reads	Number of times the variable is read
# Writes	Number of times the variable is written
Written by task	Name of tasks writing on variable using aliases, `t1,t2,t3` **Tip** To see the full names for aliases, right-click anywhere on the **Variable Access** pane and select **Show Legend**.

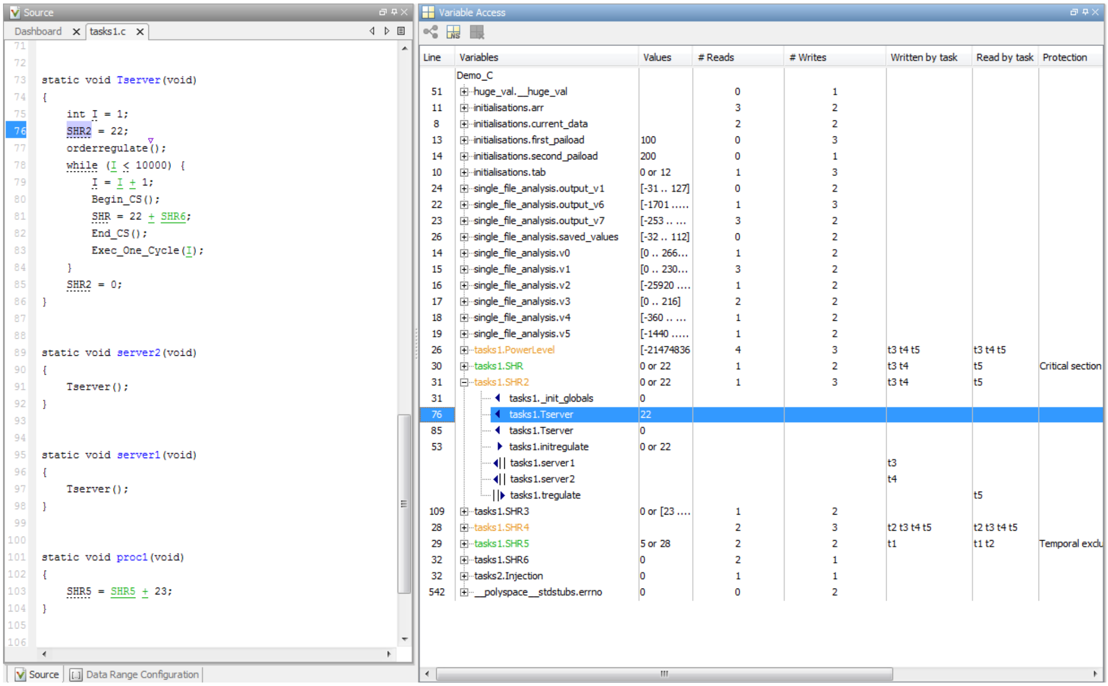
Attribute	Description
Read by task	Name of tasks reading variable using aliases, `t1,t2,t3`
Protection	Whether shared variable is protected from concurrent access (Filled only when `Usage` column has entry, `Shared`) The possible entries in this column are: • `Critical Section`: If variable is accessed in critical section of code • `Temporal Exclusion`: If variable is accessed in mutually exclusive tasks For more details on these entries, see: • "Prevent Concurrent Access Using Temporally Exclusive Tasks" • "Prevent Concurrent Access Using Critical Sections"
Usage	`Shared`, if variable is shared between tasks; otherwise, blank
Line	Line number of variable declaration
Col	Column number (number of characters from beginning of line) of variable declaration
File	Source file containing variable declaration
Data Type	Data type of variable (C/C++ data types or structures/classes)

Double-click a variable name to view read/write access operations on the variable. The arrowhead symbols ▸ and ◂ in the **Variable Access** pane indicate functions performing read and write access respectively on the global variable. Likewise, tasks performing read and write access are indicated by the symbols ||▸ and ◂|| respectively. For further information on tasks, see "Entry points (C/C++)".

For access operations on the variables, the various attributes described in the pane are listed in this table.

Attribute	Description
Variables	Names of function (or task) performing read/ write access on the variable, *`File_Name. Function_Name`* *`File_Name`*: Name of file containing function (or task) definition
Values	Value or range of values of variable in the function or task performing read/write access
Written by task	*Only for tasks*: Name of task performing write access on variable
Read by task	*Only for tasks*: Name of task performing read access on variable
Line	Line number where function or task accesses variable
Col	Column number where function or task accesses variable
File	Source file containing access operation on variable

For example, consider the global variable, `SHR2`:



The function, `Tserver`, in the file, `tasks1.c`, performs two write operations on `SHR2`. This is indicated in the **Variable Access** pane by the two instances of `tasks1.Tserver()` under the variable, `SHR2`, marked by . Likewise, the two write accesses by tasks, `server1` and `server2`, are also listed under `SHR2` and marked by .

The following color scheme is used for variables that appear on the **Variable Access** pane:

- Gray: global variable that is declared but never used. When determining whether a variable is used, the software considers the entire source code, both reachable and unreachable.
- Black: global variable that is used in one task. When determining whether a variable is shared, the software considers all operations, both reachable and unreachable. In code that is not intended for multitasking, the global variables are either black or gray.
- Orange: global variable that is used in more than one task. At least one operation on the variable is not protected from interruption by operations in other tasks.

- Green: global variable that is used in more than one task. All operations on the variable are protected from interruption through critical sections or temporal exclusion. The calls to functions beginning and ending a critical section must be reachable.

In addition, a read or write operation on a global variable appears gray if it occurs in unreachable code.

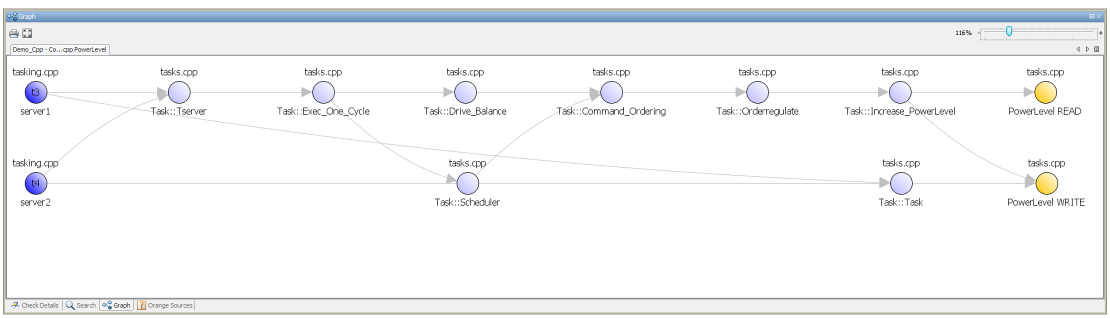
The information about global variables and read/write access operations obtained from the **Variable Access** pane is called the data dictionary. For more information on the data dictionary, see “Dataflow Verification”.

You can also perform the following actions from the **Variable Access** pane.

- ## View Access Graph

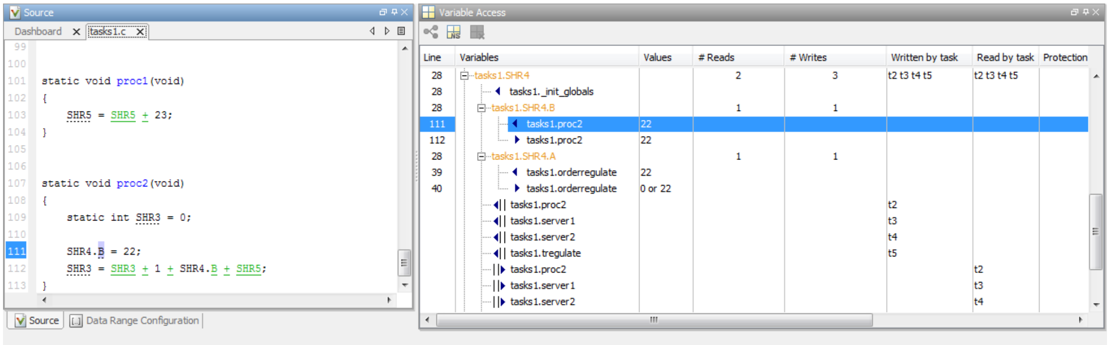
  View the access operations on a global variable in graphical format using the **Variable Access** pane. Select the global variable and click . For more information, see “View Access Graph for Global Variables”.

  Here is an example of an access graph:



- ## View Structured Variables

  For structured variables, view the individual fields from the **Variable Access** pane. For example, for the structure, `SHR4`, the pane displays the fields, `SHR4.A` and `SHR4.B`, and the functions performing read/write access on them.

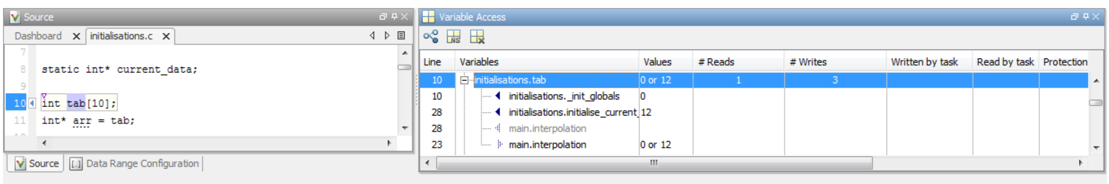


View Access Through Pointers

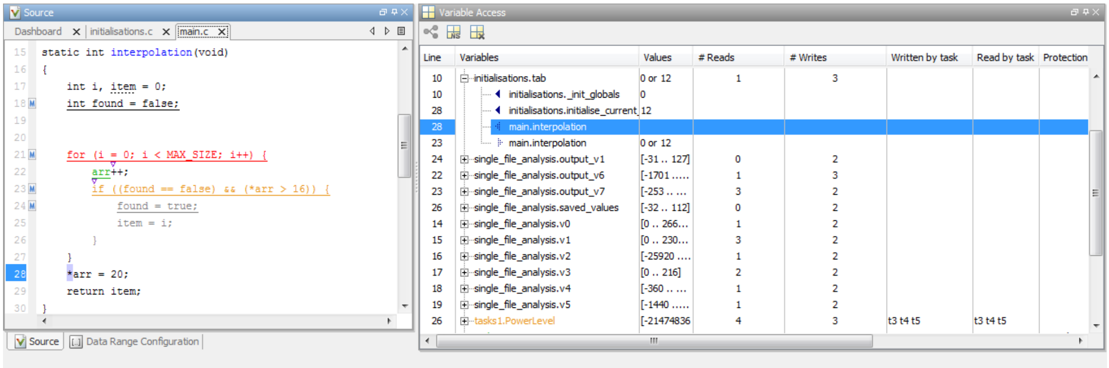
View access operations on global variables performed indirectly through pointers.

If a read/write access on a variable is performed through pointers, then the access is marked by (read) or (write).

For instance, in the file, `initialisations.c`, the variable, `arr`, is declared as a pointer to the array, `tab`.



In the file `main.c`, `tab` is both read and written in the function, `interpolation()`, through the pointer variable, `arr`. This operation is shown in the **Variable Access** pane by the and icons respectively.



Show/Hide Callers and Callees

Customize the **Variable Access** pane to show only the shared variables. On the Variable Access pane toolbar, click the Non-Shared Variables button to show or hide non-shared variables.

Hide Access in Unreachable Code

Hide read/write access occurring in dead code by clicking the filter button .

Limitations

You cannot see an addressing operation on a global variable or object (in C++) as a read/write operation in the **Variable Access** pane. For example, consider the following C++ code:

```
class CO
{
public:
  CO() {}
  int get_flag()
  {
    volatile int rd;
    return rd;
  }
  ~CO() {}
private:
  int a;               /* Never read/written */
};
```

```
CO c0;                  /* c0 is unreachable */

int main()
{
  if (c0.get_flag())    /* Uses address of the method */
    {
      int *ptr = take_addr_of_x();
      return 1;
    }
  else
    return 0;
}
```

You do not see the method call `c0.get_flag()` in the **Variable Access** pane because the call is an addressing operation on the method belonging to the object `c0`.

Red Checks

Red checks indicate code that always causes a run-time error.

Run-time errors highlighted by Polyspace Code Prover verification are determined with reference to the language standard. Though some of the errors can be acceptable for a particular environment, they are unacceptable according to the language standard.

Consider an overflow on a type restricted from -128 to 127. The type cannot store the result of the computation 127+1=128. However, depending on the environment a “wrap around” might be performed to give a result of -128. This result is mathematically incorrect, and could have serious consequences if, for example, the computation represents the altitude of a plane.

By default, Polyspace verification does not make assumptions about the way you use a variable. A deviation from the recommendations of the language standard is treated as a red error. Most of the errors you find are easy to fix once the software identifies them. Polyspace verification identifies errors regardless of their consequence, or how difficult they may be to fix.

Polyspace verification identifies two kinds of red checks:

- Red errors which are compiler-dependant in a specific way. A Polyspace option may be used to allow compiler specific behavior .

  Examples in C include options to deal with constant overflows, shift operation on negative values, and so on.
- You must fix all other red errors. They are code defects.

Gray Checks

In this section...

Gray Checks

Gray checks denote unreachable sections of code. Unreachable code can arise in the following situations:

- Unreachable code resulting from bugs in the source code
- Unreachable code resulting from a particular configuration
- Defensive code that is never reached
- Libraries that are not used to their full extent in a particular context

Common Causes for Gray Checks

- A lack of parenthesis and operand priorities in the testing clause changes the meaning significantly.

  Consider a line of code such as:

  ```
  IF NOT a AND b OR c AND d
  ```

  For this line of code, misplaced parentheses can severely influence how the line behaves. For instance, the following placement of parentheses can lead to significantly different test conditions:

  ```
  IF NOT (a AND b OR c AND d)
  ```

  ```
  IF (NOT (a) AND b) OR (c AND d))
  ```

  ```
  IF NOT (a AND (b OR c) AND d)
  ```

- The test variable takes values that never satisfy the condition tested by an `if` statement.
- The wrong variable is tested in the `if` statement.

- The test variable should be local to a file but is instead local to a function.
- The data type of the test variable leads to a comparison that is always false.

Orange Checks

Orange checks indicates that the code cannot be proved to either have or not have a run-time error.

The number of orange checks you need to review is determined by several factors, including:

- The stage of the development process
- Your quality goals

You can also take steps to reduce the number of orange checks. For more information, see "Orange Check Management".

Orange Check Identified as Potential Errors

The software identifies a subset of orange checks that are most likely run-time errors. If you choose the review methodology **First checks to review**, you can view this subset. These orange checks are related to path and bounded input values. For more information, see:

- "Path" on page 10-93
- "Bounded Input Values" on page 10-94
- "Unbounded Input Values" on page 10-95

Here, input values refer to values that are external to the application. Examples include:

- Inputs to functions called by generated main. For more information on functions called by generated main, see "Functions to call (C)".
- Global and volatile variables.
- Data returned by a stubbed function. The data can be the value returned by the function or a function parameter modified through a pointer.

Path

The following example shows a path-related orange check that might be identified as a potential run-time error.

Consider the following code.

```
void path(int x) {
   int result;
   result = 1 / (x - 10);
   // Orange Division by Zero
 }

void main() {
    path(1);
    path(10);
 }
```

The software identifies the orange ZDV check as a potential error. The **Check Details** pane indicates the potential error:

```
...
Warning: scalar division by zero may occur
...
```

This **Division by Zero** check on `result=1/(x-10)` is orange because:

- `path(1)` does not cause a division by zero error.
- `path(10)` causes a division by zero error.

Polyspace indicates the definite division by zero error through a **Non-terminating call** error on `path(10)`. If you select the red check on `path(10)`, the **Check Details** pane provides the following information:

```
NTC .... Reason for the NTC: {path.x=10)
```

Bounded Input Values

Most input values can be bounded by data range specifications (DRS). The following example shows an orange check related to bounded input values that might be identified as a potential run-time error.

```
int tab[10];
extern int val;
// You specify that val is in [5..10]

void assignElement(int index) {
   int result;
   result = tab[index];
   // Orange Out of bounds array index
 }
void main(void) {
```

```
   assignElement(val);
}
```

If you specify a **PERMANENT** data range of 5 to 10 for the variable `val`, verification generates an orange **Out of bounds array index** check on `tab[index]`. The **Check Details** pane provides information about the potential error:

```
Warning: array index may be outside bounds: [0..9]
This check may be an issue related to bounded input values
Verifying DRS on extern variable val may remove this orange.
  array size: 10
  array index value: [5 .. 10]
```

Unbounded Input Values

The following example shows an orange check related to unbounded input values that might be identified as a potential run-time error:

```
int tab[10];
extern int val;

void assignElement(int index) {
   int result;
   result = tab[index];
   // Orange Out of bounds array index
 }
void main(void) {
   assignElement(val);
}
```

The verification generates an orange **Out of bounds array index** check on `tab[index]`. The **Check Details** pane provides information about the potential error:

```
Warning: array index may be outside bounds: [0..9]
This check may be an issue related to unbounded input values
If appropriate, applying DRS to extern variable val may remove this orange.
 array size: 10
 array index value: [-2^31 .. 2^31-1]
```

Color Sequence of Checks

The following examples show how the checks obtained in a verification can depend on each other.

- The following example shows what happens after a red check:

  ```
  void red(void)
  {
  int x;
  x = 1 / x ;
  x = x + 1;
  }
  ```

  When Polyspace verification reaches the division by `x`, `x` has not yet been initialized. Therefore, the software generates a red `Non-initialized local variable` check for `x`.

  Execution paths beyond division by `x` are stopped. No checks are generated for the statement `x = x + 1;`.

- The following example shows how a green check can propagate out of an orange check.

  ```
  extern int Read_An_Input(void);
  void propagate(void)
  {
   int x;
   int y[100];
   x = Read_An_Input();
   y[x] = 0;
   y[x] = 0;
  }
  ```

  In this function:

  - `x` is assigned the return value of `Read_An_Input`. After this assignment, the software estimates the range of `x` as `[-2^31, 2^31-1]`.
  - The first `y[x]=0;` shows an `Out of bounds array index` error because `x` can have negative values.
  - After the first `y[x]=0;`, from the size of `y`, the software estimates `x` to be in the range `[0,99]`.
  - The second `y[x]=0;` shows a green check because `x` lies in the range `[0,99]`.

- The following example shows why a check should be reviewed in the context of the code.

Consider an orange `Non-initialized local variable` on `x` in the following statement:

```
if (x > 101);
```

You might conclude that the verification continues after this statement because the check is orange. However, consider the same statement in the context of the code:

```
extern int read_an_input(void);

void main(void)
{
  int x;
  if (read_an_input()) x = 100;
  if (x > 101)
  //Orange Non-initialised local variable
    {x++; }
}
```

The correct interpretation of this verification result is that if `x` is initialized, the only possible value for it is 100. Therefore, `x` can never be both initialized and greater than 101, so the rest of the code is gray. This conclusion is different from what you expect considering the line in isolation.

- The following example shows how a red error can hide a bug which occurred on previous lines.

```
%% file1.c %%

void f(int);
int read_an_input(void);

int main()  {
    int x,old_x;
    x = read_an_input();
    old_x = x;
    if (x<0 || x>10)
      return 1;
    f(x);
    x = 1 / old_x;
    // Red Division by Zero
    return 0;
}
```

```
%% file2.c %%

#include <math.h>

void f(int a) {
    int tmp;
    tmp = sqrt(0-a);
}
```

A red check occurs on `x=1/old_x;` in `file1.c` because of the following sequence of steps during verification:

1. When `x` is assigned to `old_x` in `file1.c`, the verification assumes that `x` and `old_x` have the full range of an integer, that is `[-2^31 , 2^31-1]`.
2. Following the `if` clause in `file1.c`, `x` is in `[0,10]`. Because `x` and `old_x` are equal, Polyspace considers that `old_x` is in `[0,10]` as well.
3. When `x` is passed to `f` in `file1.c`, the only possible value that `x` can have is 0. All other values lead to a run-time exception in `file2.c`, that is `tmp = sqrt(0–a);`.
4. A red error occurs on `x=1/old_x;` in `file1.c` because the software assumes `old_x` to be 0 as well.

- The following example shows how skipping intermediate code while tracing the cause of a check might lead to erroneous conclusions.

  Consider the following example:

```
extern int read_an_input(void);

void main(void)
{
 int x;
 int y[100];
 x = read_an_input();
 y[x] = 0;
 y[x-1] = (1 / x) + x ;
 if (x == 0)
  y[x] = 1;
}
```

  From the gray check, you can trace backwards as follows:

  - The line `y[x]=1;` is unreachable.
  - Therefore, the test to assess whether `x = 0` is always false.
  - The return value of `read_an_input()` is never equal to 0.

  However, `read_an_input` can return any value in the full integer range, so this is not the correct explanation.

  Instead, consider the execution path leading to the gray code:

- The orange **Out of bounds array index** check on `y[x]=0;` means that subsequent lines deal with `x` in `[0,99]`.
- The orange **Division by Zero**check on the division by `x` means that `x` cannot be equal to 0 on the subsequent lines. Therefore, following that line, `x` is in `[1,99].`
- Therefore, `x` is never equal to 0 in the `if` condition. Also, the array access through `y[x-1]` shows a green check.

Defects from Code Integration

When you integrate sections of code, the number of checks can change from when the sections were verified in isolation. The following examples show this behavior:

- A function receives two unbounded integers. When verifying the function in isolation, the software assumes that inputs are well-behaved. The software can check for the presence of an overflow only during integration.
- A function takes a structure as an input parameter. When verifying the function in isolation, the software assumes that the structure is well initialized. Consequentially, the software displays a green `Non-initialized local variable` check at the first read access to a field. During integration, this check can turn orange if a context does not initialize these fields.

If you have already performed an exhaustive review for the individual sections, during integration, review only checks that have turned from green to another color .

Defects in Unprotected Shared Data

Based on the list of entry points in a multi-task application, Polyspace verification identifies a list of shared data and provides some information about each entry:

- The data type.
- A list of read and write access to the data through functions and entry points.
- The type of any implemented protection against concurrent access.

You can specify entry points through the **Multitasking** tab on the **Configuration** pane in the Project Manager perspective. For information on command-line specification, see "Entry points (C/C++)".

A shared data item is a global data item that is read from or written to by two or more tasks. You can view information on shared data on the **Variable Access** pane. For more information, see "Variable Access".

A shared variable is protected from concurrent access when one task cannot access it while another task is in the process of doing so. A defect can arise from unprotected concurrent access on variables. To prevent defects arising from concurrent access, protect the variables by placing them in a critical section or temporally exclusive tasks. For more information, see "Critical section details (C/C++)" and "Temporally exclusive tasks (C/C++)".

Defects Related to Pointers

In this section...

For a check related to a pointer variable, on separate lines in the tooltip message, the software displays:

- The pointer name, data type of the variable, and size of the data type in bits.
- A comment that indicates whether the pointer `is null`, `is not null`, or `may be null`. See also "Messages on Dereferences".
- The number of bytes that the pointer accesses, the offset position of the pointer in the allocated buffer, and the size of this buffer in bytes.
- A comment that indicates whether the pointer *may* point to dynamically allocated memory.
- The names of the variables at which the pointer may point. See also "Variables in Structures (C)".

For a check related to a function pointer, the software displays:

- The pointer name.
- A comment that indicates whether the pointer `is null`, `is not null`, or `may be null`.
- The names of the functions that the pointer may point to, and a comment indicating whether the functions are well or badly typed (whether the number or types of arguments in a function call are compatible with the function definition).

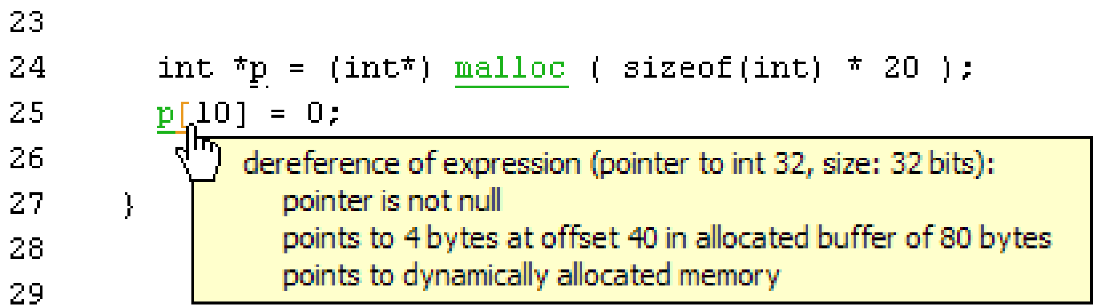
Messages on Dereferences

Tooltip messages on dereferences give information about the expression that is dereferenced.

Consider the following code:

```
int *p = (int*) malloc ( sizeof(int) * 20 );
p[10] = 0;
```

In the verification results, the tooltip on "[" displays information about the expression that is dereferenced.



`p[10]` refers to the contents of address `p + 10 * sizeof(int)`, so the tooltip message displays the following:

- The dereferenced pointer is at offset `40`.

  Explanation: `p` has offset `0`, so `p+10` has offset `10 * sizeof(int)=40`.
- The dereferenced pointer is not null.

  Explanation: `p` is null, but `p+10` is not null (`0+40` ≠ `0`).

The software reports an orange dereference check (`IDP`) on `p[10]` because `malloc` may have put `NULL` into `p`. In that case, `p + 10 * sizeof(int)` is not null, but it is not properly allocated.

Variables in Structures (C)

The information that the software displays for structure variables depends on whether you specify the option "`Enable pointer arithmetic across fields (C)`".

Consider the following code:

```
Struct { int x; int y; int z; } s ;
int *p = &s.y ;
```

If you do not specify the option (this is the default), then placing the cursor over `p` produces the following information:

```
accessing 4 bytes at offset 0 in buffer of 4 bytes
```

This information conforms with ANSI C, which

- Requires that `&s.y` points only at the field `y`
- Does not allow pointer arithmetic for access to other fields, for example, `z`

If you specify the option `-allow-ptr-arith-on-struct`, you are allowed to carry out pointer arithmetic using the addresses of structure fields. In this case, placing the cursor over `p` produces the following information:

```
accessing 4 bytes at offset 4 in buffer of 12 bytes
```

Global Variables

Initializing Global Variables

If your application defines global variables, then the software uses the dummy function `_init_globals()` to initialize the global variables. The `_init_globals()` function is the first function called in the `main` function.

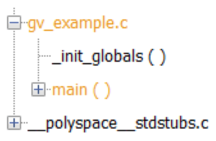
Consider the following code in the application `gv_example.c`.

```
extern int func(int);  /* External function */

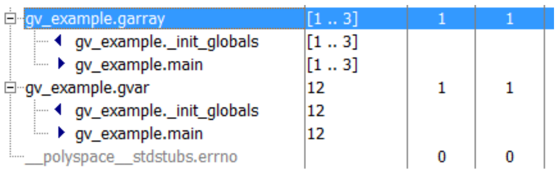
/* Global variables initialized in _init_globals() */
/* before the execution of main() procedure     */
int garray[3] = {1, 2, 3};
/* Initialized: written in __init_globals() */
int gvar = 12;
/* Initialized: written in __init_globals() */

int main(void) {
 int i, lvar = 0;
 for (i = 0; i < 3; i++)
  lvar += func(garray[i] + gvar);
 return lvar;
}
```

Verification produces the following procedural entities:



In the Variables view, `gv_example._init_globals` represents the first write access operation on a global variable, for example, `garray`. The corresponding value in the **Values** column represents the value of the global variable after initialization.



Using Global Variables

For global variables, it is not always apparent which global variables are produced or used by a given file. Excessive use of global variables can lead to design problems, such as:

- File APIs (or functions accessible from outside the file) without procedure parameters.
- The requirement for a formal list of variables which are produced and used, and the theoretical ranges they can take as input and output values.

Dataflow Verification

You can verify dataflow in Polyspace for certification purposes. Dataflow verification is a typical requirement in the avionic, aerospace, or transport markets.

Verify data flow for functions and global variables through the following Polyspace results:

- Call tree (also known as call graph) for functions (and tasks). The call tree shows the calling relationship between functions (and tasks). For more information, see “View Call Tree for Functions”.

  You can view the call tree in two ways:

  - Through the **Call Hierarchy** pane. On this pane, you can view the branch of the call tree containing a given function. You can also navigate the entire call tree from this pane. For more information, see “Call Hierarchy”.
  - In text format. Open the file, `*projectname*_Call_Tree.txt`, in the folder, `Polyspace-doc`, in your results folder.
- Data dictionary for global variables. The data dictionary lists global variables with their read/write access operations.

  You can view the data dictionary in two ways:

  - Through the **Variable Access** pane. On this pane, you can view global variables and their attributes. For more information, see “Variable Access”. You can also access a graphical representation of the call sequence for global variables using this pane. For more information, see “View Access Graph for Global Variables”.
  - In text format. Open the file, `*projectname*_Variable_View.txt`, in the folder, `Polyspace-doc`, in your results folder.

Results Folder

The Result_*n* folder contains the following files:

- Polyspace_*release*_*project_name*_*date-time*.log — A log file associated with each verification, for example, Polyspace_R2013b_example_project_05_17_2013-12h01.log.
- *project_name*.pscp — An ASCII file containing the location of the most recent results and log. The software uses this file to open results in the Results Manager.
- drs-template.xml — A file containing the data range specifications that is generated by Polyspace Code Prover during the compile phase.
- *coding_rules_std*_rules.txt — A template of coding rules. For example, misra_rules.txt is a template of MISRA rules, generated when you specify the -misra2 all-rules option.
- options — The list of options used for the most recent verification.
- pst_user_stubs.c — The list of functions and procedures stubbed by Polyspace Code Prover during the compile phase.
- source_list.txt — A list of sources verified by the latest verification.

In addition, the Result_*n* folder contains the following subfolders:

In this section...

ALL Subfolder

The ALL subfolder contains internal information that is used by Polyspace Code Prover to show sources and checks.

- SRC\MACROS\ci.zip — A zip file containing expanded source files with a .ci suffix.
- _deadproc.txt — A text file of unreachable procedures.
- SRC*.[c or h] — Source code file required for the verification. The file contains user source code and code generated by Polyspace Code Prover.

Polyspace-Doc Subfolder

The Polyspace-Doc subfolder contains the following files:

- Code_Metrics.xml — A list of metrics from the most recent verification.
- *CODING_RULES_STD*-report.xml and *CODING_RULES_STD*-summary-report.xml — Lists coding rules violated during the most recent verification. For example:
  - If you specify the option **Check MISRA C:2004 rules**, the software generates MISRA-report.xml and MISRA-summary-report.xml. These files list the violated MISRA C rules.
  - If you specify the option **Check custom rules**, the software generates Custom-rules-report.xml and Custom-rules-summary-report.xml. These files list the violated custom rules.
- *Project_name*_Call_Tree.txt — Call tree starting from entry point functions. Each level in the tree hierarchy is denoted by |. For example, a function call two levels away from an entry point function is denoted as:

  ```
  |  |  - > file_name.function_name
  ```

  Each row in this file contains a function name and the file, line, and column of the:

  - Function call
  - Function definition
- *Project_name*_Variable_View.txt — Data dictionary of global variables.

  For each variable, the rows below the variable name contain:

  - Variable reads denoted by > and writes denoted by <.
  - Call tree level of reading or writing function denoted using | in the same way as in *Project_name*_Call_Tree.txt
  - Additional information available on the **Variable Access** pane. See "Variable Access".
- Polyspace_Macros — This .xls file contains a **Generate Spreadsheet** macro. The macro collects the information contained in *Project_name*_Call_Tree.txt and *Project_name*_Variable_View.txt. The macro then displays them in a spreadsheet. For the macro to function, both .txt files must be in the same folder as the .xls file.

Polyspace-Instrumented Subfolder

When the software runs the Automatic Orange Tester (AOT) at the end of a static verification, the software creates the Polyspace-Instrumented folder. The Polyspace-Instrumented folder contains files associated with the configuration and running of the Automatic Orange Tester. These files include the following:

- _testgen.tgf — A configuration file that contains your Automatic Orange Tester preferences and variable ranges.
- reachedchecks.txt — Statistics for orange checks covered by the last run of the Automatic Orange Tester.
- reachedchecks_*dd_mm_yyyy-hhmmss*.txt — Statistics for orange checks covered by the run of the Automatic Orange Tester at the given date and time.
- TestGenerator_*dd_mm_yyyy-hhmmss*.out — Log file created at the given date and time, which contains a list of failed tests as well as summary information.
- stdout.txt — Contains data from the standard output (stdout) stream generated by your code during the last run of the Automatic Orange tester.
- stderr.txt — Contains messages from the standard error (stderr) stream generated by your code during the last run of the Automatic Orange tester.

Reusing Review Comments

After you have reviewed verification results, you can reuse your review comments for subsequent verifications. By reusing your review comments, you can:

- Avoid reviewing the same check twice.
- Compare verification results over time.

You can directly import review comments from another set of results into the current results. However, it is possible that your review comments do not apply to a subsequent verification because:

- You have changed your source code so that the check is no longer present.
- You have changed your source code so that the check color has changed.
- You have already entered different review comments for the same check.

Related Examples

- "Import Review Comments from Previous Verifications"
- "View Checks and Comments Report"

Import Review Comments from Previous Verifications

In this section...

After you have reviewed verification results, you can reuse your review comments for subsequent verifications.

After you import checks and comments, clicking the  icon skips justified checks. Therefore, you do not have to review checks twice.

Import Comments from Previous Verifications

1. Open your verification results in the Results Manager perspective.
2. Select **Tools** > **Import Comments**.
3. Navigate to the folder containing your previous results.
4. Select the results file with extension `.pscp` and then click **Open**.

   The review comments from the previous results are imported into the current results, and the Import checks and comments report opens. For more information, see "View Checks and Comments Report".

Automatically Import Comments from Last Verification

1. Select **Tools** > **Preferences**, which opens the Polyspace Preferences dialog box.
2. Select the **Project and Results Folder** tab.
3. Under **Import Comments**, select **Automatically import comments from last verification**.
4. Click **OK**.

   After you set this preference, for every run, the software imports review comments from the last run.

Automatically Import Comments During Command-Line Verification

To automatically import comments from a specific verification, use the option `-import-comments`. For example:

```
polyspace-code-prover-nodesktop -version 1.3 -import-comments C:\PolyspaceResults\1.2
```

See Also

"-import-comments"

Related Examples

- "View Checks and Comments Report"

More About

- "Reusing Review Comments"

View Checks and Comments Report

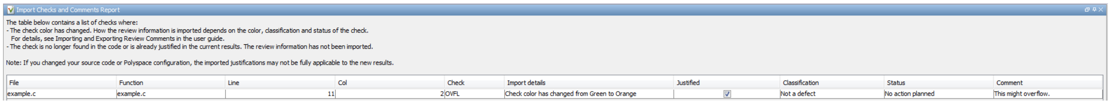
After you have reviewed verification results, you can reuse your review comments for subsequent verifications. However, it is possible that your review comments do not apply to a subsequent verification because:

- You have changed your source code so that the check is no longer present.
- You have changed your source code so that the check color has changed.
- You have already entered different review comments for the same check.

The Import Checks and Comments Report highlights differences between two verification results. When you import comments from a previous verification, you can see this report. If you have closed the report after an import, to review the report again:

1. Select **Window** > **Show/Hide View** > **Import Comments Report**.

   The Import Checks and Comments Report opens, highlighting differences in the two results.

2. Review the differences between the two results.

   - If the check color changes, Polyspace populates the **Comment** field but not the fields **Classification**, **Status** or **Justified**.
   - If a check no longer appears in the code, Polyspace highlights only the change in the Import Checks and Comments Report. It does not import review comments from the previous result.
   - If you have already entered different review comments for the same check, Polyspace highlights only the change in the Import Checks and Comments Report. It does not import review comments from the previous result.

Related Examples

- "Import Review Comments from Previous Verifications"

More About

- "Reusing Review Comments"

Generate Report from User Interface

This example shows how to generate a report from your verification results. Using a customizable template, the report presents your results in a concise manner for managerial review or other purposes. To generate a verification report, do one of the following:

- Specify certain options before verification so that the software automatically generates a report.
- Generate a report from your verification results.

Specify Report Generation Before Verification

1. In the Project Manager perspective, open your project.
2. On the **Configuration** pane, specify report generation options.

   a. Select the **Reporting** node.

   b. Select **Generate report**.

   c. Select a **Report template** and **Output format**.

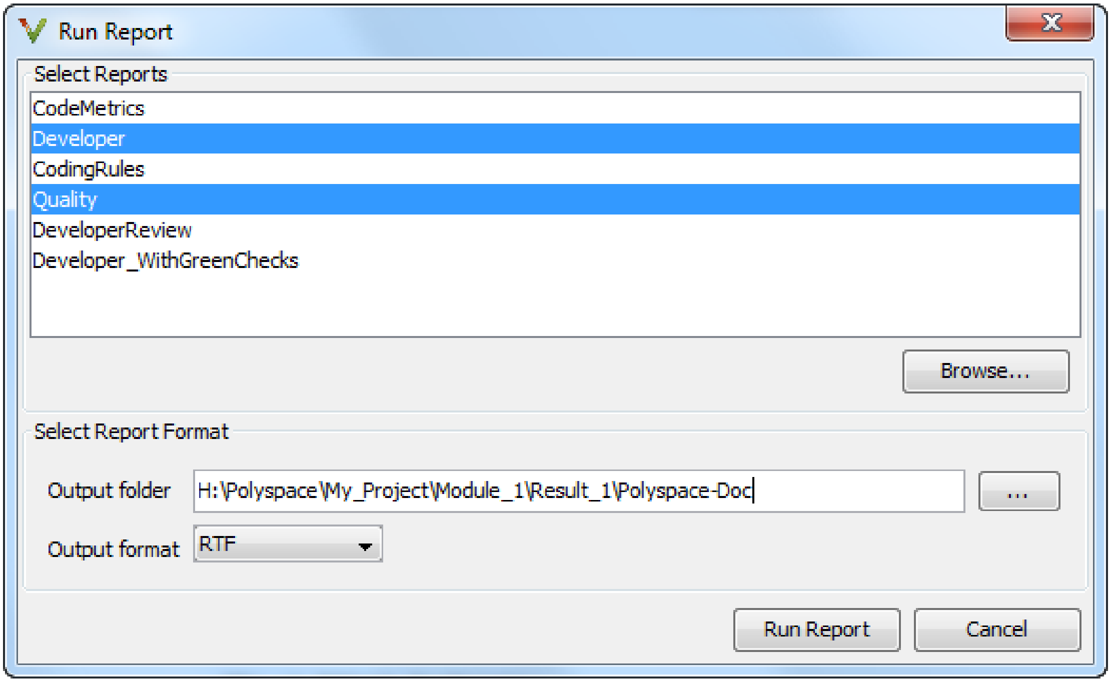
      The template determines the information to be placed in the report along with how it is presented.
3. Run verification and open your results.
4. Select **Reporting** > **Open Report**
5. Navigate to the `Polyspace-Doc` subfolder in your results folder.

   You can see the generated report in this subfolder.
6. Select the report and click **OK** to open them.

Generate Report After Verification

1. In the Results Manager perspective, open your verification results.
2. Select **Reporting** > **Run Report**.

   The Run Report dialog box opens.
3. In the **Select Reports** section, select the report templates you want to use. For example, you can select **Developer** and **Quality**.



4 Select the **Output folder** in which to save the reports.

5 Select the **Output format** for the reports.

6 Click **Run Report**.

The software creates the specified reports and opens them.

See Also

"Generate report (C/C++)" | "Report template (C/C++)" | "Output format (C/C++)"

Related Examples

- "Generate Report from Command Line"
- "Open Report"
- "Customize Report Templates"

Generate Report from Command Line

You can also run the Report Generator, with options, from the command line, for example:

```
Matlab_Install\polyspace\bin\polyspace-report-generator -template
path -format type -results-dir folder_paths
```

For information about the available options, see the following sections.

-template *path*

Specify the *path* to a valid Report Generator template file, for example:

```
Matlab_Install\polyspace\toolbox\psrptgen\templates\Developer.rpt
```

Other supplied templates are `CodingRules.rpt`, `Developer_WithGreenChecks.rpt`, `DeveloperReview.rpt`, and `Quality.rpt`.

-format *type*

Specify the format *type* of the report. Use `HTML`, `PDF`, `RTF`, `WORD`, or `XML`. The default is `RTF`.

-help or -h

Displays help information.

-output-name *filename*

Specify the *filename* for the report generated.

-results-dir *folder_paths*

Specify the paths to the folders that contain your verification results.

You can generate a single report for multiple verifications by specifying *folder_paths* as follows:

```
"folder1, folder2, folder3,..., folderN"
```

where *`folder1, folder2, ...`* are the file paths to the folders that contain the results of your verifications (normal or unit-by-unit). For example,

```
"C:\Results1,C:\Recent\results,C:\Old"
```

If you do not specify a folder path, the software uses verification results from the current folder.

See Also

“Generate report (C/C++)” | “Report template (C/C++)” | “Output format (C/C++)”

Related Examples

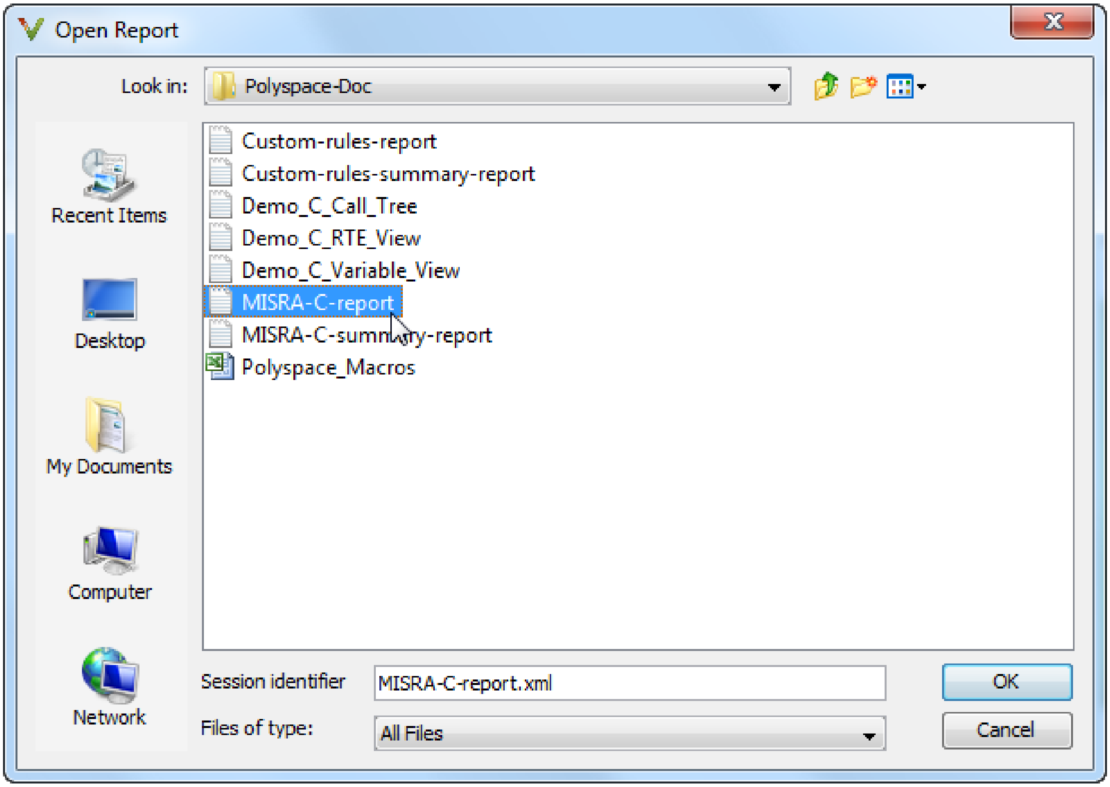
- “Generate Report from User Interface”
- “Open Report”
- “Customize Report Templates”

Open Report

This example shows how to open a verification report. Before you open the report, you must have a generated report. For more information, see “Generate Report from User Interface”.

1. Open your verification results.
2. Select **Reporting** > **Open Report**, which opens the Open Report dialog box.
3. Navigate to the folder that contains your report.

   Unless you specify an output folder explicitly during report generation, the generated report appears in the `Polyspace-Doc` subfolder in your results folder.
4. Select the report and click **OK**.



See Also

"Generate report (C/C++)" | "Report template (C/C++)" | "Output format (C/C++)"

Related Examples

- "Generate Report from User Interface"
- "Generate Report from Command Line"
- "Customize Report Templates"

Customize Report Templates

This example shows how to customize the templates that you use for report generation. To customize the templates, you must have MATLAB Report Generator™ software installed on your system.

Create Custom Template

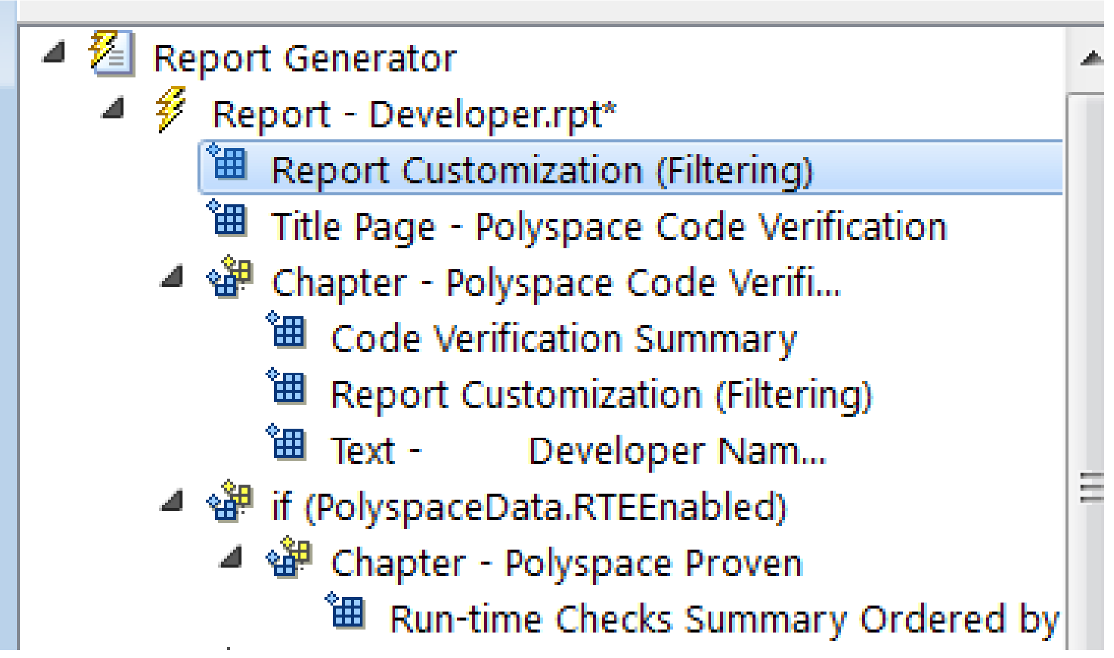
If you have MATLAB Report Generator software on your system:

1. Open the Report Explorer from the MATLAB command prompt:

   ```
   report
   ```
2. Select **File** > **Open** to open the template that you want to customize.
3. Navigate to `*Matlab_Install*/polyspace/toolbox/psrptgen/templates` where `*Matlab_Install*` is the MATLAB installation folder. Use the `matlabroot` command to find the folder location.
4. Modify the template using the options on the **Report Options** pane.
5. Save the modified template as a `.rpt` file.

Apply Global Filters in Template

1. In the Report Explorer, open the template that you want to customize. For instance, **Developer.rpt**.
2. On the **Name** pane, under the **Polyspace** node, select **Report Customization (Filtering)**.
3. Drag this component above the **Title Page** component that is located under the **Report-Developer.rpt** node.



4 On the **Report Customization (Filtering)** pane in the right side of the Report Explorer, specify your filters. For example:

- To include **Division by zero** checks, under **Advanced filters**, in the **Check types to include** field, enter `ZDV`.
- To exclude **Division by zero** checks, under **Advanced filters**, in the **Check types to include** field, enter the regular expression `^(?!ZDV).*`.
- To include the file `main.c`, under **Advanced filters**, in the **Files to include** field, enter `main.c`.
- To exclude the file `main.c`, under **Advanced filters**, in the **Files to include** field, enter the regular expression `^(?!main.c).*`.

In each text box, specify one filter per line.

For more information, see:

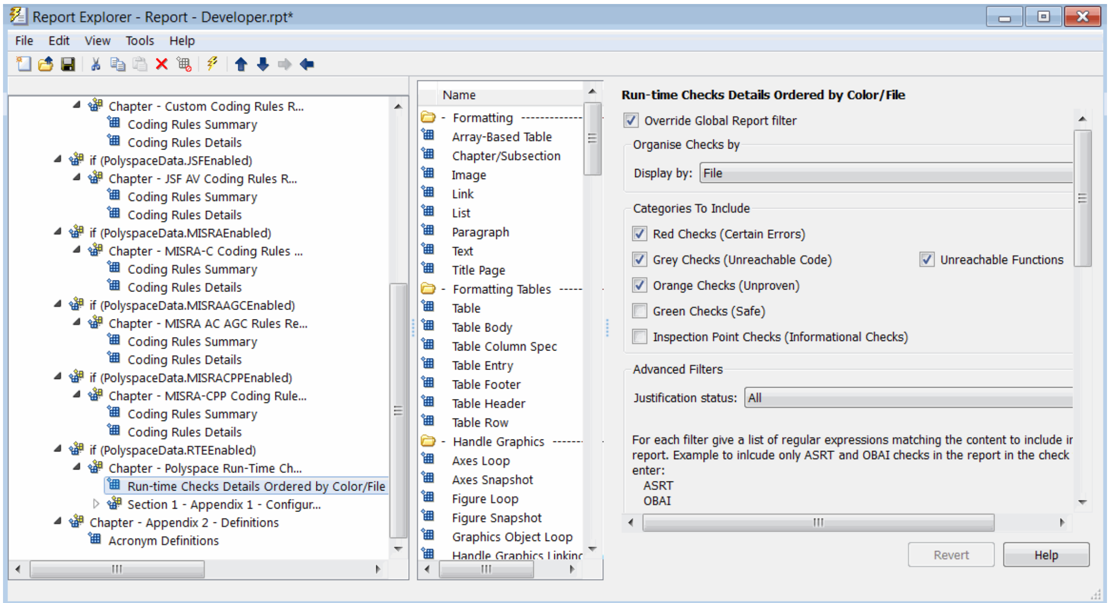
- "Check Acronyms"

- "Regular Expressions"

Override Global Filters

You can override some of the global filters using the **Run-time Check Details Ordered by Color/File** component. For example, you can have a report chapter that contains NIV checks even though NIV checks are excluded by the global filters.

1 Select the **Run-time Check Details Ordered by Color/File** component.



2 On the right of the dialog box, select the **Override Global Report filter** check box.

3 Specify your filters for this component. For example, in the **Check types to include** field, enter NIV.

4 Save the template.

For more information on the components available for customizing report, see "Code Verification" in the Simulink Report Generator documentation.

Use Custom Template

1. Open your results in the Polyspace Code Prover Results Manager.
2. Select **Reporting** > **Run Report**.
3. Click **Browse**.
4. Navigate to the location where you saved your template `.rpt` file.
5. Select the file and click **OK**. Under **Select Reports**, you see your template.
6. Select the template and click **Run Report**.

See Also

"Generate report (C/C++)" | "Report template (C/C++)" | "Output format (C/C++)"

Related Examples

- "Generate Report from User Interface"
- "Generate Report from Command Line"
- "Open Report"

Managing Orange Checks

Sources of Orange Checks

When Orange Checks Occur

An orange check indicates that Polyspace detects a possible run-time error but cannot prove it. A check on an operation appears orange if both conditions are true:

First condition	Second condition	Example
The operation occurs multiple times on an execution path or on multiple execution paths.	During static verification, the operation fails only a fraction of times or only on a fraction of paths.	The operation occurs in: • A loop with more than one iterations. • A function that is called more than once.
The operation involves a variable that can take multiple values.	During static verification, the operation fails only for a fraction of values.	The operation involves a `volatile` variable.

During static verification, Polyspace can consider more execution paths than the execution paths that occur during run time. If an operation fails on a subset of paths, Polyspace cannot determine if that subset actually occurs during run time. Therefore, instead of a red check, it produces an orange check on the operation.

Why Review Orange Checks

Considering a superset of actual execution paths is a sound approximation because Polyspace does not lose information. If an operation contains a run-time error, Polyspace does not produce a green check on the operation. If Polyspace cannot prove the run-time error because of approximations, it produces an orange check. Therefore, you must review orange checks.

Examples of Polyspace approximations include:

- Approximating the range of a variable at a certain point in the execution path. For instance, Polyspace can approximate the range `{-1} U [0,10]` of a `float` variable by `[-1,10]`.
- Approximating the interleaving of instructions in multitasking code. For instance, even if certain instructions in a pair of tasks cannot interrupt each other, Polyspace verification might not take that into account.

How to Review Orange Checks

To ensure that an operation does not fail during run time:

1. Determine if the execution paths on which the operation fails can actually occur.

   For more information, see “Review Orange Check”.
2. If any of the execution paths can occur, fix the cause of the failure.
3. If the execution paths cannot occur, enter a comment in your Polyspace result or source code, describing why they cannot occur. For more information on:

   - Entering comments in results, see “Assign Review Status to Result”.
   - Entering comments in code, see “Comment Code for Known Defects”.

   In a later verification, you can import these comments into your results. Then, if the orange check persists in the later verification, you do not have to review it again. For more information, see “Import Review Comments from Previous Verifications”.

How to Reduce Orange Checks

Polyspace performs approximations because of one of the following.

- Your code does not contain complete information about run-time execution. For example, your code is partially developed or contains variables whose values are known only at run time.

  If you want fewer orange checks, provide the information that Polyspace requires. For more information, see “Provide Context for Verification”.
- Your code is very complex. For example, there can be multiple type conversions or multiple `goto` statements.

If you want fewer orange checks, reduce the complexity of your code and follow recommended coding practices. For more information, see “Follow Coding Rules”.

- Polyspace must complete the verification in reasonable time and use reasonable computing resources.

  If you want fewer orange checks, improve the verification precision. But higher precision also increases verification time. For more information, see “Improve Verification Precision”.

Do I Have Too Many Orange Checks?

Polyspace checks every operation in your code for certain run-time errors. Therefore, you can have several orange checks in your verification results. To avoid spending unreasonable time on an orange check review, you must develop an efficient review process.

Depending on your stage of software development and quality goals, you can choose to:

- Review red checks only.
- Review all red checks and critical orange checks.
- Review all red checks and all orange checks.

To see only red and critical orange checks, on the **Results Summary** pane, select **Show** > **Critical checks**.

In this section...

Software Development Stage

Development Stage	Situation	Review Process
Initial stage or unit development stage	In initial stages of development, you can have partially developed code or want to verify each source file independently. In that case, it is possible that: • You have not defined all your functions and class methods. • You do not have a `main` function Because of insufficient information in the	In the initial stages of development, review all red checks. For orange checks, depending on your requirements, do one of the following: • You want your partially developed code to be free of errors independent of the remaining code. For instance, you want your functions to not cause run-time errors for any input.

Development Stage	Situation	Review Process
	code, Polyspace makes assumptions that result in many orange checks. For instance, if you use the default configuration, Polyspace assumes full range for inputs of functions that are not called in the code.	If so, review orange checks at this stage. • You might want your partially developed code to be free of errors only in the context of the remaining code. If so, do one of the following: • Ignore orange checks at this stage. • Provide the context and then review orange checks. For instance, you can provide stubs for undefined functions to emulate them more accurately. For more information, see "Provide Context for Verification".
Later stage or integration stage	In later stages of development, you have provided all your source files. However, it is possible that your code does not contain all information required for verification. For example, you have variables whose values are known only at run time.	Depending on the time you want to spend, do one of the following: • Review red checks only. • Review red and critical orange checks.

Development Stage	Situation	Review Process
Final stage	• You have provided all your source files. • You have emulated run-time environment accurately through the verification options.	Depending on the time you want to spend, do one of the following: • Review red checks and critical orange checks. • Review red checks and all orange checks. For each orange check: • If the check indicates a run-time error, fix the cause of the error. • If the check indicates a Polyspace approximation, enter a comment in your results or source code. As part of your final release process, you can have one of these criteria: • All red and critical orange checks must be reviewed and justified. • All red and orange checks must be reviewed and justified. To justify a check, assign the **Status** of **No action planned** or **Justify with annotations** to the check.

Quality Goals

For critical applications, you must review all red and orange checks.

- If an orange check indicates a run-time error, fix the cause of the error.
- If an orange check indicates a Polyspace approximation, enter a comment in your results or source code.

As part of your final release process, review and justify all red and orange checks. To justify a check, assign the **Status** of **No action planned** or **Justify with annotations** to the check.

For noncritical applications, you can choose whether or not to review the noncritical orange checks.

Related Examples

- "Review Orange Check"
- "Organize Check Review"

More About

- "Sources of Orange Checks"

Improve Verification Precision

This example shows how to improve the precision of your verification. Increased precision reduces orange checks, but increases verification time.

Use the following options. The options appear on the **Configuration** pane under the **Precision** node.

Option	Purpose
"Precision level (C/C++)"	Specify the verification algorithm.
• "Verification level (C)" • "Verification level (C++)"	Specify the number of times the Polyspace verification process runs on your source code.
"Improve precision of interprocedural analysis (C/C++)"	Propagate greater information about function arguments into the called function.
"Sensitivity context (C/C++)"	If a function contains a red and green check on the same instruction from two different calls, display both checks instead of an orange check.

Related Examples

- "Provide Context for Verification"
- "Follow Coding Rules"

More About

- "Sources of Orange Checks"
- "Do I Have Too Many Orange Checks?"

Provide Context for Verification

This example shows how to provide additional information about run-time execution of your code. Sometimes, the code you provide does not contain this information. For instance:

- You do not have a `main` function
- You have a function that is declared but not defined.
- You have function arguments whose values are available only at run-time.
- You have concurrently running functions that are intended for execution in a specific sequence.

Without sufficient information, Polyspace Code Prover cannot verify the presence or absence of run-time errors.

To provide more context for verification and reduce orange checks, use the following methods.

Method	Example
Define how the `main` generated by Polyspace initializes variables and calls functions	• "Provide Context for C Code Verification" • "Provide Context for C++ Code Verification"
Define a stub for functions whose definitions are not yet written.	"Constrain Data with Stubbing"
Define ranges for global variables and function arguments.	"Review Top Sources of Orange Checks"
Define execution sequence for multitasking code.	"Model Execution Sequence in Tasks"

Related Examples

- "Improve Verification Precision"
- "Follow Coding Rules"

More About

- "Sources of Orange Checks"

- "Do I Have Too Many Orange Checks?"

Follow Coding Rules

This example shows how to follow coding rules that help Polyspace Code Prover prove the presence or absence of run-time errors. If your code follows certain subsets of MISRA coding rules, Polyspace can verify the presence or absence of run-time errors more easily.

1 Check whether your code follows the relevant subset of coding rules.

   a On the **Configuration** pane, depending on the code, select one of the options under the **Coding Rules** node.

Type of Code	Option	Rule Description
Handwritten C code	**Check MISRA C:2004**	"Software Quality Objective Subsets (C:2004)"
Generated C code	**Check MISRA AC AGC**	"Software Quality Objective Subsets (AC AGC)"
Handwritten C++ code	**Check MISRA C++ rules**	"Software Quality Objective Subsets (C++)"

   b From the option drop-down list, select `SQO-subset1` or `SQO-subset2`.

2 Run verification and review your results.

3 Fix the coding rule violations.

More About

- "Sources of Orange Checks"
- "Do I Have Too Many Orange Checks?"

Review Orange Check

This example shows how to identify the cause of an orange check and decide whether it must be fixed.

1. On the **Results Summary** pane, select an orange check.
2. On the **Check Details** pane, view further information about the check.

   Sometimes, this information can be sufficient to identify the cause of the orange check.
3. If the information is not sufficient, trace the cause of the orange check.

   a. Identify the variable `var` that causes the check. For instance, for an **Out of bound array index** error, `var` can be the array index.
   b. On the **Source** pane, place your cursor on `var` to see the values it can take. Identify which value of `var` can cause a run-time error.
   c. Right-click `var` and select **Search For All References**. All instances of `var` appear on the **Search** tab.

      Alternatively, double-click `var` to see all instances highlighted on the **Source** pane.
   d. Click each instance. The **Source** pane shows that instance of `var`.
   e. On the **Source** pane, place your cursor on each instance of `var` to see its values.
   f. If `var` is a function argument, use the **Call Hierarchy** pane to identify the calling function. In the calling function, identify the variable `var_calling_func` which gets copied into `var`. If necessary, browse through the instances of `var_calling_func`.
   g. Find the instance where `var` acquires the value that can cause the run-time error.
4. If you identify that the orange check occurs because of insufficient information available to Polyspace, consider changing your verification options. For more information, see “Provide Context for Verification”.
5. If you identify that the orange check represents a run-time error, write defensive code to prevent the error. For instance, for an **Out of bound array index** error, before you use the array index, check if it is greater than the array size.
6. If you identify that the orange check is caused by a value that does not occur at run time, place a code comment with the rationale. For instance, for an **Out of bound**

array index error, if the array index is a function argument, write a comment describing why the argument cannot be greater than the array size.

If your code comments are in a specific format, Polyspace can read them in a future verification. For more information, see “Comment Code for Known Defects”.

Related Examples

- “Organize Check Review”
- “Review Top Sources of Orange Checks”
- “Test Orange Checks for Run-Time Errors”
- “Identify Function Call Causing Orange Check”

More About

- “Sources of Orange Checks”
- “Do I Have Too Many Orange Checks?”

Organize Check Review

This example shows how to organize your check review. Try the following approach. You can also develop your own procedure for organizing your orange check review.

1 On the **Results Summary** pane, select **Show** > **Critical Checks**.

   This action retains only red, gray and critical orange checks.

2 Before reviewing orange checks, review red and gray checks.

3 Prioritize your orange check review by:

   - Files and functions: For easier review, begin your orange check review from files and functions with fewer orange checks.

     To view the percentage of non-orange checks per file and function, on the **Results Summary** pane, select **Group by** > **File**. Right-click a column header and select %.

   - Check type: Review orange checks in the following order. Checks are more difficult to review as you go down this order.

Review Order	Checks
First	• "Out of bounds array index" • "Non-initialized local variable" • "Division by zero" • "Shift operations"
Second	• "Overflow" • "Illegally dereferenced pointer"
Third	Remaining checks

   - Orange check sources: Review all orange checks caused by a single variable or function. Orange checks often arise from variables whose values cannot be determined from the code or functions that are not defined.

     To review the top sources, view the **Top 5 orange sources** graph on the **Dashboard** tab or the **Orange Sources** tab.

4 Identify the cause of each orange check. On the **Results Summary** pane, assign a **Classification** and **Status** to the check. Add additional comments if necessary.

5 After you have reviewed critical orange checks, on the **Results Summary** pane, select **Show** > **All checks**.

Depending on the quality level that you want, you can choose whether to review the noncritical orange checks or not.

Related Examples

- "Review Orange Check"
- "Review Top Sources of Orange Checks"
- "Test Orange Checks for Run-Time Errors"
- "Identify Function Call Causing Orange Check"

More About

- "Sources of Orange Checks"
- "Do I Have Too Many Orange Checks?"

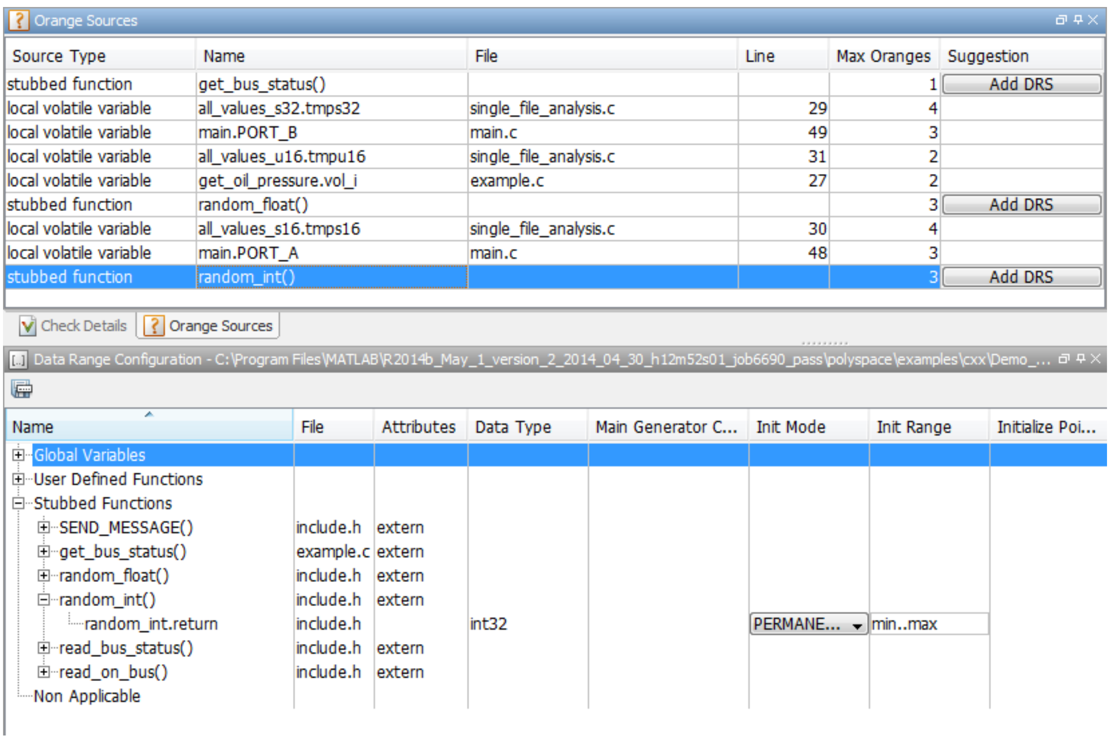
Review Top Sources of Orange Checks

This example shows how to provide a range for variables and function parameters whose values are not known during static analysis. Many orange checks occur due to these unknown values. You can view the top sources of orange checks on the **Orange Sources** tab and provide ranges on this tab.

1 Select the **Orange Sources** tab.

2 On the **Orange Sources** tab, click the **Add DRS** button when available. The **Data Range Configuration** tab opens.

In the example below, clicking the **Add DRS** button for `random_int()` opens the **Data Range Configuration** tab with the node for `random_int()` expanded.



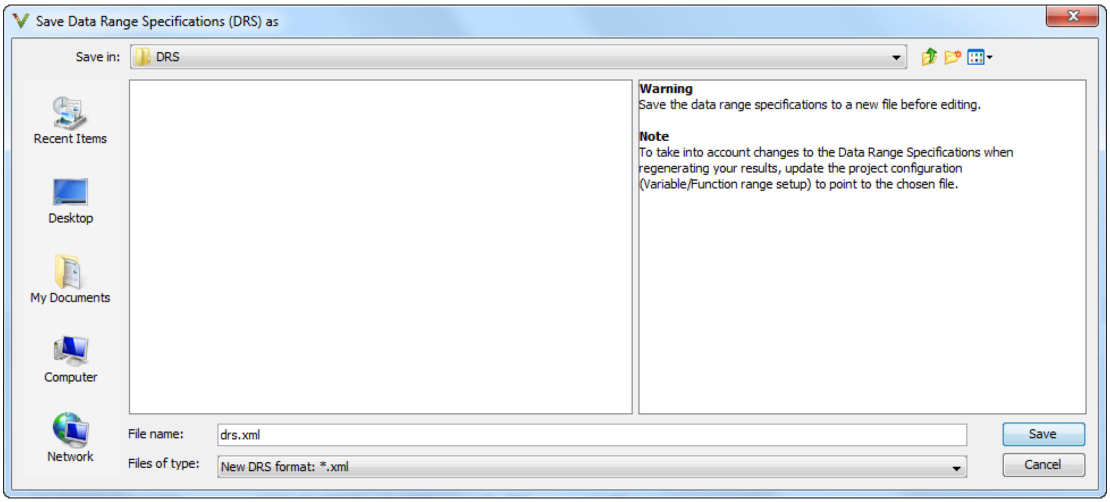
3 You can specify a range for the value returned by the function `random_int`. In the **Init Range** column, replace `min..max` by `-10..10`.

In the **Comment** column, you can also add remarks.

4 Save the changes to a new configuration file:

   a Click .

      The Save Data Range Specifications (DRS) as dialog box opens.



   b Navigate to the required folder, and in the **File name** field, specify the name for the new configuration file. Then click **Save**.

5 In the Project Manager perspective, use the **Configuration** > **Code Prover Verification** > **Inputs & Stubbing** > **Variable/function range setup** field to specify the new DRS configuration file.

6 Rerun the verification. Depending on the data range you specified, the software can replace the orange checks for the source `random_int()` with a green check.

Related Examples

- "Specify Data Ranges Using Existing Template"
- "Review Orange Check"
- "Organize Check Review"
- "Test Orange Checks for Run-Time Errors"

- "Identify Function Call Causing Orange Check"

More About

- "Sources of Orange Checks"
- "Do I Have Too Many Orange Checks?"

Identify Function Call Causing Orange Check

This example shows how to find the function call that causes an orange check in the function body. If a function is called multiple times, an orange check can appear on an operation in the function body because different calls cause different colors on the operation. For example:

- Some calls cause a red check on the operation and the other calls cause a green check.
- Some calls cause an orange check on the operation and the other calls cause a green check.

In the first case, a red **Non-terminating call** check appears on function calls that cause a red check. Using this red check on the function calls, you can identify which calls cause the orange check in the function body. In the second case, a green check appears on all the function calls. Therefore, you have to specify certain verification options to identify which function calls cause the orange check in the function body. For this example, store the following code in `file.c`:

```
double getRatio(int num, int den) {
  return(num/den);
}

int input(void);

void main() {
  int i=1, j=1;
  double ratio;

  /* First division */
  ratio = getRatio(i,j);

  /* Second division */
  j=input();
  if(j>=0)
    ratio = getRatio(i,j);
}
```

1. Create a Polyspace project. Add `file.c` to the project.
2. Specify that you want to store call context information for the function `getRatio`.

   a. On the **Configuration** pane, select **Precision**.

   b. Under **Specific Construct Settings**, for **Sensitivity context**, select `custom`.

- **c** Click [+] to add a new field. Enter `getRatio`.

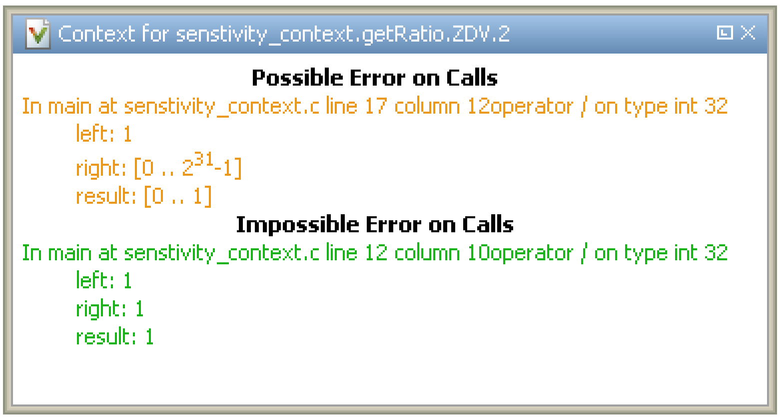
3 Run a verification and open the results.

An orange **Division by zero** check appears in the body of `getRatio`.

4 To identify which of the two calls to `getRatio` produces the orange check:

- **a** On the **Results Summary** pane, select the orange check.
- **b** Select **Window** > **Show/Hide View** > **Sensitivity Context**.

A window opens displaying the line numbers of the two calls. You can see that one call produces a green check on the division operation and the other call produces an orange check.



See Also

"Sensitivity context (C/C++)"

Related Examples

- "Review Orange Check"
- "Review Top Sources of Orange Checks"
- "Test Orange Checks for Run-Time Errors"

More About

- “Sources of Orange Checks”

Test Orange Checks for Run-Time Errors

This example shows how to run dynamic tests on orange checks. An orange check means that Polyspace static verification detects a possible error but cannot prove it. Orange checks can occur because of:

- Run-time errors.
- Approximations that Polyspace made during static verification.

By running tests, you can determine which orange checks represent run-time errors. Provided that you have emulated the run-time environment accurately, if a dynamic test fails, the orange check represents a run-time error. For this example, save the following code in a file `test_orange.c`:

```
volatile int r;
#include <stdio.h>

int input() {
 int k;
 k = r%21 - 10;
 // k  has value in [-10,10]
 return k;
}


void main() {
int x=input();
printf("%.2f",1.0/x);
}
```

Run Tests for Full Range of Input

Note: The Automatic Orange Tester is not supported on Mac.

---

1. Create a Polyspace project. Add `test_orange.c` to your project.
2. On the **Configuration** pane, under **Advanced Settings**, select **Automatic Orange Tester**.

After verification, Polyspace generates additional source code that tests each orange check for run-time errors. The software compiles this instrumented code. When you run the automatic orange tester later, the software tests the resulting binary code.

3. Run a verification and open the results.

   An orange **Division by Zero** error appears on the operation `1.0/x`.
4. Select **Tools** > **Automatic Orange Tester**.
5. In the Automatic Orange Tester window, click **Start**.

   The Automatic Orange Tester runs tests on your code. If the tests take too long, use the **Stop All** button to stop the tests. Reduce **Number of tests** before running again.
6. After the tests are completed, under **AOT Results**, view the number of **Tests that detected run-time errors**.

   The orange **Division by Zero** check represents a run-time error, so you see test case failures.
7. On the **Results** tab, click the row describing the check.

   A Test Case Detail window shows:

   - The operation on which the tests were run.
   - The test cases that failed with the reason for the failure.

Run Tests for Specified Range of Input

The Automatic Orange Tester window lists variables that cause orange checks. Because Polyspace does not have sufficient information about these variables, it makes assumptions about their range. If you know the variable range, you can specify the variables before running dynamic tests on orange checks. For pointer variables, you can specify the amount of memory written through the pointer. For instance, if the pointer points to an array, you can specify whether the first element of the array or the entire array is written through the pointer.

1. On the row describing `r`, click **Advanced**.
2. In the Edit Values window, under **Variable Values**, select **Range of values**.
3. Specify a minimum value of 1 and maximum of 9 for `r`. The Automatic Orange Tester saves the range as a `.tgf` file in the `Polyspace-Instrumented` folder in your results folder.

4 Click **Start** to restart tests on the orange **Division by Zero** check for `r` in `[1,9]`.

   A division by zero cannot occur for `r` in `[1,9]`, so there are no test failures. Although a test failure indicates a run-time error for specified inputs, because of the finite number of tests performed, the absence of test failures does not mean absence of a run-time error.

5 To prove that your range converts the orange check into a green check, you must provide the range during another static verification.

   a Select **File** > **Export DRS**.

   b Save your ranges as a text file.

   c Before running the next verification, on the **Configuration** pane, under **Inputs & Stubbing**, provide the text file for **Variable/function range setup**.

   d Run a verification and open your results.

      Instead of orange, there is a green **Division by Zero** check on the operation `1.0/x`.

Related Examples

- "Review Orange Check"
- "Organize Check Review"
- "Review Top Sources of Orange Checks"
- "Identify Function Call Causing Orange Check"

More About

- "Limitations of Automatic Orange Tester"
- "Sources of Orange Checks"
- "Do I Have Too Many Orange Checks?"

Limitations of Automatic Orange Tester

The Automatic Orange Tester has the following limitations:

In this section...

Unsupported Platforms

The Automatic Orange Tester is not supported on Mac.

Unsupported Polyspace Options

The software does not support the following options with `-automatic-orange-tester`.

- `-div-round-down`
- `-char-is-16its`
- `-short-is-8bits`

In addition, the software does not support global asserts in the code of the form `Pst_Global_Assert(A,B)` .

Options with Restrictions

Do not specify the following with `-automatic-orange-tester`:

- `-target [c18 | tms320c3c | x86_64 | sharc21x61]`
- `-data-range-specification` (in global assert mode)

You must use the `-target mcpu` option together with `-pointer-is-32bits`.

Unsupported C Routines

The software does not support verification of C code that contains calls to the following routines:

- va_start
- va_arg
- va_end
- va_copy
- setjmp
- sigsetjmp
- longjmp
- siglongjmp
- signal
- sigset
- sighold
- sigrelse
- sigpause
- sigignore
- sigaction
- sigpending
- sigsuspend
- sigvec
- sigblock
- sigsetmask
- sigprocmask
- siginterrupt
- srand
- srandom
- initstate
- setstate

Coding Rule Sets and Concepts

Rule Checking

Polyspace Coding Rule Checker

Polyspace software allows you to analyze code to demonstrate compliance with established C and C++ coding standards:

- MISRA C 2004
- MISRA C 2012
- MISRA C++:2008
- JSF++:2005

Applying coding rules can reduce the number of defects and improve the quality of your code.

While creating a project, you specify both the coding standard, and which rules to enforce. Polyspace software then performs rule checking before starting analysis, and reports any violations in the Results Manager perspective.

If any source files in the analysis do not compile, coding rules checking will be incomplete. The coding rules checker results:

- May not contain full results for files that did not compile
- May not contain full results for the files that did compile as some rules are checked only after compilation is complete

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Note: When you enable the Compilation Assistant *and* coding rules checking, the software does not report coding rule violations if there are compilation errors.

Differences Between Bug Finder and Code Prover

Coding rule checker results can differ between Polyspace Bug Finder and Polyspace Code Prover. The rule checking engines are identical in Bug Finder and Code Prover, but the context in which the checkers execute is not the same. If a project is launched from Bug Finder and Code Prover with the same source files and same configuration options, the coding rule results can differ. For example, the main generator used in Code Prover activates global variables, which causes the rule checkers to identify such global variables as initialized. The Bug Finder does not have a main generator, so handles the initialization of the global variables differently. Another difference is how violations are reported. The coding rules violations found in header files are not reported to the user in Bug Finder, but these violations are visible in Code Prover.

This difference can occur in MISRA C:2004, MISRA C:2012, MISRA C++, and JSF++. See the **Polyspace Specification** column for each rule.

Even though there are differences between rules checkers in Bug Finder and Code Prover, both reports are valid in their own context. For quick coding rules checking, use Polyspace Bug Finder.

Custom Naming Convention Rules

The following table provides information about the custom rules that you can define.

Rule group	Number	Rule Applied	Message generated if rule is violated	Other details
Files (C/C++)	1.1	All source file names must follow the specified pattern.	The source file name “file_name” does not match the specified pattern.	Only the base name is checked. A source file is a file that is not included.
	1.2	All source folder names must follow the specified pattern.	The source dir name “dir_name” does not match the specified pattern.	Only the folder name is checked. A source file is a file that is not included.
	1.3	All include file names must follow the specified pattern.	The include file name “file_name” does not match the specified pattern.	Only the base name is checked. An include file is a file that is included.
	1.4	All include folder names must follow the specified pattern.	The include dir name “dir_name” does not match the specified pattern.	Only the folder name is checked. An include file is a file that is included.
Preprocessing (C/C++)	2.1	All macros must follow the specified pattern.	The macro “macro_name” does not match the specified pattern.	Macro names are checked before preprocessing.
	2.2	All macro parameters must follow the specified pattern.	The macro parameter “param_name” does not match the specified pattern.	Macro parameters are checked before preprocessing.
Type definitions (C/C++)	3.1	All integer types must follow the specified pattern.	The integer type “type_name” does not match the specified pattern.	Applies to integer types specified by `typedef` statements. Does not apply to enumeration types. For example: `typedef signed int int32_t;`

Rule group	Number	Rule Applied	Message generated if rule is violated	Other details
	3.2	All float types must follow the specified pattern.	The float type “type_name” does not match the specified pattern.	Applies to float types specified by `typedef` statements. For example: `typedef float f32_t;`
	3.3	All pointer types must follow the specified pattern.	The pointer type “type_name” does not match the specified pattern.	Applies to pointer types specified by `typedef` statements. For example: `typedef int* p_int;`
	3.4	All array types must follow the specified pattern.	The array type “type_name” does not match the specified pattern.	Applies to array types specified by `typedef` statements. For example: `typedef int[3] a_int_3;`
	3.5	All function pointer types must follow the specified pattern.	The function pointer type “type_name” does not match the specified pattern.	Applies to function pointer types specified by `typedef` statements. For example: `typedef void (*pf_callback) (int);`
Structures (C/C++)	4.1	All `struct` tags must follow the specified pattern.	The struct tag “tag_name” does not match the specified pattern.	
	4.2	All `struct` types must follow the specified pattern.	The struct type “type_name” does not match the specified pattern.	This is the `typedef` name.
	4.3	All `struct` fields must follow the specified pattern.	The struct field “field_name” does not match the specified pattern.	

Rule group	Number	Rule Applied	Message generated if rule is violated	Other details
	4.4	All `struct` bit fields must follow the specified pattern.	The struct bit field "field_name" does not match the specified pattern.	
Classes (C++)	5.1	All class names must follow the specified pattern.	The class tag "tag_name" does not match the specified pattern.	
	5.2	All class types must follow the specified pattern.	The class type "type_name" does not match the specified pattern.	This is the `typedef` name.
	5.3	All data members must follow the specified pattern.	The data member "member_name" does not match the specified pattern.	
	5.4	All function members must follow the specified pattern.	The function member "member_name" does not match the specified pattern.	
	5.5	All static data members must follow the specified pattern.	The static data member "member_name" does not match the specified pattern.	
	5.6	All static function members must follow the specified pattern.	The static function member "member_name" does not match the specified pattern.	
	5.7	All bitfield members must follow the specified pattern.	The bitfield "member_name" does not match the specified pattern.	

Rule group	Number	Rule Applied	Message generated if rule is violated	Other details
Enumerations (C/C++)	6.1	All enumeration tags must follow the specified pattern.	The enumeration tag “tag_name” does not match the specified pattern.	
	6.2	All enumeration types must follow the specified pattern.	The enumeration type “type_name” does not match the specified pattern.	This is the typedef name.
	6.3	All enumeration constants must follow the specified pattern.	The enumeration constant “constant_name” does not match the specified pattern.	
Functions (C/C++)	7.1	All global functions must follow the specified pattern.	The global function “function_name” does not match the specified pattern.	A global function is a function with external linkage.
	7.2	All static functions must follow the specified pattern.	The static function “function_name” does not match the specified pattern.	A static function is a function with internal linkage.
	7.3	All function parameters must follow the specified pattern.	The function parameter “param_name” does not match the specified pattern.	In C++, applies to non-member functions.
Constants (C/C++)	8.1	All global constants must follow the specified pattern.	The global constant “constant_name” does not match the specified pattern.	A global constant is a constant with external linkage.
	8.2	All static constants must follow the specified pattern.	The static constant “constant_name” does not match the specified pattern.	A static constant is a constant with internal linkage.

Rule group	Number	Rule Applied	Message generated if rule is violated	Other details
	8.3	All local constants must follow the specified pattern.	The local constant "constant_name" does not match the specified pattern.	A local constant is a constant with no linkage.
	8.4	All static local constants must follow the specified pattern.	The static local constant "constant_name" does not match the specified pattern.	A static local constant is a constant declared static in a function.
Variables (C/C++)	9.1	All global variables must follow the specified pattern.	The global variable "var_name" does not match the specified pattern.	A global variable is a variable with external linkage.
	9.2	All static variables must follow the specified pattern.	The static variable "var_name" does not match the specified pattern.	A static variable is a variable with internal linkage.
	9.3	All local variables must follow the specified pattern.	The local variable "var_name" does not match the specified pattern.	A local variable is a variable with no linkage.
	9.4	All static local variables must follow the specified pattern.	The static local variable "var_name" does not match the specified pattern.	A static local variable is a variable declared static in a function.
Name spaces (C++)	10.1	All names paces must follow the specified pattern.	The name space "name space_name" does not match the specified pattern.	
Class templates (C++)	11.1	All class templates must follow the specified pattern.	The class template "template_name" does not match the specified pattern.	

Rule group	Number	Rule Applied	Message generated if rule is violated	Other details
	11.2	All class template parameters must follow the specified pattern.	The class template parameter “param_name” does not match the specified pattern.	
Function templates (C++)	12.1	All function templates must follow the specified pattern.	The function template “template_name” does not match the specified pattern.	Applies to non-member functions.
	12.2	All function template parameters must follow the specified pattern.	The function template parameter “param_name” does not match the specified pattern.	Applies to non-member functions.
	12.3	All function template members must follow the specified pattern.	The function template member “member_name” does not match the specified pattern.	

Polyspace MISRA C 2004 and MISRA AC AGC Checkers

The Polyspace MISRA C:2004 checker helps you comply with the MISRA C 2004 coding standard.[3]

When MISRA C rules are violated, the MISRA C checker enables Polyspace software to provide messages with information about the rule violations. Most messages are reported during the compile phase of an analysis.

The MISRA C checker can check nearly all of the **142** MISRA C:2004 rules.

The MISRA AC AGC checker checks rules from the OBL (obligatory) and REC (recommended) categories specified by *MISRA AC AGC Guidelines for the Application of MISRA-C:2004 in the Context of Automatic Code Generation*.

There are subsets of MISRA coding rules that can have a direct or indirect impact on the selectivity (reliability percentage) of your results. When you set up rule checking, you can select these subsets directly. These subsets are defined in:

- "Software Quality Objective Subsets (C:2004)" on page 12-11
- "Software Quality Objective Subsets (AC AGC)" on page 12-15

Note: The Polyspace MISRA checker is based on MISRA C:2004, which also incorporates MISRA C Technical Corrigendum (http://www.misra-c.com).

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Software Quality Objective Subsets (C:2004)

In this section...

Rules in `SQO-Subset1`

In Polyspace Code Prover, the following set of coding rules will typically reduce the number of unproven results.

Rule number	Description
5.2	Identifiers in an inner scope shall not use the same name as an identifier in an outer scope, and therefore hide that identifier.
8.11	The *static* storage class specifier shall be used in definitions and declarations of objects and functions that have internal linkage.
8.12	When an array is declared with external linkage, its size shall be stated explicitly or defined implicitly by initialization.
11.2	Conversion shall not be performed between a pointer to an object and any type other than an integral type, another pointer to a object type or a pointer to void.
11.3	A cast should not be performed between a pointer type and an integral type.
12.12	The underlying bit representations of floating-point values shall not be used.
13.3	Floating-point expressions shall not be tested for equality or inequality.
13.4	The controlling expression of a *for* statement shall not contain any objects of floating type.
13.5	The three expressions of a *for* statement shall be concerned only with loop control.
14.4	The *goto* statement shall not be used.
14.7	A function shall have a single point of exit at the end of the function.

Rule number	Description
16.1	Functions shall not be defined with variable numbers of arguments.
16.2	Functions shall not call themselves, either directly or indirectly.
16.7	A pointer parameter in a function prototype should be declared as pointer to const if the pointer is not used to modify the addressed object.
17.3	>, >=, <, <= shall not be applied to pointer types except where they point to the same array.
17.4	Array indexing shall be the only allowed form of pointer arithmetic.
17.5	The declaration of objects should contain no more than 2 levels of pointer indirection.
17.6	The address of an object with automatic storage shall not be assigned to an object that may persist after the object has ceased to exist.
18.3	An area of memory shall not be reused for unrelated purposes.
18.4	Unions shall not be used.
20.4	Dynamic heap memory allocation shall not be used.

Note: Polyspace software does not check MISRA rule **18.3**.

Rules in `SQO-Subset2`

Good design practices generally lead to less code complexity, which can reduce the number of unproven results in Polyspace Code Prover. The following set of coding rules enforce good design practices. The `SQO-subset2` option checks the rules in `SQO-subset1` and `SQO-subset2`.

Rule number	Description
6.3	*typedefs* that indicate size and signedness should be used in place of the basic types
8.7	Objects shall be defined at block scope if they are only accessed from within a single function
9.2	Braces shall be used to indicate and match the structure in the nonzero initialization of arrays and structures

Rule number	Description
9.3	In an enumerator list, the = construct shall not be used to explicitly initialize members other than the first, unless all items are explicitly initialized
10.3	The value of a complex expression of integer type may only be cast to a type that is narrower and of the same signedness as the underlying type of the expression
10.5	Bitwise operations shall not be performed on signed integer types
11.1	Conversion shall not be performed between a pointer to a function and any type other than an integral type
11.5	Type casting from any type to or from pointers shall not be used
12.1	Limited dependence should be placed on C's operator precedence rules in expressions
12.2	The value of an expression shall be the same under any order of evaluation that the standard permits
12.5	The operands of a logical && or || shall be primary-expressions
12.6	Operands of logical operators (&&, || and !) should be effectively Boolean. Expression that are effectively Boolean should not be used as operands to operators other than (&&, || or !)
12.9	The unary minus operator shall not be applied to an expression whose underlying type is unsigned
12.10	The comma operator shall not be used
13.1	Assignment operators shall not be used in expressions that yield Boolean values
13.2	Tests of a value against zero should be made explicit, unless the operand is effectively Boolean
13.6	Numeric variables being used within a *"for"* loop for iteration counting should not be modified in the body of the loop
14.8	The statement forming the body of a *switch, while, do while* or *for* statement shall be a compound statement
14.10	All *if else if* constructs should contain a final *else* clause
15.3	The final clause of a *switch* statement shall be the *default* clause

Rule number	Description
16.3	Identifiers shall be given for all of the parameters in a function prototype declaration
16.8	All exit paths from a function with non-void return type shall have an explicit return statement with an expression
16.9	A function identifier shall only be used with either a preceding &, or with a parenthesized parameter list, which may be empty
19.4	C macros shall only expand to a braced initializer, a constant, a parenthesized expression, a type qualifier, a storage class specifier, or a do-while-zero construct
19.9	Arguments to a function-like macro shall not contain tokens that look like preprocessing directives
19.10	In the definition of a function-like macro each instance of a parameter shall be enclosed in parentheses unless it is used as the operand of # or ##
19.11	All macro identifiers in preprocessor directives shall be defined before use, except in #ifdef and #ifndef preprocessor directives and the defined() operator
19.12	There shall be at most one occurrence of the # or ## preprocessor operators in a single macro definition.
20.3	The validity of values passed to library functions shall be checked.

Note: Polyspace software does not check MISRA rule **20.3** directly.

However, you can check this rule by writing manual stubs that check the validity of values. For example, the following code checks the validity of an input being greater than 1:

```
int my_system_library_call(int in) {assert (in>1); if random \
return -1 else return 0; }
```

Software Quality Objective Subsets (AC AGC)

In this section...

Rules in `SQO-Subset1`

The following set of MISRA AC AGC coding rules typically reduces the number of unproven results.

- 5.2
- 8.11 and 8.12
- 11.2 and 11.3
- 12.12
- 14.7
- 16.1 and 16.2
- 17.3 and 17.6
- 18.4

For more information about these rules, see *MISRA AC AGC Guidelines for the Application of MISRA-C:2004 in the Context of Automatic Code Generation*.

Rules in `SQO-Subset2`

Good design practices generally lead to less code complexity, which can reduce the number of unproven results. The following set of coding rules enforce good design practices. The `SQO-subset2` option checks the rules in `SQO-subset1` and `SQO-subset2`.

- 5.2
- 6.3
- 8.7, 8.11, and 8.12
- 9.3
- 11.1, 11.2, 11.3, and 11.5

- 12.2, 12.9, 12.10, and 12.12
- 14.7
- 16.1, 16.2, 16.3, 16.8, and 16.9
- 17.3, and 17.6
- 18.4
- 19.9, 19.10, 19.11, and 19.12
- 20.3

For more information about these rules, see *MISRA AC AGC Guidelines for the Application of MISRA-C:2004 in the Context of Automatic Code Generation*.

MISRA C:2004 Coding Rules

In this section...

Supported MISRA C:2004 Rules

The following tables list MISRA C:2004 coding rules that the Polyspace coding rules checker supports. Details regarding how the software checks individual rules and any limitations on the scope of checking are described in the "Polyspace Specification" column.

Note: The Polyspace coding rules checker:

- Supports MISRA-C:2004 Technical Corrigendum 1 for rules 4.1, 5.1, 5.3, 6.1, 6.3, 7.1, 9.2, 10.5, 12.6, 13.5, and 15.0.
- Checks rules specified by *MISRA AC AGC Guidelines for the Application of MISRA-C:2004 in the Context of Automatic Code Generation*.

The software reports most violations during the compile phase of an analysis. However, the software detects violations of rules 9.1 (`Non-initialized variable`), 12.11 (one of the overflow checks) using `-scalar-overflows-checks signed-and-unsigned`), 13.7 (dead code), 14.1 (dead code), 16.2 and 21.1 during code analysis, and reports these violations as run-time errors.

Note: Some violations of rules 13.7 and 14.1 are reported during the compile phase of analysis.

Environment

N.	MISRA Definition	Messages in report file	Polyspace Specification
1.1	All code shall conform to ISO 9899:1990 "Programming	The text *All code shall conform to ISO 9899:1990*	All the supported extensions lead to a violation of this

N.	MISRA Definition	Messages in report file	Polyspace Specification
	languages - C”, amended and corrected by ISO/IEC 9899/ COR1:1995, ISO/IEC 9899/ AMD1:1995, and ISO/IEC 9899/COR2:1996.	*Programming languages C, amended and corrected by ISO/IEC 9899/COR1:1995, ISO/IEC 9899/AMD1:1995, and ISO/IEC 9899/ COR2:1996* precedes each of the following messages: • ANSI C does not allow ‘#include_next' • ANSI C does not allow macros with variable arguments list • ANSI C does not allow ‘#assert’ • ANSI C does not allow '#unassert' • ANSI C does not allow testing assertions • ANSI C does not allow '#ident' • ANSI C does not allow '#sccs' • text following '#else' violates ANSI standard. • text following '#endif' violates ANSI standard. • text following '#else' or '#endif' violates ANSI standard.	MISRA rule. Standard compilation error messages do not lead to a violation of this MISRA rule and remain unchanged.

N.	MISRA Definition	Messages in report file	Polyspace Specification
1.1 (cont.)		The text *All code shall conform to ISO 9899:1990 Programming languages C, amended and corrected by ISO/IEC 9899/COR1:1995, ISO/IEC 9899/AMD1:1995, and ISO/IEC 9899/ COR2:1996* precedes each of the following messages: • ANSI C90 forbids 'long long int' type. • ANSI C90 forbids 'long double' type. • ANSI C90 forbids long long integer constants. • Keyword 'inline' should not be used. • Array of zero size should not be used. • Integer constant does not fit within unsigned long int. • Integer constant does not fit within long int. • Too many nesting levels of #includes: N_1. The limit is N_0. • Too many macro definitions: N_1. The limit is N_0. • Too many nesting levels for control flow: N_1. The limit is N_0.	

N.	MISRA Definition	Messages in report file	Polyspace Specification
		• Too many enumeration constants: N_1. The limit is N_0.	

Language Extensions

N.	MISRA Definition	Messages in report file	Polyspace Specification
2.1	Assembly language shall be encapsulated and isolated.	Assembly language shall be encapsulated and isolated.	No warnings if code is encapsulated in `asm` functions or in `asm pragma` (only warning is given on asm statements even if it is encapsulated by a MACRO).
2.2	Source code shall only use /* */ style comments	C++ comments shall not be used.	C++ comments are handled as comments but lead to a violation of this MISRA rule **Note**: This rule cannot be annotated in the source code.
2.3	The character sequence /* shall not be used within a comment	The character sequence /* shall not appear within a comment.	This rule violation is also raised when the character sequence /* inside a C++ comment. **Note**: This rule cannot be annotated in the source code.

Documentation

Rule	MISRA Definition	Messages in report file	Polyspace Specification
3.4	All uses of the *#pragma* directive shall be documented and explained.	All uses of the #pragma directive shall be documented and explained.	To check this rule, the option `-allowed-pragmas` must be set to the list of pragmas that are allowed in source files. Warning if a pragma that does not belong to the list is found.

Character Sets

N.	MISRA Definition	Messages in report file	Polyspace Specification
4.1	Only those escape sequences which are defined in the ISO C standard shall be used.	\<character> is not an ISO C escape sequence Only those escape sequences which are defined in the ISO C standard shall be used.	
4.2	Trigraphs shall not be used.	Trigraphs shall not be used.	Trigraphs are handled and converted to the equivalent character but lead to a violation of the MISRA rule

Identifiers

N.	MISRA Definition	Messages in report file	Polyspace Specification
5.1	Identifiers (internal and external) shall not rely on the significance of more than 31 characters	Identifier 'XX' should not rely on the significance of more than 31 characters.	All identifiers (global, static and local) are checked.
5.2	Identifiers in an inner scope shall not use the same name as an identifier in an outer scope, and therefore hide that identifier.	• Local declaration of XX is hiding another identifier. • Declaration of parameter XX is hiding another identifier.	Assumes that rule 8.1 is not violated.
5.3	A typedef name shall be a unique identifier	{typedef name}'%s' should not be reused. (already used as {typedef name} at %s:%d)	Warning when a typedef name is reused as another identifier name.
5.4	A tag name shall be a unique identifier	{tag name}'%s' should not be reused. (already used as {tag name} at %s:%d)	Warning when a tag name is reused as another identifier name
5.5	No object or function identifier with a static storage duration should be reused.	{static identifier/parameter name}'%s' should not be reused. (already used as {static identifier/parameter name} with static storage duration at %s:%d)	Warning when a static name is reused as another identifier name Bug Finder and Code Prover check this coding rule

N.	MISRA Definition	Messages in report file	Polyspace Specification
			differently. The analyses can produce different results.
5.6	No identifier in one name space should have the same spelling as an identifier in another name space, with the exception of structure and union member names.	{member name}'%s' should not be reused. (already used as {member name} at %s:%d)	Warning when an `idf` in a namespace is reused in another namespace
5.7	No identifier name should be reused.	{identifier}'%s' should not be reused. (already used as {identifier} at %s:%d)	No violation reported when: • Different functions have parameters with the same name • Different functions have local variables with the same name • A function has a local variable that has the same name as a parameter of another function

Types

N.	MISRA Definition	Messages in report file	Polyspace Specification
6.1	The plain char type shall be used only for the storage and use of character values	Only permissible operators on plain chars are '=', '==' or '!=' operators, explicit casts to integral types and '?' (for the 2nd and 3rd operands)	Warning when a plain char is used with an operator other than =, ==, !=, explicit casts to integral types, or as the second or third operands of the ? operator.
6.2	Signed and unsigned char type shall be used only for the storage and use of numeric values.	• Value of type plain char is implicitly converted to signed char. • Value of type plain char is implicitly converted to unsigned char.	Warning if value of type plain char is implicitly converted to value of type signed char or unsigned char.

N.	MISRA Definition	Messages in report file	Polyspace Specification
		• Value of type signed char is implicitly converted to plain char. • Value of type unsigned char is implicitly converted to plain char.	
6.3	*typedefs* that indicate size and signedness should be used in place of the basic types	typedefs that indicate size and signedness should be used in place of the basic types.	No warning is given in typedef definition.
6.4	Bit fields shall only be defined to be of type *unsigned int* or *signed int*.	Bit fields shall only be defined to be of type unsigned int or signed int.	
6.5	Bit fields of type *signed int* shall be at least 2 bits long.	Bit fields of type signed int shall be at least 2 bits long.	No warning on anonymous signed int bitfields of width 0 - Extended to all signed bitfields of size <= 1 (if Rule **6.4** is violated).

Constants

N.	MISRA Definition	Messages in report file	Polyspace Specification
7.1	Octal constants (other than zero) and octal escape sequences shall not be used.	• Octal constants other than zero and octal escape sequences shall not be used. • Octal constants (other than zero) should not be used. • Octal escape sequences should not be used.	

Declarations and Definitions

N.	MISRA Definition	Messages in report file	Polyspace Specification
8.1	Functions shall have prototype declarations and the prototype shall be visible at both the function definition and call.	• Function XX has no complete prototype visible at call. • Function XX has no prototype visible at definition.	Prototype visible at call must be complete.
8.2	Whenever an object or function is declared or defined, its type shall be explicitly stated	Whenever an object or function is declared or defined, its type shall be explicitly stated.	
8.3	For each function parameter the type given in the declaration and definition shall be identical, and the return types shall also be identical.	Definition of function 'XX' incompatible with its declaration.	Assumes that rule 8.1 is not violated. The rule is restricted to compatible types. Can be turned to Off
8.4	If objects or functions are declared more than once their types shall be compatible.	• If objects or functions are declared more than once their types shall be compatible. • Global declaration of 'XX' function has incompatible type with its definition. • Global declaration of 'XX' variable has incompatible type with its definition.	Violations of this rule might be generated during the link phase. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
8.5	There shall be no definitions of objects or functions in a header file	• Object 'XX' should not be defined in a header file. • Function 'XX' should not be defined in a header file.	Tentative of definitions are considered as definitions.

N.	MISRA Definition	Messages in report file	Polyspace Specification
		• Fragment of function should not be defined in a header file.	
8.6	Functions shall always be declared at file scope.	Function 'XX' should be declared at file scope.	
8.7	Objects shall be defined at block scope if they are only accessed from within a single function	Object 'XX' should be declared at block scope.	Restricted to static objects.
8.8	An external object or function shall be declared in one file and only one file	Function/Object 'XX' has external declarations in multiples files.	Restricted to explicit extern declarations (tentative of definitions are ignored). Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
8.9	Definition: An identifier with external linkage shall have exactly one external definition.	• Procedure/Global variable XX multiply defined. • Forbidden multiple tentative of definition for object XX • Global variable has multiples tentative of definitions • Undefined global variable XX	Tentative of definitions are considered as definitions, no warning on predefined symbols. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
8.10	All declarations and definitions of objects or functions at file scope shall have internal linkage unless external linkage is required	Function/Variable XX should have internal linkage.	Assumes that 8.1 is not violated. No warning if 0 uses. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

N.	MISRA Definition	Messages in report file	Polyspace Specification
8.11	The *static* storage class specifier shall be used in definitions and declarations of objects and functions that have internal linkage	static storage class specifier should be used on internal linkage symbol XX.	
8.12	When an array is declared with external linkage, its size shall be stated explicitly or defined implicitly by initialization	Size of array 'XX' should be explicitly stated.	

Initialization

N.	MISRA Definition	Messages in report file	Polyspace Specification
9.1	All automatic variables shall have been assigned a value before being used.		Checked during code analysis. Violations displayed as Non-initialized variable results. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
9.2	Braces shall be used to indicate and match the structure in the nonzero initialization of arrays and structures.	Braces shall be used to indicate and match the structure in the nonzero initialization of arrays and structures.	
9.3	In an enumerator list, the = construct shall not be used to explicitly initialize members other than the first, unless all items are explicitly initialized.	In an enumerator list, the = construct shall not be used to explicitly initialize members other than the first, unless all items are explicitly initialized.	

Arithmetic Type Conversion

N.	MISRA Definition	Messages in report file	Polyspace Specification
10.1	The value of an expression of integer type shall not be implicitly converted to a different underlying type if: • it is not a conversion to a wider integer type of the same signedness, or • the expression is complex, or • the expression is not constant and is a function argument, or • the expression is not constant and is a return expression	• Implicit conversion of the expression of underlying type XX to the type XX that is not a wider integer type of the same signedness. • Implicit conversion of one of the binary operands whose underlying types are XX and XX • Implicit conversion of the binary right hand operand of underlying type XX to XX that is not an integer type. • Implicit conversion of the binary left hand operand of underlying type XX to XX that is not an integer type.	ANSI C base types order (signed char, short, int, long) defines that T2 is wider than T1 if T2 is on the right hand of T1 or T2 = T1. The same interpretation is applied on the unsigned version of base types. An expression of bool or enum types has int as underlying type. Plain char may have signed or unsigned underlying type (depending on Polyspace target configuration or option setting). The underlying type of a simple expression of struct.bitfield is the base type used in the bitfield definition, the bitfield width is not token into account and it assumes that only signed | unsigned int are used for bitfield (Rule 6.4).
10.1 (cont)		• Implicit conversion of the binary right hand operand of underlying type XX to XX that is not a wider integer type of the same signedness or Implicit conversion of the binary ? left hand operand of underlying	No violation reported when: • The implicit conversion is a type widening, without change of signedness if integer • The expression is an argument expression or a return expression

N.	MISRA Definition	Messages in report file	Polyspace Specification
		type XX to XX, but it is a complex expression. • Implicit conversion of complex integer expression of underlying type XX to XX. • Implicit conversion of non-constant integer expression of underlying type XX in function return whose expected type is XX. • Implicit conversion of non-constant integer expression of underlying type XX as argument of function whose corresponding parameter type is XX.	No violation reported when the following are all true: • Implicit conversion applies to a constant expression and is a type widening, with a possible change of signedness if integer • The conversion does not change the representation of the constant value or the result of the operation • The expression is an argument expression or a return expression or an operand expression of a non-bitwise operator

N.	MISRA Definition	Messages in report file	Polyspace Specification
10.2	The value of an expression of floating type shall not be implicitly converted to a different type if • it is not a conversion to a wider floating type, or • the expression is complex, or • the expression is a function argument, or • the expression is a return expression	• Implicit conversion of the expression from XX to XX that is not a wider floating type. • Implicit conversion of the binary ? right hand operand from XX to XX, but it is a complex expression. • Implicit conversion of the binary ? right hand operand from XX to XX that is not a wider floating type or Implicit conversion of the binary ? left hand operand from XX to XX, but it is a complex expression. • Implicit conversion of complex floating expression from XX to XX. • Implicit conversion of floating expression of XX type in function return whose expected type is XX. • Implicit conversion of floating expression of XX type as argument of function whose corresponding parameter type is XX.	ANSI C base types order (float, double) defines that T2 is wider than T1 if T2 is on the right hand of T1 or T2 = T1. No violation reported when: • The implicit conversion is a type widening • The expression is an argument expression or a return expression.

N.	MISRA Definition	Messages in report file	Polyspace Specification
10.3	The value of a complex expression of integer type may only be cast to a type that is narrower and of the same signedness as the underlying type of the expression	Complex expression of underlying type XX may only be cast to narrower integer type of same signedness, however the destination type is XX.	• ANSI C base types order (signed char, short, int, long) defines that T1 is narrower than T2 if T2 is on the right hand of T1 or T1 = T2. The same methodology is applied on the unsigned version of base types. • An expression of bool or enum types has int as underlying type. • Plain char may have signed or unsigned underlying type (depending on target configuration or option setting). • The underlying type of a simple expression of struct.bitfield is the base type used in the bitfield definition, the bitfield width is not token into account and it assumes that only signed, unsigned int are used for bitfield (Rule 6.4).
10.4	The value of a complex expression of float type may only be cast to narrower floating type	Complex expression of XX type may only be cast to narrower floating type, however the destination type is XX.	ANSI C base types order (float, double) defines that T1 is narrower than T2 if T2 is on the right hand of T1 or T2 = T1.

<table>
<tr><th>N.</th><th>MISRA Definition</th><th>Messages in report file</th><th>Polyspace Specification</th></tr>
<tr><td>10.5</td><td>If the bitwise operator ~ and << are applied to an operand of underlying type unsigned char or unsigned short, the result shall be immediately cast to the underlying type of the operand</td><td>Bitwise [<<|~] is applied to the operand of underlying type [unsigned char| unsigned short], the result shall be immediately cast to the underlying type.</td><td></td></tr>
<tr><td>10.6</td><td>The “U” suffix shall be applied to all constants of unsigned types</td><td>No explicit 'U suffix on constants of an unsigned type.</td><td>Warning when the type determined from the value and the base (octal, decimal or hexadecimal) is unsigned and there is no suffix <code>u</code> or <code>U</code>.

For example, when the size of the <code>int</code> and <code>long int</code> data types is 32 bits, the coding rule checker will report a violation of rule 10.6 for the following line:

<code>int a = 2147483648;</code>

There is a difference between decimal and hexadecimal constants when <code>int</code> and <code>long int</code> are not the same size.</td></tr>
</table>

Pointer Type Conversion

<table>
<tr><th>N.</th><th>MISRA Definition</th><th>Messages in report file</th><th>Polyspace Specification</th></tr>
<tr><td>11.1</td><td>Conversion shall not be performed between a pointer to a function and any type other than an integral type</td><td>Conversion shall not be performed between a pointer to a function and any type other than an integral type.</td><td>Casts and implicit conversions involving a function pointer.

Casts or implicit conversions from <code>NULL</code> or <code>(void*)0</code> do not give any warning.</td></tr>
</table>

N.	MISRA Definition	Messages in report file	Polyspace Specification
11.2	Conversion shall not be performed between a pointer to an object and any type other than an integral type, another pointer to a object type or a pointer to void	Conversion shall not be performed between a pointer to an object and any type other than an integral type, another pointer to a object type or a pointer to void.	There is also a warning on qualifier loss
11.3	A cast should not be performed between a pointer type and an integral type	A cast should not be performed between a pointer type and an integral type.	Exception on zero constant. Extended to all conversions
11.4	A cast should not be performed between a pointer to object type and a different pointer to object type.	A cast should not be performed between a pointer to object type and a different pointer to object type.	
11.5	A cast shall not be performed that removes any *const* or *volatile* qualification from the type addressed by a pointer	A cast shall not be performed that removes any *const* or *volatile* qualification from the type addressed by a pointer	Extended to all conversions

Expressions

N.	MISRA Definition	Messages in report file	Polyspace Specification
12.1	Limited dependence should be placed on C's operator precedence rules in expressions	Limited dependence should be placed on C's operator precedence rules in expressions	
12.2	The value of an expression shall be the same under any order of evaluation that the standard permits.	• The value of 'sym' depends on the order of evaluation. • The value of volatile 'sym' depends on the order of evaluation because of multiple accesses.	The expression is a simple expression of symbols (Unlike i = i++; no detection on tab[2] = tab[2]++;). Rule 12.2 check assumes that no assignment in expressions that yield a Boolean values (rule 13.1) and the comma operator is not used (rule 12.10).

N.	MISRA Definition	Messages in report file	Polyspace Specification
12.3	The `sizeof` operator should not be used on expressions that contain side effects.	The `sizeof` operator should not be used on expressions that contain side effects.	No warning on volatile accesses
12.4	The right hand operand of a logical && or `||` operator shall not contain side effects.	The right hand operand of a logical && or `||` operator shall not contain side effects.	No warning on volatile accesses
12.5	The operands of a logical && or `||` shall be primary-expressions.	• operand of logical && is not a primary expression • operand of logical `||` is not a primary expression • The operands of a logical && or `||` shall be primary-expressions.	During preprocessing, violations of this rule are detected on the expressions in #if directives. Allowed exception on associatively (a && b && c), (a `||` b `||` c).

<table>
<tr><th>N.</th><th>MISRA Definition</th><th>Messages in report file</th><th>Polyspace Specification</th></tr>
<tr>
<td>12.6</td>
<td>Operands of logical operators (&&, || and !) should be effectively Boolean. Expression that are effectively Boolean should not be used as operands to operators other than (&&, || or !).</td>
<td>Operand of '!' logical operator should be effectively Boolean. Left operand of '%s' logical operator should be effectively Boolean. Right operand of '%s' logical operator should be effectively Boolean. %s operand of '%s' is effectively Boolean. Boolean should not be used as operands to operators other than '&&', '||', '!', '=', '==', '!=' and '?:'.</td>
<td>The operand of a logical operator should be a Boolean data type. Although the C standard does not explicitly define the Boolean data type, the standard implicitly assumes the use of the Boolean data type.

Some operators may return Boolean-like expressions, for example, <code>(var == 0)</code>.

Consider the following code:

<code>unsigned char flag;</code>
<code>if (!flag)</code>

The rule checker reports a violation of rule 12.6:

<code>Operand of '!' logical operator should be effectively Boolean.</code>
The operand <code>flag</code> is not a Boolean but an <code>unsigned char</code>.

To be compliant with rule 12.6, the code must be rewritten either as

<code>if (!(flag != 0))</code>
or

<code>if (flag == 0)</code>

The use of the option <code>-boolean-types</code> may increase or decrease the</td>
</tr>
</table>

N.	MISRA Definition	Messages in report file	Polyspace Specification
			number of warnings generated.
12.7	Bitwise operators shall not be applied to operands whose underlying type is signed	• [~/Left Shift/Right shift/ &] operator applied on an expression whose underlying type is signed. • Bitwise ~ on operand of signed underlying type XX. • Bitwise [<<|>>] on left hand operand of signed underlying type XX. • Bitwise [& | ^] on two operands of s	The underlying type for an integer is signed when: • it does not have a u or U suffix • it is small enough to fit into a 64 bits signed number
12.8	The right hand operand of a shift operator shall lie between zero and one less than the width in bits of the underlying type of the left hand operand.	• shift amount is negative • shift amount is bigger than 64 • Bitwise [<< >>] count out of range [0 ..X] (width of the underlying type XX of the left hand operand - 1)..	The numbers that are manipulated in preprocessing directives are 64 bits wide so that valid shift range is between 0 and 63 Check is also extended onto bitfields with the field width or the width of the base type when it is within a complex expression
12.9	The unary minus operator shall not be applied to an expression whose underlying type is unsigned.	• Unary - on operand of unsigned underlying type XX. • Minus operator applied to an expression whose underlying type is unsigned	The underlying type for an integer is signed when: • it does not have a u or U suffix • it is small enough to fit into a 64 bits signed number
12.10	The comma operator shall not be used.	The comma operator shall not be used.	

N.	MISRA Definition	Messages in report file	Polyspace Specification
12.11	Evaluation of constant unsigned expression should not lead to wraparound.	Evaluation of constant unsigned integer expressions should not lead to wrap-around.	

12.12	The underlying bit representations of floating-point values shall not be used.	The underlying bit representations of floating-point values shall not be used.	Warning when:
			• A float pointer is cast as a pointer to another data type. Casting a float pointer as a pointer to `void` does not generate a warning.
			• A float is packed with another data type. For example:
			`union {`
			` float f;`
			` int i;`
			`} …`

12.13	The increment (++) and decrement (--) operators should not be mixed with other operators in an expression	The increment (++) and decrement (--) operators should not be mixed with other operators in an expression	Warning when ++ or -- operators are not used alone.

Control Statement Expressions

N.	MISRA Definition	Messages in report file	Polyspace Specification
13.1	Assignment operators shall not be used in expressions that yield Boolean values.	Assignment operators shall not be used in expressions that yield Boolean values.	
13.2	Tests of a value against zero should be made explicit, unless the operand is effectively Boolean	Tests of a value against zero should be made explicit, unless the operand is effectively Boolean	No warning is given on integer constants. Example: if (2) The use of the option `-boolean-types` may

N.	MISRA Definition	Messages in report file	Polyspace Specification
			increase or decrease the number of warnings generated.
13.3	Floating-point expressions shall not be tested for equality or inequality.	Floating-point expressions shall not be tested for equality or inequality.	Warning on directs tests only.
13.4	The controlling expression of a *for* statement shall not contain any objects of floating type	The controlling expression of a for statement shall not contain any objects of floating type	If *for* index is a variable symbol, checked that it is not a float.

N.	MISRA Definition	Messages in report file	Polyspace Specification
13.5	The three expressions of a *for* statement shall be concerned only with loop control	• 1st expression should be an assignment. • Bad type for loop counter (XX). • 2nd expression should be a comparison. • 2nd expression should be a comparison with loop counter (XX). • 3rd expression should be an assignment of loop counter (XX). • 3rd expression: assigned variable should be the loop counter (XX). • The following kinds of for loops are allowed: (a) all three expressions shall be present; (b) the 2nd and 3rd expressions shall be present with prior initialization of the loop counter; (c) all three expressions shall be empty for a deliberate infinite loop.	Checked if the for loop index (V) is a variable symbol; checked if V is the last assigned variable in the first expression (if present). Checked if, in first expression, if present, is assignment of V; checked if in 2nd expression, if present, must be a comparison of V; Checked if in 3rd expression, if present, must be an assignment of V.
13.6	Numeric variables being used within a *for* loop for iteration counting should not be modified in the body of the loop.	Numeric variables being used within a for loop for iteration counting should not be modified in the body of the loop.	Detect only direct assignments if the for loop index is known and if it is a variable symbol.

N.	MISRA Definition	Messages in report file	Polyspace Specification
13.7	Boolean operations whose results are invariant shall not be permitted	• Boolean operations whose results are invariant shall not be permitted. Expression is always true. • Boolean operations whose results are invariant shall not be permitted. Expression is always false. • Boolean operations whose results are invariant shall not be permitted.	During compilation, check comparisons with at least one constant operand.

Control Flow

N.	MISRA Definition	Messages in report file	Polyspace Specification
14.1	There shall be no unreachable code.	There shall be no unreachable code.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
14.2	All non-null statements shall either have at lest one side effect however executed, or cause control flow to change	• All non-null statements shall either: • have at lest one side effect however executed, or • cause control flow to change	
14.3	All non-null statements shall either • have at lest one side effect however executed, or • cause control flow to change	A null statement shall appear on a line by itself	We assume that a ';' is a null statement when it is the first character on a line (excluding comments). The rule is violated when:

N.	MISRA Definition	Messages in report file	Polyspace Specification
			• there are some comments before it on the same line. • there is a comment immediately after it • there is something else than a comment after the ';' on the same line.
14.4	The *goto* statement shall not be used.	The goto statement shall not be used.	
14.5	The *continue* statement shall not be used.	The continue statement shall not be used.	
14.6	For any iteration statement there shall be at most one *break* statement used for loop termination	For any iteration statement there shall be at most one break statement used for loop termination	
14.7	A function shall have a single point of exit at the end of the function	A function shall have a single point of exit at the end of the function	
14.8	The statement forming the body of a *switch, while, do while* or *for* statement shall be a compound statement	• The body of a do while statement shall be a compound statement. • The body of a for statement shall be a compound statement. • The body of a switch statement shall be a compound statement	

N.	MISRA Definition	Messages in report file	Polyspace Specification
14.9	An *if (expression)* construct shall be followed by a compound statement. The *else* keyword shall be followed by either a compound statement, or another *if* statement	• An if (expression) construct shall be followed by a compound statement. • The else keyword shall be followed by either a compound statement, or another if statement	
14.10	All *if else if* constructs should contain a final *else* clause.	All if else if constructs should contain a final else clause.	

Switch Statements

N.	MISRA Definition	Messages in report file	Polyspace Specification

15.0	Unreachable code is detected between switch statement and first case.
	
	Note: This is not a MISRA C2004 rule.
		switch statements syntax normative restrictions.	Warning on declarations or any statements before the first switch case.
			
			Warning on label or jump statements in the body of switch cases.
			
			On the following example, the rule is displayed in the log file at line 3:
			
			`1 ...`
			`2 switch(index) {`
			`3  var = var + 1;`
			`// RULE 15.0`
			`// violated`
			`4case 1: ...`
			
			The code between switch statement and first case is checked as dead code by Polyspace. It follows ANSI standard behavior.

N.	MISRA Definition	Messages in report file	Polyspace Specification
15.1	A switch label shall only be used when the most closely-enclosing compound statement is the body of a *switch* statement	A switch label shall only be used when the most closely-enclosing compound statement is the body of a switch statement	
15.2	An unconditional *break* statement shall terminate every non-empty switch clause	An unconditional break statement shall terminate every non-empty switch clause	Warning for each non-compliant case clause.
15.3	The final clause of a *switch* statement shall be the *default* clause	The final clause of a switch statement shall be the default clause	
15.4	A *switch* expression should not represent a value that is effectively Boolean	A switch expression should not represent a value that is effectively Boolean	The use of the option `-boolean-types` may increase the number of warnings generated.
15.5	Every *switch* statement shall have at least one *case* clause	Every switch statement shall have at least one case clause	

Functions

N.	MISRA Definition	Messages in report file	Polyspace Specification
16.1	Functions shall not be defined with variable numbers of arguments.	Function XX should not be defined as varargs.	
16.2	Functions shall not call themselves, either directly or indirectly.	Function %s should not call itself.	Done by Polyspace software (Call graph in the Results Manager perspective gives the information). Polyspace also checks that partially during compilation phase.
16.3	Identifiers shall be given for all of the parameters in a function prototype declaration.	Identifiers shall be given for all of the parameters in a function prototype declaration.	Assumes Rule **8.6** is not violated.

N.	MISRA Definition	Messages in report file	Polyspace Specification
16.4	The identifiers used in the declaration and definition of a function shall be identical.	The identifiers used in the declaration and definition of a function shall be identical.	Assumes that rules **8.8**, **8.1** and **16.3** are not violated. All occurrences are detected.
16.5	Functions with no parameters shall be declared with parameter type *void*.	Functions with no parameters shall be declared with parameter type void.	Definitions are also checked.
16.6	The number of arguments passed to a function shall match the number of parameters.	• Too many arguments to XX. • Insufficient number of arguments to XX.	Assumes that rule **8.1** is not violated.
16.7	A pointer parameter in a function prototype should be declared as pointer to `const` if the pointer is not used to modify the addressed object.	Pointer parameter in a function prototype should be declared as pointer to `const` if the pointer is not used to modify the addressed object.	Warning if a non-`const` pointer parameter is either not used to modify the addressed object or is passed to a call of a function that is declared with a `const` pointer parameter.
16.8	All exit paths from a function with non-void return type shall have an explicit return statement with an expression.	Missing return value for non-void function XX.	Warning when a non-void function is not terminated with an unconditional return with an expression.
16.9	A function identifier shall only be used with either a preceding &, or with a parenthesized parameter list, which may be empty.	Function identifier XX should be preceded by a & or followed by a parameter list.	

N.	MISRA Definition	Messages in report file	Polyspace Specification
16.10	If a function returns error information, then that error information shall be tested.	If a function returns error information, then that error information shall be tested.	Warning if a non-`void` function is called and the returned value is ignored. No warning if the result of the call is cast to `void`. No check performed for calls of `memcpy`, `memmove`, `memset`, `strcpy`, `strncpy`, `strcat`, or `strncat`.

Pointers and Arrays

N.	MISRA Definition	Messages in report file	Polyspace Specification
17.1	Pointer arithmetic shall only be applied to pointers that address an array or array element.	Pointer arithmetic shall only be applied to pointers that address an array or array element.	
17.2	Pointer subtraction shall only be applied to pointers that address elements of the same array	Pointer subtraction shall only be applied to pointers that address elements of the same array.	
17.3	>, >=, <, <= shall not be applied to pointer types except where they point to the same array.	>, >=, <, <= shall not be applied to pointer types except where they point to the same array.	
17.4	Array indexing shall be the only allowed form of pointer arithmetic.	Array indexing shall be the only allowed form of pointer arithmetic.	Warning on operations on pointers. (`p+I`, `I+p` and `p-I`, where `p` is a pointer and `I` an integer).
17.5	A type should not contain more than 2 levels of pointer indirection	A type should not contain more than 2 levels of pointer indirection	
17.6	The address of an object with automatic storage shall not	Pointer to a parameter is an illegal return value. Pointer	Warning when assigning address to a global variable,

N.	MISRA Definition	Messages in report file	Polyspace Specification
	be assigned to an object that may persist after the object has ceased to exist.	to a local is an illegal return value.	returning a local variable address, or returning a parameter address.

Structures and Unions

N.	MISRA Definition	Messages in report file	Polyspace Specification
18.1	All structure or union types shall be complete at the end of a translation unit.	All structure or union types shall be complete at the end of a translation unit.	Warning for all incomplete declarations of structs or unions.
18.2	An object shall not be assigned to an overlapping object.	• An object shall not be assigned to an overlapping object. • Destination and source of XX overlap, the behavior is undefined.	
18.4	Unions shall not be used	Unions shall not be used.	

Preprocessing Directives

N.	MISRA Definition	Messages in report file	Polyspace Specification
19.1	#include statements in a file shall only be preceded by other preprocessors directives or comments	#include statements in a file shall only be preceded by other preprocessors directives or comments	A message is displayed when a #include directive is preceded by other things than preprocessor directives, comments, spaces or “new lines”.
19.2	Nonstandard characters should not occur in header file names in #include directives	• A message is displayed on characters ', \, " or /* between < and > in #include <filename> • A message is displayed on characters ', \or /* between " and " in #include "filename"	

N.	MISRA Definition	Messages in report file	Polyspace Specification
19.3	The *#include* directive shall be followed by either a <filename> or "filename" sequence.	• '#include' expects "FILENAME" or <FILENAME> • '#include_next' expects "FILENAME" or <FILENAME>	
19.4	C macros shall only expand to a braced initializer, a constant, a parenthesized expression, a type qualifier, a storage class specifier, or a do-while-zero construct.	Macro '<name>' does not expand to a compliant construct.	We assume that a macro definition does not violate this rule when it expands to: • a braced construct (not necessarily an initializer) • a parenthesized construct (not necessarily an expression) • a number • a character constant • a string constant (can be the result of the concatenation of string field arguments and literal strings) • the following keywords: typedef, extern, static, auto, register, const, volatile, __asm__ and __inline__ • a do-while-zero construct
19.5	Macros shall not be #defined and #undefd within a block.	• Macros shall not be `#define`'d within a block. • Macros shall not be `#undef`'d within a block.	
19.6	#undef shall not be used.	`#undef` shall not be used.	

N.	MISRA Definition	Messages in report file	Polyspace Specification
19.7	A function should be used in preference to a function like-macro.	A function should be used in preference to a function like-macro	Message on all function-like macro definitions.
19.8	A function-like macro shall not be invoked without all of its arguments	• arguments given to macro '<name>' • macro '<name>' used without args. • macro '<name>' used with just one arg. • macro '<name>' used with too many (<number>) args.	
19.9	Arguments to a function-like macro shall not contain tokens that look like preprocessing directives.	Macro argument shall not look like a preprocessing directive.	This rule is detected as violated when the '#' character appears in a macro argument (outside a string or character constant)
19.10	In the definition of a function-like macro each instance of a parameter shall be enclosed in parentheses unless it is used as the operand of # or ##.	Parameter instance shall be enclosed in parentheses.	If `x` is a macro parameter, the following instances of x as an operand of the # and ## operators do not generate a warning: `#x`, `##x`, and `x##`. Otherwise, parentheses are required around `x`. The software does not generate a warning if a parameter is reused as an argument of a function or function-like macro. For example, consider a parameter x. The software does not generate a warning if `x` appears as `(x)` or `(x,` or `,x)` or `,x,`.

N.	MISRA Definition	Messages in report file	Polyspace Specification
19.11	All macro identifiers in preprocessor directives shall be defined before use, except in #ifdef and #ifndef preprocessor directives and the defined() operator.	'<name>' is not defined.	
19.12	There shall be at most one occurrence of the # or ## preprocessor operators in a single macro definition.	More than one occurrence of the # or ## preprocessor operators.	
19.13	The # and ## preprocessor operators should not be used	Message on definitions of macros using # or ## operators	
19.14	The defined preprocessor operator shall only be used in one of the two standard forms.	'defined' without an identifier.	

N.	MISRA Definition	Messages in report file	Polyspace Specification
19.15	Precautions shall be taken in order to prevent the contents of a header file being included twice.	Precautions shall be taken in order to prevent multiple inclusions.	When a header file is formatted as: #ifndef <control macro> #define <control macro> <contents> #endif or: #ifdef <control macro> #error ... #else #define <control macro> <contents> #endif it is assumed that precautions have been taken to prevent multiple inclusions. Otherwise, a violation of this MISRA rule is detected.
19.16	Preprocessing directives shall be syntactically meaningful even when excluded by the preprocessor.	directive is not syntactically meaningful.	

N.	MISRA Definition	Messages in report file	Polyspace Specification
19.17	All #else, #elif and #endif preprocessor directives shall reside in the same file as the #if or #ifdef directive to which they are related.	• '#elif' not within a conditional. • '#else' not within a conditional. • '#elif' not within a conditional. • '#endif' not within a conditional. • unbalanced '#endif'. • unterminated '#if' conditional. • unterminated '#ifdef' conditional. • unterminated '#ifndef' conditional.	

Standard Libraries

N.	MISRA Definition	Messages in report file	Polyspace Specification
20.1	Reserved identifiers, macros and functions in the standard library, shall not be defined, redefined or undefined.	• The macro '<name> shall not be redefined. • The macro '<name> shall not be undefined.	
20.2	The names of standard library macros, objects and functions shall not be reused.	Identifier XX should not be used.	In case a macro whose name corresponds to a standard library macro, object or function is defined, the rule that is detected as violated is **20.1**. Tentative of definitions are considered as definitions.
20.3	The validity of values passed to library functions shall be checked.	Validity of values passed to library functions shall be checked	Warning for argument in library function call if the following are all true:

N.	MISRA Definition	Messages in report file	Polyspace Specification
			• Argument is a local variable • Local variable is not tested between last assignment and call to the library function • Library function is a common mathematical function • Corresponding parameter of the library function has a restricted input domain. The library function can be one of the following : `sqrt`, `tan`, `pow`, `log`, `log10`, `fmod`, `acos`, `asin`, `acosh`, `atanh`, or `atan2`.
20.4	Dynamic heap memory allocation shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case the dynamic heap memory allocation functions are actually macros and the macro is expanded in the code, this rule is detected as violated. Assumes rule **20.2** is not violated.
20.5	The error indicator errno shall not be used	The error indicator errno shall not be used	Assumes that rule **20.2** is not violated
20.6	The macro *offsetof*, in library <stddef.h>, shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	Assumes that rule **20.2** is not violated

N.	MISRA Definition	Messages in report file	Polyspace Specification
20.7	The *setjmp* macro and the *longjmp* function shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case the longjmp function is actually a macro and the macro is expanded in the code, this rule is detected as violated. Assumes that rule **20.2** is not violated
20.8	The signal handling facilities of <signal.h> shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case some of the signal functions are actually macros and are expanded in the code, this rule is detected as violated. Assumes that rule **20.2** is not violated
20.9	The input/output library <stdio.h> shall not be used in production code.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case the input/output library functions are actually macros and are expanded in the code, this rule is detected as violated. Assumes that rule **20.2** is not violated
20.10	The library functions atof, atoi and toll from library <stdlib.h> shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case the atof, atoi and atoll functions are actually macros and are expanded, this rule is detected as violated. Assumes that rule **20.2** is not violated
20.11	The library functions abort, exit, getenv and system from library <stdlib.h> shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case the abort, exit, getenv and system functions are actually macros and are expanded, this rule is detected as violated. Assumes that rule **20.2** is not violated
20.12	The time handling functions of library <time.h> shall not be used.	• The macro '<name> shall not be used. • Identifier XX should not be used.	In case the time handling functions are actually macros and are expanded, this rule is detected as violated. Assumes that rule **20.2** is not violated

Runtime Failures

N.	MISRA Definition	Messages in report file	Polyspace Specification
21.1	Minimization of runtime failures shall be ensured by the use of at least one of: • static verification tools/ techniques; • dynamic verification tools/ techniques; • explicit coding of checks to handle runtime faults.		Done by Polyspace. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

MISRA C:2004 Rules Not Checked

The Polyspace coding rules checker does not check the following MISRA C:2004 coding rules. These rules cannot be enforced because they are outside the scope of Polyspace software. They may concern documentation, dynamic aspects, or functional aspects of MISRA rules. The "**Polyspace Specification**" column describes the reason each rule is not checked.

Environment

Rule	Description	Polyspace Specification
1.2 (Required)	No reliance shall be placed on undefined or unspecified behavior	Not statically checkable unless the data dynamic properties is taken into account
1.3 (Required)	Multiple compilers and/or languages shall only be used if there is a common defined interface standard for object code to which the language/compilers/ assemblers conform.	It is a process rule method.
1.4 (Required)	The compiler/linker/Identifiers (internal and external) shall not rely on significance of more than 31 characters. Furthermore the compiler/linker shall be checked to ensure that 31 character	The documentation of compiler must be checked.

Rule	Description	Polyspace Specification
	significance and case sensitivity are supported for external identifiers.	
1.5 (Advisory)	Floating point implementations should comply with a defined floating point standard.	The documentation of compiler must be checked as this implementation is done by the compiler

Language Extensions

Rule	Description	Polyspace Specification
2.4 (Advisory)	Sections of code should not be “commented out”	It might be some pseudo code or code that does not compile inside a comment.

Documentation

Rule	Description	Polyspace Specification
3.1 (Required)	All usage of implementation-defined behavior shall be documented.	The documentation of compiler must be checked. Error detection is based on undefined behavior, according to choices made for implementation- defined constructions. Documentation can not be checked.
3.2 (Required)	The character set and the corresponding encoding shall be documented.	The documentation of compiler must be checked.
3.3 (Advisory)	The implementation of integer division in the chosen compiler should be determined, documented and taken into account.	The documentation of compiler must be checked.
3.5 (Required)	The implementation-defined behavior and packing of bitfields shall be documented if being relied upon.	The documentation of compiler must be checked.
3.6 (Required)	All libraries used in production code shall be written to comply with the provisions of this document, and shall have been subject to appropriate validation.	The documentation of compiler must be checked.

Structures and Unions

Rule	Description	Polyspace Specification
18.3 (Required)	An area of memory shall not be reused for unrelated purposes.	"purpose" is functional design issue.

Polyspace MISRA C:2012 Checker

The Polyspace MISRA C:2012 checker helps you to comply with the MISRA C 2012 coding standard.[4]

When MISRA C:2012 guidelines are violated, the Polyspace MISRA C:2012 checker provides messages with information about the violated rule or directive. Most violations are found during the compile phase of an analysis.

The checker can check **138** of the **159** MISRA C:2012 guidelines.

Each guideline is categorized into one of these three categories: mandatory, required, or advisory. When you set up rule checking, you can select subsets of these categories to check. For automatically generated code, some rules change categories, including to one additional category: readability. The “Use generated code requirements (C)” option activates the categorization for automatically generated code.

There are additional subsets of MISRA C:2012 guidelines defined by Polyspace called Software Quality Objectives (SQO) that can have a direct or indirect impact on the precision of your results. When you set up checking, you can select these subsets. These subsets are defined in “Software Quality Objective Subsets (C:2012)” on page 12-57.

See Also

“Check MISRA C:2012” | “Use generated code requirements (C)”

Related Examples

- “Activate Coding Rules Checker”

More About

- “MISRA C:2012 Coding Directives and Rules” on page 12-59
- “Software Quality Objective Subsets (C:2012)” on page 12-57

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Software Quality Objective Subsets (C:2012)

In this section...

Polyspace defined these subsets of MISRA C:2012 guidelines to identify the guidelines that can have a direct or indirect impact on the precision of your Polyspace results. When you set up checking, you can select these subsets.

Guidelines in `SQO-Subset1`

The following set of MISRA C:2012 coding guidelines typically reduces the number of unproven results.

- 8.8, 8.11, and 8.13
- 11.1, 11.2, 11.4, 11.5, 11.6, and 11.7
- 14.1 and 14.2
- 15.1, 15.2, 15.3, and 15.5
- 17.1 and 17.2
- 18.3, 18.4, 18.5, and 18.6
- 19.2
- 21.3

Guidelines in `SQO-Subset2`

Good design practices generally lead to less code complexity, which can reduce the number of unproven results. The following set of coding guidelines enforce good design practices. The `SQO-subset2` option contains the guidelines in `SQO-subset1` and some additional guidelines.

- 8.8, 8.11, and 8.13
- 11.1, 11.2, 11.4, 11.5, 11.6, 11.7, and 11.8
- 12.1 and 12.3
- 13.2 and 13.4

- 14.1, 14.2 and 14.4
- 15.1, 15.2, 15.3, 15.5, 15.6 and 15.7
- 16.4 and 16.5
- 17.1,17.2, and 17.4
- 18.3, 18.4, 18.5, and 18.6
- 19.2
- 20.4, 20.6, 20.7, 20.9, and 20.11
- 21.3

MISRA C:2012 Coding Directives and Rules

In this section...
"Supported MISRA C:2012 Rules" on page 12-59
"MISRA C:2012 Guidelines Not Checked" on page 12-99

Supported MISRA C:2012 Rules

The following tables list MISRA C:2012 coding rules that the Polyspace coding rules checker supports. The "Polyspace Specification" column describes how the software checks individual rules and any limitations on the scope of checking.

- "Code Design" on page 12-60
- "A Standard C Environment" on page 12-62
- "Unused Code" on page 12-66
- "Comments" on page 12-67
- "Character Sets and Lexical Conventions" on page 12-67
- "Identifiers" on page 12-68
- "Types" on page 12-70
- "Literals and Constants" on page 12-70
- "Declarations and Definitions" on page 12-71
- "Initialization" on page 12-75
- "The Essential Type Model" on page 12-76
- "Pointer Type Conversions" on page 12-79
- "Expressions" on page 12-81
- "Side Effects" on page 12-82
- "Control Statement Expressions" on page 12-83
- "Control Flow" on page 12-85
- "Switch Statements" on page 12-87
- "Function" on page 12-89
- "Pointers and Arrays" on page 12-90

Code Design

Directive Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Dir 4.1	Required	Required	Run-time failures shall be minimized	Run-time failures shall be minimized	Done by Polyspace. Bug Finder and Code Prover check this directive differently. The analyses can produce different results.
Dir 4.3	Required	Required	Assembly language shall be encapsulated and isolated	Assembly language shall be encapsulated and isolated	No warnings if code is encapsulated in asm functions or in asm pragma. The only warning on asm statements is if the statement is encapsulated by a MACRO.
Dir 4.6	Advisory	Advisory	typedefs that indicate size and signedness should be used in place of the basic numerical types	typedefs that indicate size and signedness should be used in place of the basic numerical types	No warning is given in typedef definition.
Dir 4.9	Advisory	Advisory	A function should be used in preference to a function-like macro where they are interchangeable	A function should be used in preference to a function like-macro	Message on all function-like macros definitions.

Directive Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification

Dir 4.10	Required	Required	Precautions shall be taken in order to prevent the contents of a header file being included more than once	Precautions shall be taken in order to prevent the contents of a header file being included more than once	Take precautions to prevent multiple inclusions when a header file is formatted as:
					#ifndef <control macro>
					#define <control macro>
					    contents
					#endif
					or
					#ifdef <control macro>
					#error ...
					#else
					#define <control macro>
					    contents
					#endif
					Otherwise, a violation of this MISRA rule is detected.

Directive Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Dir 4.11	Required	Required	The validity of values passed to library functions shall be checked	The validity of values passed to library functions shall be checked	Warning for argument in library function call, if the following are all true: • Argument is a local variable • Local variable is not tested between last assignment and call to the library function • Library function is a common mathematical function • Corresponding parameter of the library function has a restricted input domain. The library function can be one of the following : `sqrt`, `tan`, `pow`, `log`, `log10`, `fmod`, `acos`, `asin`, `acosh`, `atanh`, or `atan2`.

A Standard C Environment

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 1.1	Required	Required	The program shall contain no violations of the standard C syntax	Too many nesting levels of #includes: N1. The limit is N0.	Standard compilation error messages do not lead to a violation of

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
			and constraints, and shall not exceed the implementation's translation limits	Integer constant is too large. ANSI C does not allow '#XX'. Text following preprocessing directive violates ANSI standard. Too many macro definitions: N1. The limit is N0. Array of zero size should not be used. Integer constant does not fit within long int. Integer constant does not fit within unsigned long int. Too many nesting levels for control flow: N1. The limit is N0. Assembly language should not be used. Too many enumeration constants: N1. The limit is N0.	this MISRA rule and remain unchanged

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 1.2	Advisory	Advisory	Language extensions should not be used	ANSI C90 forbids hexadecimal floating-point constants. ANSI C90 forbids universal character names. ANSI C90 forbids mixed declarations and code. ANSI C90/C99 forbids case ranges. ANSI C90/C99 forbids local label declaration. ANSI C90 forbids mixed declarations and code. ANSI C90/C99 forbids typeof operator. ANSI C90/C99 forbids casts to union. ANSI C90 forbids compound literals. ANSI C90/C99 forbids statements and declarations in expressions.	All the supported extensions lead to a violation of this MISRA rule.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
				ANSI C90 forbids __func__ predefined identifier.	
Rule 1.2 (cont)				ANSI C90 forbids keyword '_Bool'. ANSI C90 forbids 'long long int' type. ANSI C90 forbids long long integer constants. ANSI C90 forbids 'long double' type. ANSI C90/C99 forbids 'short long int' type. ANSI C90 forbids _Pragma preprocessing operator. ANSI C90 does not allow macros with variable arguments list. ANSI C90 forbids designated initializer. Keyword 'inline' should not be used.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 1.3	Required	Required	There shall be no occurrence of undefined or critical unspecified behaviour	There shall be no occurrence of undefined or critical unspecified behavior • 'defined' without an identifier. • macro 'XX' used with too few arguments. • macro 'XX used with too many arguments.	

Unused Code

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 2.1	Required	Required	A project shall not contain unreachable code.	A project shall not contain unreachable code.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
Rule 2.2	Required	Required	There shall be no dead code.	There shall be no dead code.	Useless writes done by Polyspace.
Rule 2.3	Advisory	Readability	A project should not contain unused type declarations.	A project should not contain unused type declarations: type XX is not used.	
Rule 2.4	Advisory	Readability	A project should not contain unused tag declarations.	A project should not contain unused tag declarations: tag XX is not used.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 2.5	Advisory	Readability	A project should not contain unused macro declarations.	A project should not contain unused macro declarations: macro XX is not used.	

Comments

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 3.1	Required	Required	The character sequences /* and // shall not be used within a comment	The character sequence /* shall not appear within a comment.	This rule violation is also raised when the character sequence "/*" is inside a C++ comment. *Note*: This rule cannot be annotated in the source code.
Rule 3.2	Required	Required	Line-splicing shall not be used in // comments	Line-splicing shall not be used in // comments.	

Character Sets and Lexical Conventions

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 4.1	Required	Required	Octal and hexadecimal escape sequences shall be terminated	Octal and hexadecimal escape sequences shall be terminated.	
Rule 4.2	Advisory	Advisory	Trigraphs should not be used	Trigraphs should not be used.	Trigraphs are handled and converted to the equivalent character but lead to a violation of the MISRA rule.

Identifiers

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 5.1	Required	Required	External identifiers shall be distinct	External %s %s conflicts with the external identifier XX in file YY.	
Rule 5.2	Required	Required	Identifiers declared in the same scope and name space shall be distinct	Identifiers declared in the same scope and name space shall be distinct. Identifier XX has same significant characters as identifier YY.	
Rule 5.3	Required	Advisory	An identifier declared in an inner scope shall not hide an identifier declared in an outer scope	Variable XX hides variable XX (FILE line LINE column COLUMN).	
Rule 5.4	Required	Required	Macro identifiers shall be distinct	Macro identifiers shall be distinct. Macro XX has same significant characters as macro YY. Macro identifiers shall be distinct. Macro parameter XX has same significant characters as macro parameter YY in macro ZZ.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 5.5	Required	Required	Identifiers shall be distinct from macro names	Identifiers shall be distinct from macro names. Identifier XX has same significant characters as macro YY.	
Rule 5.6		Required	A typedef name shall be a unique identifier	XX conflicts with the typedef name YY.	
Rule 5.7	Required	Required	A tag name shall be a unique identifier	XX conflicts with the tag name YY.	
Rule 5.8	Required	Required	Identifiers that define objects or functions with external linkage shall be unique	Object XX conflicts with the object name YY. Function XX conflicts with the function name YY.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
Rule 5.9	Advisory	Readability	Identifiers that define objects or functions with internal linkage should be unique	Object XX conflicts with the object name YY. Function XX conflicts with the function name YY.	This rule checker assumes that rule 5.8 is not violated. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

Types

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 6.1	Required	Required	Bit-fields shall only be declared with an appropriate type	Bit-fields shall only be declared with an appropriate type.	
Rule 6.2	Required	Required	Single-bit named bit fields shall not be of a signed type	Single-bit named bit fields shall not be of a signed type.	

Literals and Constants

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 7.1	Required	Advisory	Octal constants shall not be used	Octal constants shall not be used.	
Rule 7.2	Required	Readability	A "u" or "U" suffix shall be applied to all integer constants that are represented in an unsigned type	A "u" or "U" suffix shall be applied to all integer constants that are represented in an unsigned type.	Warning when the type determined from the value and the base (octal, decimal, or hexadecimal) is unsigned and there is no suffix u or U. For example, when the size of the int and long int data types is 32 bits, the coding rule checker reports a violation of rule 10.6 for the following line: `int a = 2147483648;` There is a difference between decimal and hexadecimal constants

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
					when int and long int are not the same size.
Rule 7.3	Required	Readability	The lowercase character “l” shall not be used in a literal suffix	The lowercase character “l” shall not be used in a literal suffix.	
Rule 7.4	Required	Required	A string literal shall not be assigned to an object unless the object’s type is “pointer to const-qualified char	A string literal shall not be assigned to an object unless the object’s type is “pointer to const-qualified char.	

Declarations and Definitions

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 8.1	Required	Required	Types shall be explicitly specified	Types shall be explicitly specified.	
Rule 8.2	Required	Required	Function types shall be in prototype form with named parameters	Too many arguments to 'XX'. Too few arguments to 'XX'. Function types shall be in prototype form with named parameters.	Definitions are also checked.
Rule 8.3	Required	Required	All declarations of an object or function shall use the same names and type qualifiers	Definition of function 'XX' incompatible with its declaration.	There is a possibility that violations of this rule are generated during the link phase.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
				Global declaration of 'XX' function has incompatible type with its definition. Global declaration of 'XX' variable has incompatible type with its definition. All declarations of an object or function shall use the same names and type qualifiers.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
Rule 8.4	Required	Advisory	A compatible declaration shall be visible when an object or function with external linkage is defined	Global definition of 'XX' variable has no previous declaration. Function 'XX' has no visible compatible prototype at definition.	
Rule 8.5	Required	Advisory	An external object or function shall be declared once in one and only one file	Object 'XX' has external declarations in multiples files. Function 'XX' has external declarations in multiples files.	Restricted to explicit extern declarations (tentative definitions are ignored). Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 8.6	Required	Required	An identifier with external linkage shall have exactly one external definition	Forbidden multiple definitions for function XX. Forbidden multiple tentatives of definition for object XX. Global variable XX multiply defined. Function XX multiply defined. Global variable has multiples tentative of definitions Undefined global variable XX	Tentative definitions are considered as definitions, no warning on predefined symbols. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results. .
Rule 8.7	Advisory	Advisory	Functions and objects should not be defined with external linkage if they are referenced in only one translation unit	Variable XX should have internal linkage. Function XX should have internal linkage.	If there are no uses, no warning is raised. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 8.8	Required	Required	The static storage class specifier shall be used in all declarations of objects and functions that have internal linkage	The static storage class specifier shall be used in all declarations of objects and functions that have internal linkage.	
Rule 8.9	Advisory	Advisory	An object should be defined at block scope if its identifier only appears in a single function	An object should be defined at block scope if its identifier only appears in a single function.	Restricted to static objects.
Rule 8.10	Required	Required	An inline function shall be declared with the static storage class	An inline function shall be declared with the static storage class.	
Rule 8.11	Advisory	Advisory	When an array with external linkage is declared, its size should be explicitly specified	Size of array 'XX' should be explicitly stated. When an array with external linkage is declared, its size should be explicitly specified	
Rule 8.12	Required	Required	Within an enumerator list, the value of an implicitly-specified enumeration constant shall be unique	The constant XX has same value as the constant YY.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 8.13	Advisory	Advisory	A pointer should point to a const-qualified type whenever possible	A pointer should point to a const-qualified type whenever possible.	A warning is issued if a non-const pointer parameter is either: • Not used to modify the addressed object, or • Is passed to a call of a function that is declared with a const pointer parameter.
Rule 8.14	Required	Advisory	The restrict type qualifier shall not be used	The restrict type qualifier shall not be used.	

Initialization

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 9.1	Mandatory	Mandatory	The value of an object with automatic storage duration shall not be read before it has been set	The value of an object with automatic storage duration shall not be read before it has been set.	The Polyspace analysis checks some of the violations as non-initialized variables. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
Rule 9.2	Required	Readability	The initializer for an aggregate or union shall be enclosed in braces	The initializer for an aggregate or union shall be enclosed in braces	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 9.3	Required	Readability	Arrays shall not be partially initialized	Arrays shall not be partially initialized	
Rule 9.4	Required	Required	An element of an object shall not be initialized more than once	An element of an object shall not be initialized more than once	
Rule 9.5	Required	Readability	Where designated initializers are used to initialize an array object the size of the array shall be specified explicitly	Where designated initializers are used to initialize an array object the size of the array shall be specified explicitly	

The Essential Type Model

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 10.1	Required	Advisory	Operands shall not be of an inappropriate essential type	The XX operand of the YY operator is of an inappropriate essential type category ZZ.	
Rule 10.2	Required	Advisory	Expressions of essentially character type shall not be used inappropriately in addition and subtraction operations	The XX operand of the + operator applied to an expression of essentially character type shall have essentially signed or unsigned type. The right operand of the - operator	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
				applied to an expression of essentially character type shall have essentially signed or unsigned or character type. The left operand of the - operator shall have essentially character type if the right operand has essentially character type.	
Rule 10.3	Required	Advisory	The value of an expression shall not be assigned to an object with a narrower essential type or of a different essential type category	The expression is assigned to an object with a different essential type category. The expression is assigned to an object with a narrower essential type.	
Rule 10.4	Required	Advisory	Both operands of an operator in which the usual arithmetic conversions are performed shall have the same essential type category	Operands of XX operator shall have the same essential type category.	
Rule 10.5	Advisory	Advisory	The value of an expression should	The value of an expression should	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
			not be cast to an inappropriate essential type	not be cast to an inappropriate essential type.	
Rule 10.6	Required	Advisory	The value of a composite expression shall not be assigned to an object with wider essential type	The composite expression is assigned to an object with a wider essential type.	
Rule 10.7	Required	Advisory	If a composite expression is used as one operand of an operator in which the usual arithmetic conversions are performed then the other operand shall not have wider essential type	The right operand shall not have wider essential type than the left operand which is a composite expression. The left operand shall not have wider essential type than the right operand which is a composite expression.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 10.8	Required	Advisory	The value of a composite expression shall not be cast to a different essential type category or a wider essential type	The value of a composite expression shall not be cast to a different essential type category. The value of a composite expression shall not be cast to a wider essential type.	

Pointer Type Conversions

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 11.1	Required	Required	Conversions shall not be performed between a pointer to a function and any other type	Conversions shall not be performed between a pointer to a function and any other type	Casts and implicit conversions involve a function pointer. Casts or implicit conversions from `NULL` or `(void*)0` do not generate a warning.
Rule 11.2	Required	Required	Conversions shall not be performed between a pointer to an incomplete type and any other type	Conversions shall not be performed between a pointer to an incomplete type and any other type.	
Rule 11.3	Required	Required	A cast shall not be performed between a pointer to object type and a pointer to	A cast shall not be performed between a pointer to object type and a pointer to a different object type.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
			a different object type		
Rule 11.4	Advisory	Advisory	A conversion should not be performed between a pointer to object and an integer type	A conversion should not be performed between a pointer to object and an integer type	Casts or implicit conversions from `NULL` or `(void*)0` do not generate a warning.
Rule 11.5	Advisory	Advisory	A conversion should not be performed from pointer to void into pointer to object.	A conversion should not be performed from pointer to void into pointer to object.	Casts or implicit conversions from `NULL` or `(void*)0` do not generate a warning.
Rule 11.6	Required	Required	A cast shall not be performed between pointer to void and an arithmetic type	A cast shall not be performed between pointer to void and an arithmetic type.	Casts or implicit conversions from `NULL` or `(void*)0` do not generate a warning.
Rule 11.7	Required	Required	A cast shall not be performed between pointer to object and a non-integer arithmetic type	A cast shall not be performed between pointer to object and a non-integer arithmetic type.	
Rule 11.8	Required	Required	A cast shall not remove any const or volatile qualification from the type pointed to by a pointer	A cast shall not remove any const or volatile qualification from the type pointed to by a pointer.	Extended to all conversions.
Rule 11.9	Required	Readability	The macro NULL shall be the only permitted form of integer null pointer constant	The macro NULL shall be the only permitted form of integer null pointer constant.	Extended to all zero constants.

Expressions

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 12.1	Advisory	Advisory	The precedence of operators within expressions should be made explicit	Operand of logical %s is not a primary expression. The precedence of operators within expressions should be made explicit.	
Rule 12.2	Required	Required	The right hand operand of a shift operator shall lie in the range zero to one less than the width in bits of the essential type of the left hand operand	Shift amount is bigger than XX. Shift amount is negative. The right hand operand of a shift operator shall lie in the range zero to one less than the width in bits of the essential type of the left hand operand.	The numbers that are manipulated in preprocessing directives are 64 bits wide. The valid shift range is between 0 and 63. This check is also extended onto bitfields with the field width or the width of the base type when it is within a complex expression.
Rule 12.3	Advisory	Advisory	The comma operator should not be used	The comma operator should not be used.	
Rule 12.4	Advisory	Advisory	Evaluation of constant expressions should not lead to unsigned integer wrap-around	Evaluation of constant expressions should not lead to unsigned integer wrap-around.	

Side Effects

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 13.1	Required	Required	Initializer lists shall not contain persistent side effects	Initializer lists shall not contain persistent side effects.	All function calls are interpreted as side effects.
Rule 13.2	Required	Required	The value of an expression and its persistent side effects shall be the same under all permitted evaluation orders	The value of 'XX' depends on the order of evaluation. The value of volatile 'XX' depends on the order of evaluation because of multiple accesses.	The expression is a simple expression of symbols. Rule 13.2 assumes that the comma operator is not used (rule 12.3).
Rule 13.3	Advisory	Readability	A full expression containing an increment (++) or decrement (--) operator should have no other potential side effects other than that caused by the increment or decrement operator	A full expression containing an increment (++) or decrement (--) operator should have no other potential side effects other than that caused by the increment or decrement operator.	Warning when ++ or -- operators are not used by themselves.
Rule 13.4	Advisory	Advisory	The result of an assignment operator should not be used	The result of an assignment operator should not be used.	
Rule 13.5	Required	Required	The right hand operand of a logical && or || operator shall not	The right hand operand of a && operator shall not contain side effects. The right hand	No warning on volatile accesses. All function calls are seen as side effects.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
			contain persistent side effects	operand of a || operator shall not contain side effects.	
Rule 13.6	Mandatory	Mandatory	The operand of the sizeof operator shall not contain any expression which has potential side effects	The operand of the sizeof operator shall not contain any expression which has potential side effects.	No warning on volatile accesses.

Control Statement Expressions

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 14.1	Required	Advisory	A loop counter shall not have essentially floating type.	A loop counter shall not have essentially floating type.	If the 'for' index is a variable symbol, it is checked that it is not a float.
Rule 14.2	Required	Readability	A for loop shall be well-formed.	1st expression should be an assignment. The following kinds of for loops are allowed: • all three expressions shall be present; • the 2nd and 3rd expressions shall be present with prior initialization of the loop counter; • all three expressions shall be empty for	Checks if: • The for loop index (V) is a variable symbol. • V is the last assigned variable in the first expression (if present). • If the first expression exists, it contains an assignment of V. • If the second expression exists, it is a comparison of V.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
				a deliberate infinite loop 3rd expression should be an assignment of a loop counter. 3rd expression : assigned variable should be the loop counter (XX). 3rd expression should be an assignment of loop counter (XX) only. 2nd expression should contain a comparison with loop counter (XX). Loop counter (XX) should not be modified in the body of the loop. Bad type for loop counter (XX).	• If the third expression exists, it is an assignment of V. • There are direct assignments of the for loop index.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 14.3	Required	Required	Controlling expressions shall not be invariant.	Boolean operations whose results are invariant shall not be permitted. Expression is always true. Boolean operations whose results are invariant shall not be permitted. Expression is always false. Controlling expressions shall not be invariant.	Some of the violations are found by Polyspace Bug Finder as Dead Code and Useless If checkers. No violations from dead code checks in Polyspace Code Prover. Because Bug Finder and Code Prover check this coding rule differently, the analyses can produce different results.
Rule 14.4	Required	Advisory	The controlling expression of an if statement and the controlling expression of an iteration-statement shall have essentially Boolean type.	The controlling expression of an if statement and the controlling expression of an iteration-statement shall have essentially Boolean type	No warning is generated for integer constants, for example. `if(2)`. The use of the option `-boolean-types` can increase or decrease the number of warnings generated.

Control Flow

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 15.1	Advisory	Advisory	The goto statement should not be used	The goto statement should not be used.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 15.2	Required	Advisory	The goto statement shall jump to a label declared later in the same function	The goto statement shall jump to a label declared later in the same function.	
Rule 15.3	Required	Advisory	Any label referenced by a goto statement shall be declared in the same block, or in any block enclosing the goto statement	Any label referenced by a goto statement shall be declared in the same block, or in any block enclosing the goto statement.	
Rule 15.4	Advisory	Advisory	There should be no more than one break or goto statement used to terminate any iteration statement	There should be no more than one break or goto statement used to terminate any iteration statement.	
Rule 15.5	Advisory	Advisory	A function should have a single point of exit at the end	A function should have a single point of exit at the end.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 15.6	Required	Required	The body of an iteration-statement or a selection-statement shall be a compound-statement	The else keyword shall be followed by either a compound statement, or another if statement. An if (expression) construct shall be followed by a compound statement. The statement forming the body of a while statement shall be a compound statement. The statement forming the body of a do ... while statement shall be a compound statement. The statement forming the body of a for statement shall be a compound statement. The statement forming the body of a switch statement shall be a compound statement.	
Rule 15.7	Required	Readability	All if … else if constructs shall be terminated with an else statement	All if … else if constructs shall be terminated with an else statement.	

Switch Statements

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 16.1	Required	Advisory	All switch statements shall be well-formed	Initializers shall not be used in switch clauses.	All messages in report file begin with "MISRA-C switch statements syntax normative restriction."

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
				The child statement of a switch shall be a compound statement. All switch clauses shall appear at the same level. A switch clause shall only contain switch labels and switch clauses, and no other code. A switch statement shall only contain switch labels and switch clauses, and no other code.	
Rule 16.2	Required	Advisory	A switch label shall only be used when the most closely-enclosing compound statement is the body of a switch statement	A switch label shall only be used when the most closely-enclosing compound statement is the body of a switch statement.	
Rule 16.3	Required	Advisory	An unconditional break statement shall terminate every switch-clause	An unconditional break statement shall terminate every switch-clause.	Warning for each noncompliant case clause.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 16.4	Required	Advisory	Every switch statement shall have a default label	Every switch statement shall have a default label.	
Rule 16.5	Required	Advisory	A default label shall appear as either the first or the last switch label of a switch statement	A default label shall appear as either the first or the last switch label of a switch statement.	
Rule 16.6	Required	Advisory	Every switch statement shall have at least two switch-clauses	Every switch statement shall have at least two switch-clauses.	
Rule 16.7	Required	Advisory	A switch-expression shall not have essentially Boolean type	A switch-expression shall not have essentially Boolean type.	The use of the option `-boolean-types` can increase the number of warnings generated.

Function

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 17.1	Required	Required	The features of <starg.h> shall not be used.	The features of <starg.h> shall not be used.	
Rule 17.2	Required	Required	Functions shall not call themselves, either directly or indirectly	Function XX shall not call itself either directly or indirectly. Functions shall not call themselves, either directly or indirectly. Function XX is	Found by Polyspace software. The call graph in the Results Manager perspective of Polyspace Code Prover shows a visual representation of a function's calls.Polyspace also

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
				called indirectly by YY.	partially checks this guideline during the compilation phase.
Rule 17.3	Mandatory	Mandatory	A function shall not be declared implicitly	Function 'XX' has no complete visible prototype at call.	Prototype visible at call must be complete.
Rule 17.4	Mandatory	Mandatory	All exit paths from a function with non-void return type shall have an explicit return statement with an expression	Missing return value for non-void function 'XX'.	
Rule 17.6	Mandatory	Mandatory	The declaration of an array parameter shall not contain the static keyword between the [ ]	The declaration of an array parameter shall not contain the static keyword between the [ ].	
Rule 17.7	Required	Readability	The value returned by a function having non-void return type shall be used	The value returned by a function having non-void return type shall be used.	

Pointers and Arrays

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 18.1	Required	Required	A pointer resulting from arithmetic on a pointer operand shall address an element of the same array as that pointer operand	A pointer resulting from arithmetic on a pointer operand shall address an element of the same array as that pointer operand.	Found during the Polyspace analysis as (Code Prover) Illegally dereferenced pointer checks and Out-of-bounds array checks

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
					and (Bug Finder) Out-of-bound defects.
Rule 18.2	Required	Required	Subtraction between pointers shall only be applied to pointers that address elements of the same array	Subtraction between pointers shall only be applied to pointers that address elements of the same array.	
Rule 18.3	Required	Required	The relational operators >, >=, < and <= shall not be applied to objects of pointer type except where they point into the same object	The relational operators >, >=, < and <= shall not be applied to objects of pointer type except where they point into the same object.	
Rule 18.4	Advisory	Advisory	The +, -, += and -= operators should not be applied to an expression of pointer type	The +, -, += and -= operators should not be applied to an expression of pointer type.	Warning on operations on pointers. (p+I, I +p and p-I. Where p is a pointer and I an integer).
Rule 18.5	Advisory	Readability	Declarations should contain no more than two levels of pointer nesting	Declarations should contain no more than two levels of pointer nesting.	
Rule 18.6	Required	Required	The address of an object with automatic storage shall not be copied to another object that persists after the first object has ceased to exist	The address of an object with automatic storage shall not be copied to another object that persists after the first object has ceased to exist.	Warning when assigning address to a global variable, returning a local variable address or a parameter address.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 18.7	Required	Required	Flexible array members shall not be declared	Flexible array members shall not be declared.	
Rule 18.8	Required	Required	Variable-length array types shall not be used	Variable-length array types shall not be used.	

Overlapping Storage

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 19.1	Mandatory	Mandatory	An object shall not be assigned or copied to an overlapping object	An object shall not be assigned or copied to an overlapping object. Destination and source of XX overlap, the behavior is undefined.	
Rule 19.2	Advisory	Advisory	The union keyword should not be used	The union keyword should not be used.	

Preprocessing Directives

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 20.1	Advisory	Advisory	#include directives should only be preceded by preprocessor directives or comments	#include directives should only be preceded by preprocessor directives or comments.	A message is displayed when a #include directive is preceded by text other than preprocessor directives, comments, spaces or "new lines".

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 20.2	Required	Required	The', "or \characters and the /* or //character sequences shall not occur in a header file name	The', "or \characters and the /* or //character sequences shall not occur in a header file name.	A message is displayed on the characters ', \, ", or /* between < and > in `#include <filename>`. A message is displayed on characters ', \, or /* between " and " in `#include "filename"`.
Rule 20.3	Required	Required	The #include directive shall be followed by either a <filename> or \"filename\" sequence	• '#include' expects \"FILENAME \" or <FILENAME> • '#include_next' expects \"FILENAME \" or <FILENAME> • '#include' does not expect string concatenation. • '#include_next' does not expect string concatenation.	
Rule 20.4	Required	Required	A macro shall not be defined with the same name as a keyword	The macro 'XX' shall not be redefined. The macro 'XX' shall not be undefined.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 20.5	Advisory	Readability	#undef should not be used	#undef shall not be used.	
Rule 20.6	Required	Required	Tokens that look like a preprocessing directive shall not occur within a macro argument	Macro argument shall not look like a preprocessing directive.	This rule is detected as violated when the '#' character appears in a macro argument (outside a string or character constant).
Rule 20.7	Required	Required	Expressions resulting from the expansion of macro parameters shall be enclosed in parentheses	Expanded macro parameter 'XX' shall be enclosed in parentheses.	
Rule 20.8	Required	Advisory	The controlling expression of a #if or #elif preprocessing directive shall evaluate to 0 or 1	The controlling expression of a #if or #elif preprocessing directive shall evaluate to 0 or 1.	
Rule 20.9	Required	Required	All identifiers used in the controlling expression of #if or #elif preprocessing directives shall be #define'd before evaluation	'XX*s' is not defined.	
Rule 20.10	Advisory	Advisory	The# and ## preprocessor operators should not be used	The # and ## preprocessor operators should not be used.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 20.11	Required	Required	A macro parameter immediately following a # operator shall not immediately be followed by a ## operator	The ## preprocessor operator shall not follow a macro parameter following a # preprocessor operator.	
Rule 20.12	Required	Required	A macro parameter used as an operand to the # or ## operators, which is itself subject to further macro replacement, shall only be used as an operand to these operators	Expanded macro parameter 'XX' is also an operand of 'YY' operator.	
Rule 20.13	Required	Required	A line whose first token is # shall be a valid preprocessing directive	Directive is not syntactically meaningful.	

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 20.14	Required	Required	All #else, #elif and #endif preprocessor directives shall reside in the same file as the #if, #ifdef or #ifndef directive to which they are related	• '#else' not within a conditional. • '#elsif' not within a conditional. • '#endif' not within a conditional. unterminated conditional directive.	

Standard Libraries

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 21.1	Required	Required	#define and #undef shall not be used on a reserved identifier or reserved macro name	The macro 'XX' shall not be redefined. The macro 'XX' shall not be undefined. The macro 'XX' shall not be defined.	
Rule 21.2	Required	Required	A reserved identifier or macro name shall not be declared	Identifier 'XX' shall not be reused.	In case a macro whose name corresponds to a standard library macro, object, or function is defined, the rule that is detected as violated is 21.1. Tentative definitions

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
					are considered as definitions.
Rule 21.3	Required	Required	The memory allocation and deallocation functions of <stdlib.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case the dynamic heap memory allocation functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.
Rule 21.4	Required	Required	The standard header file <setjmp.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case the longjmp function is actually a macro, and the macro is expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.
Rule 21.5	Required	Required	The standard header file <signal.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case some of the signal functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 21.6	Required	Required	The Standard Library input/ output functions shall not be used	The macro '<name> shall not be used. Identifier XX should not be used.	In case the input/ output library functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.
Rule 21.7	Required	Required	The atof, atoi, atol, and atoll functions of <stdlib.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case the atof, atoi, atol, and atoll functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.
Rule 21.8	Required	Required	The library functions abort, exit, getenv and system of <stdlib.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case the abort, exit, getenv, and system functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.
Rule 21.9	Required	Required	The library functions bsearch and qsort of <stdlib.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case the bsearch and qsort functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.

Rule Number	Category	AGC Category	Definition	Messages in report file	Polyspace Specification
Rule 21.10	Required	Required	The Standard Library time and date functions shall not be used	The macro '<name> shall not be used. Identifier XX should not be used.	In case the time handling functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.
Rule 21.11	Required	Required	The standard header file <tgmath.h> shall not be used.	The macro '<name> shall not be used. Identifier XX should not be used.	In case some of the type generic math functions are actually macros, and the macros are expanded in the code, this rule is detected as violated. It is assumed that rule 21.2 is not violated.

MISRA C:2012 Guidelines Not Checked

The Polyspace coding rules checker does not check the following MISRA C:2012 coding rules. These rules cannot be enforced because they are outside the scope of Polyspace software. These guidelines concern documentation, dynamic aspects, or functional aspects of MISRA rules.

Directive Number	Category	AGC Category	Definition
Dir 1.1	Required	Required	Any implementation-defined behavior on which the output of the program depends shall be documented and understood
Dir 3.1	Required	Required	All code shall be traceable to documented requirements
Dir 4.2	Advisory	Advisory	All usage of assembly language should be documented

Directive Number	Category	AGC Category	Definition
Dir 4.4	Advisory	Advisory	Sections of code should not be “commented out”
Dir 4.7	Required	Required	If a function returns error information, then that error information shall be tested
Dir 2.1	Required	Required	All source files shall compile without any compilation errors
Dir 4.12	Required	Required	Dynamic memory allocation shall not be used
Dir 4.13	Advisory	Advisory	Functions which are designed to provide operations on a resource should be called in an appropriate sequence
Dir 4.5	Advisory	Readability	Identifiers in the same name space with overlapping visibility should be typographically unambiguous
Dir 4.8	Advisory	Advisory	If a pointer to a structure or union is never dereferenced within a translation unit, then the implementation of the object should be hidden
Rule 17.5	Advisory	Readability	The function argument corresponding to a parameter declared to have an array type shall have an appropriate number of elements
Rule 17.8	Advisory	Readability	A function parameter should not be modified
Rule 2.6	Advisory	Readability	A function should not contain unused label declarations
Rule 2.7	Advisory	Readability	There should be no unused parameters in functions
Rule 21.12	Advisory	Advisory	The exception handling features of <fenv.h> should not be used.
Rule 22.1	Required	Required	All resources obtained dynamically by means of Standard Library functions shall be explicitly released
Rule 22.2	Mandatory	Mandatory	A block of memory shall only be freed if it was allocated by means of a Standard Library function

Directive Number	Category	AGC Category	Definition
Rule 22.3	Required	Required	The same file shall not be open for read and write access at the same time on different streams
Rule 22.4	Mandatory	Mandatory	There shall be no attempt to write to a stream which has been opened as read only
Rule 22.5	Mandatory	Mandatory	A pointer to a FILE object shall not be dereferenced
Rule 22.6	Mandatory	Mandatory	The value of a pointer to a FILE shall not be used after the associated stream has been closed

Polyspace MISRA C++ Checker

The Polyspace MISRA C++ checker helps you comply with theMISRA C++:2008 coding standard.[5]

When MISRA C++ rules are violated, the Polyspace MISRA C++ checker enables Polyspace software to provide messages with information about the rule violations. Most messages are reported during the compile phase of an analysis. The MISRA C++ checker can check 185 of the 228 MISRA C++ coding rules.

There are subsets of MISRA C++ coding rules that can have a direct or indirect impact on the selectivity (reliability percentage) of your results. When you set up rule checking, you can select these subsets directly. These subsets are defined in “Software Quality Objective Subsets (C++)” on page 12-103.

Note: The Polyspace MISRA C++ checker is based on MISRA C++:2008 – “Guidelines for the use of the C++ language in critical systems." For more information on these coding standards, see http://www.misra-cpp.com.

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5. MISRA is a registered trademark of MISRA Ltd., held on behalf of the MISRA Consortium.

Software Quality Objective Subsets (C++)

In this section...

SQO Subset 1 – Direct Impact on Selectivity

The following set of coding rules will typically improve the selectivity of your results.

MISRA C++ Rule	Description
2-10-2	Identifiers declared in an inner scope shall not hide an identifier declared in an outer scope.
3-1-3	When an array is declared, its size shall either be stated explicitly or defined implicitly by initialization.
3-3-2	The One Definition Rule shall not be violated.
3-9-3	The underlying bit representations of floating-point values shall not be used.
5-0-15	Array indexing shall be the only form of pointer arithmetic.
5-0-18	>, >=, <, <= shall not be applied to objects of pointer type, except where they point to the same array.
5-0-19	The declaration of objects shall contain no more than two levels of pointer indirection.
5-2-8	An object with integer type or pointer to void type shall not be converted to an object with pointer type.
5-2-9	A cast should not convert a pointer type to an integral type.
6-2-2	Floating-point expressions shall not be directly or indirectly tested for equality or inequality.
6-5-1	A for loop shall contain a single loop-counter which shall not have floating type.
6-5-2	If loop-counter is not modified by -- or ++, then, within condition, the loop-counter shall only be used as an operand to <=, <, > or >=.
6-5-3	The loop-counter shall not be modified within condition or statement.
6-5-4	The loop-counter shall be modified by one of: --, ++, -=n, or +=n ; where n remains constant for the duration of the loop.

MISRA C++ Rule	Description
6-6-1	Any label referenced by a goto statement shall be declared in the same block, or in a block enclosing the goto statement.
6-6-2	The goto statement shall jump to a label declared later in the same function body.
6-6-4	For any iteration statement there shall be no more than one break or goto statement used for loop termination.
6-6-5	A function shall have a single point of exit at the end of the function.
7-5-1	A function shall not return a reference or a pointer to an automatic variable (including parameters), defined within the function.
7-5-2	The address of an object with automatic storage shall not be assigned to another object that may persist after the first object has ceased to exist.
7-5-4	Functions should not call themselves, either directly or indirectly.
8-4-1	Functions shall not be defined using the ellipsis notation.
9-5-1	Unions shall not be used.
10-1-2	A base class shall only be declared virtual if it is used in a diamond hierarchy.
10-1-3	An accessible base class shall not be both virtual and nonvirtual in the same hierarchy.
10-3-1	There shall be no more than one definition of each virtual function on each path through the inheritance hierarchy.
10-3-2	Each overriding virtual function shall be declared with the virtual keyword.
10-3-3	A virtual function shall only be overridden by a pure virtual function if it is itself declared as pure virtual.
15-0-3	Control shall not be transferred into a try or catch block using a goto or a switch statement.
15-1-3	An empty throw (throw;) shall only be used in the compound- statement of a catch handler.
15-3-3	Handlers of a function-try-block implementation of a class constructor or destructor shall not reference non-static members from this class or its bases.
15-3-5	A class type exception shall always be caught by reference.

MISRA C++ Rule	Description
15-3-6	Where multiple handlers are provided in a single try-catch statement or function-try-block for a derived class and some or all of its bases, the handlers shall be ordered most-derived to base class.
15-3-7	Where multiple handlers are provided in a single try-catch statement or function-try-block, any ellipsis (catch-all) handler shall occur last.
15-4-1	If a function is declared with an exception-specification, then all declarations of the same function (in other translation units) shall be declared with the same set of type-ids.
15-5-1	A class destructor shall not exit with an exception.
15-5-2	Where a function's declaration includes an exception-specification, the function shall only be capable of throwing exceptions of the indicated type(s).
18-4-1	Dynamic heap memory allocation shall not be used.

SQO Subset 2 – Indirect Impact on Selectivity

Good design practices generally lead to less code complexity, which can improve the selectivity of your results. The following set of coding rules may help to address design issues that impact selectivity. The `SQO-subset2` option checks the rules in `SQO-subset1` and `SQO-subset2`.

MISRA C++ Rule	Description
2-10-2	Identifiers declared in an inner scope shall not hide an identifier declared in an outer scope.
3-1-3	When an array is declared, its size shall either be stated explicitly or defined implicitly by initialization.
3-3-2	If a function has internal linkage then all re-declarations shall include the static storage class specifier.
3-4-1	An identifier declared to be an object or type shall be defined in a block that minimizes its visibility.
3-9-2	typedefs that indicate size and signedness should be used in place of the basic numerical types.
3-9-3	The underlying bit representations of floating-point values shall not be used.
4-5-1	Expressions with type bool shall not be used as operands to built-in operators other than the assignment operator =, the logical operators &&, `||`, !, the

MISRA C++ Rule	Description
	equality operators == and !=, the unary & operator, and the conditional operator.
5-0-1	The value of an expression shall be the same under any order of evaluation that the standard permits.
5-0-2	Limited dependence should be placed on C++ operator precedence rules in expressions.
5-0-7	There shall be no explicit floating-integral conversions of a cvalue expression.
5-0-8	An explicit integral or floating-point conversion shall not increase the size of the underlying type of a cvalue expression.
5-0-9	An explicit integral conversion shall not change the signedness of the underlying type of a cvalue expression.
5-0-10	If the bitwise operators ~ and << are applied to an operand with an underlying type of unsigned char or unsigned short, the result shall be immediately cast to the underlying type of the operand.
5-0-13	
5-0-15	Array indexing shall be the only form of pointer arithmetic.
5-0-18	>, >=, <, <= shall not be applied to objects of pointer type, except where they point to the same array.
5-0-19	The declaration of objects shall contain no more than two levels of pointer indirection.
5-2-1	Each operand of a logical && or || shall be a postfix - expression.
5-2-2	A pointer to a virtual base class shall only be cast to a pointer to a derived class by means of dynamic_cast.
5-2-5	A cast shall not remove any const or volatile qualification from the type of a pointer or reference.
5-2-6	A cast shall not convert a pointer to a function to any other pointer type, including a pointer to function type.
5-2-7	An object with pointer type shall not be converted to an unrelated pointer type, either directly or indirectly.
5-2-8	An object with integer type or pointer to void type shall not be converted to an object with pointer type.
5-2-9	A cast should not convert a pointer type to an integral type.

MISRA C++ Rule	Description
5-2-11	The comma operator, && operator and the || operator shall not be overloaded.
5-3-2	The unary minus operator shall not be applied to an expression whose underlying type is unsigned.
5-3-3	The unary & operator shall not be overloaded.
5-18-1	The comma operator shall not be used.
6-2-1	Assignment operators shall not be used in sub-expressions.
6-2-2	Floating-point expressions shall not be directly or indirectly tested for equality or inequality.
6-3-1	The statement forming the body of a switch, while, do ... while or for statement shall be a compound statement.
6-4-2	All if ... else if constructs shall be terminated with an else clause.
6-4-6	The final clause of a switch statement shall be the default-clause.
6-5-1	A for loop shall contain a single loop-counter which shall not have floating type.
6-5-2	If loop-counter is not modified by -- or ++, then, within condition, the loop-counter shall only be used as an operand to <=, <, > or >=.
6-5-3	The loop-counter shall not be modified within condition or statement.
6-5-4	The loop-counter shall be modified by one of: --, ++, -=n, or +=n ; where n remains constant for the duration of the loop.
6-6-1	Any label referenced by a goto statement shall be declared in the same block, or in a block enclosing the goto statement.
6-6-2	The goto statement shall jump to a label declared later in the same function body.
6-6-4	For any iteration statement there shall be no more than one break or goto statement used for loop termination.
6-6-5	A function shall have a single point of exit at the end of the function.
7-5-1	A function shall not return a reference or a pointer to an automatic variable (including parameters), defined within the function.
7-5-2	The address of an object with automatic storage shall not be assigned to another object that may persist after the first object has ceased to exist.

MISRA C++ Rule	Description
7-5-4	Functions should not call themselves, either directly or indirectly.
8-4-1	Functions shall not be defined using the ellipsis notation.
8-4-3	All exit paths from a function with non- void return type shall have an explicit return statement with an expression.
8-4-4	A function identifier shall either be used to call the function or it shall be preceded by &.
8-5-2	Braces shall be used to indicate and match the structure in the non- zero initialization of arrays and structures.
8-5-3	In an enumerator list, the = construct shall not be used to explicitly initialize members other than the first, unless all items are explicitly initialized.
10-1-2	A base class shall only be declared virtual if it is used in a diamond hierarchy.
10-1-3	An accessible base class shall not be both virtual and nonvirtual in the same hierarchy.
10-3-1	There shall be no more than one definition of each virtual function on each path through the inheritance hierarchy.
10-3-2	Each overriding virtual function shall be declared with the virtual keyword.
10-3-3	A virtual function shall only be overridden by a pure virtual function if it is itself declared as pure virtual.
11-0-1	Member data in non- POD class types shall be private.
12-1-1	An object's dynamic type shall not be used from the body of its constructor or destructor.
12-8-2	The copy assignment operator shall be declared protected or private in an abstract class.
15-0-3	Control shall not be transferred into a try or catch block using a goto or a switch statement.
15-1-3	An empty throw (throw;) shall only be used in the compound- statement of a catch handler.
15-3-3	Handlers of a function-try-block implementation of a class constructor or destructor shall not reference non-static members from this class or its bases.
15-3-5	A class type exception shall always be caught by reference.

MISRA C++ Rule	Description
15-3-6	Where multiple handlers are provided in a single try-catch statement or function-try-block for a derived class and some or all of its bases, the handlers shall be ordered most-derived to base class.
15-3-7	Where multiple handlers are provided in a single try-catch statement or function-try-block, any ellipsis (catch-all) handler shall occur last.
15-4-1	If a function is declared with an exception-specification, then all declarations of the same function (in other translation units) shall be declared with the same set of type-ids.
15-5-1	A class destructor shall not exit with an exception.
15-5-2	Where a function's declaration includes an exception-specification, the function shall only be capable of throwing exceptions of the indicated type(s).
16-0-5	Arguments to a function-like macro shall not contain tokens that look like preprocessing directives.
16-0-6	In the definition of a function-like macro, each instance of a parameter shall be enclosed in parentheses, unless it is used as the operand of # or ##.
16-0-7	Undefined macro identifiers shall not be used in #if or #elif preprocessor directives, except as operands to the defined operator.
16-2-2	C++ macros shall only be used for: include guards, type qualifiers, or storage class specifiers.
16-3-1	There shall be at most one occurrence of the # or ## operators in a single macro definition.
18-4-1	Dynamic heap memory allocation shall not be used.

MISRA C++ Coding Rules

In this section...

Supported MISRA C++ Coding Rules

Language Independent Issues

N.	MISRA Definition	Polyspace Specification
0-1-1	A project shall not contain unreachable code.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
0-1-2	A project shall not contain infeasible paths.	
0-1-7	The value returned by a function having a non- void return type that is not an overloaded operator shall always be used.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
0-1-10	Every defined function shall be called at least once.	Detects if static functions are not called in their translation unit. Other cases are detected by the software.

General

N.	MISRA Definition	Polyspace Specification
1-0-1	All code shall conform to ISO/IEC 14882:2003 "The C++ Standard Incorporating Technical Corrigendum 1".	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

Lexical Conventions

N.	MISRA Definition	Polyspace Specification
2-3-1	Trigraphs shall not be used.	
2-5-1	Digraphs should not be used.	
2-7-1	The character sequence /* shall not be used within a C-style comment.	This rule cannot be annotated in the source code.
2-10-1	Different identifiers shall be typographically unambiguous.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
2-10-2	Identifiers declared in an inner scope shall not hide an identifier declared in an outer scope.	No detection for logical scopes: fields or member functions hiding outer scopes identifiers or hiding ancestors members.

N.	MISRA Definition	Polyspace Specification
		Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
2-10-3	A typedef name (including qualification, if any) shall be a unique identifier.	No detection across namespaces. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
2-10-4	A class, union or enum name (including qualification, if any) shall be a unique identifier.	No detection across namespaces. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
2-10-5	The identifier name of a non-member object or function with static storage duration should not be reused.	For functions the detection is only on the definition where there is a declaration. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
2-10-6	If an identifier refers to a type, it shall not also refer to an object or a function in the same scope.	If the identifier is a function and the function is both declared and defined then the violation is reported only once. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
2-13-1	Only those escape sequences that are defined in ISO/IEC 14882:2003 shall be used.	
2-13-2	Octal constants (other than zero) and octal escape sequences (other than "\0") shall not be used.	
2-13-3	A "U" suffix shall be applied to all octal or hexadecimal integer literals of unsigned type.	
2-13-4	Literal suffixes shall be upper case.	

N.	MISRA Definition	Polyspace Specification
2-13-5	Narrow and wide string literals shall not be concatenated.	

Basic Concepts

N.	MISRA Definition	Polyspace Specification
3-1-1	It shall be possible to include any header file in multiple translation units without violating the One Definition Rule.	
3-1-2	Functions shall not be declared at block scope.	
3-1-3	When an array is declared, its size shall either be stated explicitly or defined implicitly by initialization.	
3-2-1	All declarations of an object or function shall have compatible types.	
3-2-2	The One Definition Rule shall not be violated.	Report type, template, and inline function defined in source file
3-2-3	A type, object or function that is used in multiple translation units shall be declared in one and only one file.	
3-2-4	An identifier with external linkage shall have exactly one definition.	
3-3-1	Objects or functions with external linkage shall be declared in a header file.	
3-3-2	If a function has internal linkage then all re-declarations shall include the static storage class specifier.	
3-4-1	An identifier declared to be an object or type shall be defined in a block that minimizes its visibility.	
3-9-1	The types used for an object, a function return type, or a function parameter	Comparison is done between current declaration and last seen declaration.

N.	MISRA Definition	Polyspace Specification
	shall be token-for-token identical in all declarations and re-declarations.	
3-9-2	typedefs that indicate size and signedness should be used in place of the basic numerical types.	No detection in non-instantiated templates.
3-9-3	The underlying bit representations of floating-point values shall not be used.	

Standard Conversions

N.	MISRA Definition	Polyspace Specification
4-5-1	Expressions with type bool shall not be used as operands to built-in operators other than the assignment operator =, the logical operators &&, ||, !, the equality operators == and !=, the unary & operator, and the conditional operator.	
4-5-2	Expressions with type enum shall not be used as operands to built- in operators other than the subscript operator [ ], the assignment operator =, the equality operators == and !=, the unary & operator, and the relational operators <, <=, >, >=.	
4-5-3	Expressions with type (plain) char and wchar_t shall not be used as operands to built-in operators other than the assignment operator =, the equality operators == and !=, and the unary & operator. N	

Expressions

N.	MISRA Definition	Polyspace Specification
5-0-1	The value of an expression shall be the same under any order of evaluation that the standard permits.	

N.	MISRA Definition	Polyspace Specification
5-0-2	Limited dependence should be placed on C++ operator precedence rules in expressions.	
5-0-3	A cvalue expression shall not be implicitly converted to a different underlying type.	Assumes that `ptrdiff_t` is signed integer
5-0-4	An implicit integral conversion shall not change the signedness of the underlying type.	Assumes that `ptrdiff_t` is signed integer If the conversion is to a narrower integer with a different sign then MISRA C++ 5-0-4 takes precedence over MISRA C++ 5-0-6.
5-0-5	There shall be no implicit floating-integral conversions.	This rule takes precedence over 5-0-4 and 5-0-6 if they apply at the same time.
5-0-6	An implicit integral or floating-point conversion shall not reduce the size of the underlying type.	If the conversion is to a narrower integer with a different sign then MISRA C++ 5-0-4 takes precedence over MISRA C++ 5-0-6.
5-0-7	There shall be no explicit floating-integral conversions of a cvalue expression.	
5-0-8	An explicit integral or floating-point conversion shall not increase the size of the underlying type of a cvalue expression.	
5-0-9	An explicit integral conversion shall not change the signedness of the underlying type of a cvalue expression.	
5-0-10	If the bitwise operators ~ and << are applied to an operand with an underlying type of unsigned char or unsigned short, the result shall be immediately cast to the underlying type of the operand.	
5-0-11	The plain char type shall only be used for the storage and use of character values.	For numeric data, use a type which has explicit signedness.
5-0-12	Signed char and unsigned char type shall only be used for the storage and use of numeric values.	
5-0-14	The first operand of a conditional-operator shall have type bool.	

<table>
<tr><th>N.</th><th>MISRA Definition</th><th>Polyspace Specification</th></tr>
<tr><td>5-0-15</td><td>Array indexing shall be the only form of pointer arithmetic.</td><td>Warning on operations on pointers. (p+I, I+p and p-I, where p is a pointer and I an integer, p[i] accepted).</td></tr>
<tr><td>5-0-18</td><td>>, >=, <, <= shall not be applied to objects of pointer type, except where they point to the same array.</td><td>Report when relational operator are used on pointers types (casts ignored).</td></tr>
<tr><td>5-0-19</td><td>The declaration of objects shall contain no more than two levels of pointer indirection.</td><td></td></tr>
<tr><td>5-0-20</td><td>Non-constant operands to a binary bitwise operator shall have the same underlying type.</td><td></td></tr>
<tr><td>5-0-21</td><td>Bitwise operators shall only be applied to operands of unsigned underlying type.</td><td></td></tr>
<tr><td>5-2-1</td><td>Each operand of a logical && or || shall be a postfix - expression.</td><td>During preprocessing, violations of this rule are detected on the expressions in #if directives. Allowed exception on associativity (a && b && c), (a || b || c).</td></tr>
<tr><td>5-2-2</td><td>A pointer to a virtual base class shall only be cast to a pointer to a derived class by means of dynamic_cast.</td><td></td></tr>
<tr><td>5-2-3</td><td>Casts from a base class to a derived class should not be performed on polymorphic types.</td><td></td></tr>
<tr><td>5-2-4</td><td>C-style casts (other than void casts) and functional notation casts (other than explicit constructor calls) shall not be used.</td><td></td></tr>
<tr><td>5-2-5</td><td>A cast shall not remove any const or volatile qualification from the type of a pointer or reference.</td><td></td></tr>
<tr><td>5-2-6</td><td>A cast shall not convert a pointer to a function to any other pointer type, including a pointer to function type.</td><td>No violation if pointer types of operand and target are identical.</td></tr>
</table>

N.	MISRA Definition	Polyspace Specification
5-2-7	An object with pointer type shall not be converted to an unrelated pointer type, either directly or indirectly.	"Extended to all pointer conversions including between pointer to struct object and pointer to type of the first member of the struct type. Indirect conversions through non-pointer type (e.g. int) are not detected."
5-2-8	An object with integer type or pointer to void type shall not be converted to an object with pointer type.	Exception on zero constants. Objects with pointer type include objects with pointer to function type.
5-2-9	A cast should not convert a pointer type to an integral type.	
5-2-10	The increment (++) and decrement (--) operators should not be mixed with other operators in an expression.	
5-2-11	The comma operator, && operator and the || operator shall not be overloaded.	
5-2-12	An identifier with array type passed as a function argument shall not decay to a pointer.	
5-3-1	Each operand of the ! operator, the logical && or the logical || operators shall have type bool.	
5-3-2	The unary minus operator shall not be applied to an expression whose underlying type is unsigned.	
5-3-3	The unary & operator shall not be overloaded.	
5-3-4	Evaluation of the operand to the sizeof operator shall not contain side effects.	No warning on volatile accesses and function calls
5-8-1	The right hand operand of a shift operator shall lie between zero and one less than the width in bits of the underlying type of the left hand operand.	

N.	MISRA Definition	Polyspace Specification
5-14-1	The right hand operand of a logical && or || operator shall not contain side effects.	No warning on volatile accesses and function calls.
5-18-1	The comma operator shall not be used.	
5-19-1	Evaluation of constant unsigned integer expressions should not lead to wrap-around.	

Statements

N.	MISRA Definition	Polyspace Specification
6-2-1	Assignment operators shall not be used in sub-expressions.	
6-2-2	Floating-point expressions shall not be directly or indirectly tested for equality or inequality.	
6-2-3	Before preprocessing, a null statement shall only occur on a line by itself; it may be followed by a comment, provided that the first character following the null statement is a white - space character.	
6-3-1	The statement forming the body of a switch, while, do ... while or for statement shall be a compound statement.	
6-4-1	An if (condition) construct shall be followed by a compound statement. The else keyword shall be followed by either a compound statement, or another if statement.	
6-4-2	All if ... else if constructs shall be terminated with an else clause.	Also detects cases where the last `if` is in the block of the last `else` (same behavior as JSF, stricter than MISRA C). Example: "`if` ... `else` { `if` ...{}}" raises the rule

N.	MISRA Definition	Polyspace Specification
6-4-3	A switch statement shall be a well-formed switch statement.	Return statements are considered as jump statements.
6-4-4	A switch-label shall only be used when the most closely-enclosing compound statement is the body of a switch statement.	
6-4-5	An unconditional throw or break statement shall terminate every non - empty switch-clause.	
6-4-6	The final clause of a switch statement shall be the default-clause.	
6-4-7	The condition of a switch statement shall not have bool type.	
6-4-8	Every switch statement shall have at least one case-clause.	
6-5-1	A for loop shall contain a single loop-counter which shall not have floating type.	
6-5-2	If loop-counter is not modified by -- or ++, then, within condition, the loop-counter shall only be used as an operand to <=, <, > or >=.	
6-5-3	The loop-counter shall not be modified within condition or statement.	Detect only direct assignments if for_index is known (see 6-5-1).
6-5-4	The loop-counter shall be modified by one of: --, ++, -=n, or +=n ; where n remains constant for the duration of the loop.	
6-5-5	A loop-control-variable other than the loop-counter shall not be modified within condition or expression.	
6-5-6	A loop-control-variable other than the loop-counter which is modified in statement shall have type bool.	

N.	MISRA Definition	Polyspace Specification
6-6-1	Any label referenced by a goto statement shall be declared in the same block, or in a block enclosing the goto statement.	
6-6-2	The goto statement shall jump to a label declared later in the same function body.	
6-6-3	The continue statement shall only be used within a well-formed for loop.	Assumes 6.5.1 to 6.5.6: so it is implemented only for supported 6_5_x rules.
6-6-4	For any iteration statement there shall be no more than one break or goto statement used for loop termination.	
6-6-5	A function shall have a single point of exit at the end of the function.	At most one return not necessarily as last statement for void functions.

Declarations

N.	MISRA Definition	Polyspace Specification
7-3-1	The global namespace shall only contain main, namespace declarations and extern "C" declarations.	
7-3-2	The identifier main shall not be used for a function other than the global function main.	
7-3-3	There shall be no unnamed namespaces in header files.	
7-3-4	using-directives shall not be used.	
7-3-5	Multiple declarations for an identifier in the same namespace shall not straddle a using-declaration for that identifier.	
7-3-6	using-directives and using-declarations (excluding class scope or function scope using-declarations) shall not be used in header files.	

N.	MISRA Definition	Polyspace Specification
7-4-2	Assembler instructions shall only be introduced using the asm declaration.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
7-4-3	Assembly language shall be encapsulated and isolated.	
7-5-1	A function shall not return a reference or a pointer to an automatic variable (including parameters), defined within the function.	
7-5-2	The address of an object with automatic storage shall not be assigned to another object that may persist after the first object has ceased to exist.	
7-5-3	A function shall not return a reference or a pointer to a parameter that is passed by reference or const reference.	
7-5-4	Functions should not call themselves, either directly or indirectly.	

Declarators

N.	MISRA Definition	Polyspace Specification
8-0-1	An init-declarator-list or a member-declarator-list shall consist of a single init-declarator or member-declarator respectively.	
8-3-1	Parameters in an overriding virtual function shall either use the same default arguments as the function they override, or else shall not specify any default arguments.	
8-4-1	Functions shall not be defined using the ellipsis notation.	
8-4-2	The identifiers used for the parameters in a re-declaration of a function shall be identical to those in the declaration.	

N.	MISRA Definition	Polyspace Specification
8-4-3	All exit paths from a function with non-void return type shall have an explicit return statement with an expression.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
8-4-4	A function identifier shall either be used to call the function or it shall be preceded by &.	
8-5-1	All variables shall have a defined value before they are used.	Non-initialized variable in results and error messages for obvious cases
8-5-2	Braces shall be used to indicate and match the structure in the non- zero initialization of arrays and structures.	
8-5-3	In an enumerator list, the = construct shall not be used to explicitly initialize members other than the first, unless all items are explicitly initialized.	

Classes

N.	MISRA Definition	Polyspace Specification
9-3-1	const member functions shall not return non-const pointers or references to class-data.	Class-data for a class is restricted to all non-static member data.
9-3-2	Member functions shall not return non-const handles to class-data.	Class-data for a class is restricted to all non-static member data.
9-5-1	Unions shall not be used.	
9-6-2	Bit-fields shall be either bool type or an explicitly unsigned or signed integral type.	
9-6-3	Bit-fields shall not have enum type.	
9-6-4	Named bit-fields with signed integer type shall have a length of more than one bit.	

Derived Classes

N.	MISRA Definition	Polyspace Specification
10-1-1	Classes should not be derived from virtual bases.	
10-1-2	A base class shall only be declared virtual if it is used in a diamond hierarchy.	Assumes 10.1.1 not required
10-1-3	An accessible base class shall not be both virtual and nonvirtual in the same hierarchy.	
10-2-1	All accessible entity names within a multiple inheritance hierarchy should be unique.	No detection between entities of different kinds (member functions against data members, ...).
10-3-1	There shall be no more than one definition of each virtual function on each path through the inheritance hierarchy.	Member functions that are virtual by inheritance are also detected.
10-3-2	Each overriding virtual function shall be declared with the virtual keyword.	
10-3-3	A virtual function shall only be overridden by a pure virtual function if it is itself declared as pure virtual.	

Member Access Control

N.	MISRA Definition	Polyspace Specification
11-0-1	Member data in non- POD class types shall be private.	

Special Member Functions

N.	MISRA Definition	Polyspace Specification
12-1-1	An object's dynamic type shall not be used from the body of its constructor or destructor.	
12-1-2	All constructors of a class should explicitly call a constructor for all of its immediate base classes and all virtual base classes.	

N.	MISRA Definition	Polyspace Specification
12-1-3	All constructors that are callable with a single argument of fundamental type shall be declared explicit.	
12-8-1	A copy constructor shall only initialize its base classes and the non- static members of the class of which it is a member.	
12-8-2	The copy assignment operator shall be declared protected or private in an abstract class.	

Templates

N.	MISRA Definition	Polyspace Specification
14-5-2	A copy constructor shall be declared when there is a template constructor with a single parameter that is a generic parameter.	
14-5-3	A copy assignment operator shall be declared when there is a template assignment operator with a parameter that is a generic parameter.	
14-6-1	In a class template with a dependent base, any name that may be found in that dependent base shall be referred to using a qualified-id or this->	
14-6-2	The function chosen by overload resolution shall resolve to a function declared previously in the translation unit.	
14-7-3	All partial and explicit specializations for a template shall be declared in the same file as the declaration of their primary template.	
14-8-1	Overloaded function templates shall not be explicitly specialized.	All specializations of overloaded templates are rejected even if overloading occurs after the call.

N.	MISRA Definition	Polyspace Specification
		Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
14-8-2	The viable function set for a function call should either contain no function specializations, or only contain function specializations.	

Exception Handling

N.	MISRA Definition	Polyspace Specification
15-0-2	An exception object should not have pointer type.	NULL not detected (see 15-1-2).
15-0-3	Control shall not be transferred into a try or catch block using a goto or a switch statement.	
15-1-2	NULL shall not be thrown explicitly.	
15-1-3	An empty throw (throw;) shall only be used in the compound- statement of a catch handler.	
15-3-2	There should be at least one exception handler to catch all otherwise unhandled exceptions.	Detect that there is no try/catch in the main and that the catch does not handle all exceptions. Not detected if no "main". Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
15-3-3	Handlers of a function-try-block implementation of a class constructor or destructor shall not reference non-static members from this class or its bases.	
15-3-5	A class type exception shall always be caught by reference.	
15-3-6	Where multiple handlers are provided in a single try-catch statement or function-try-block for a derived class and some or all	

N.	MISRA Definition	Polyspace Specification
	of its bases, the handlers shall be ordered most-derived to base class.	
15-3-7	Where multiple handlers are provided in a single try-catch statement or function-try-block, any ellipsis (catch-all) handler shall occur last.	
15-4-1	If a function is declared with an exception-specification, then all declarations of the same function (in other translation units) shall be declared with the same set of type-ids.	
15-5-1	A class destructor shall not exit with an exception.	Limit detection to throw and catch that are internals to the destructor; rethrows are partially processed; no detections in nested handlers.
15-5-2	Where a function's declaration includes an exception-specification, the function shall only be capable of throwing exceptions of the indicated type(s).	Limit detection to throw that are internals to the function; rethrows are partially processed; no detections in nested handlers.

Preprocessing Directives

N.	MISRA Definition	Polyspace Specification
16-0-1	#include directives in a file shall only be preceded by other preprocessor directives or comments.	
16-0-2	Macros shall only be #define 'd or #undef 'd in the global namespace.	
16-0-3	#undef shall not be used.	
16-0-4	Function-like macros shall not be defined.	
16-0-5	Arguments to a function-like macro shall not contain tokens that look like preprocessing directives.	
16-0-6	In the definition of a function-like macro, each instance of a parameter shall be	

N.	MISRA Definition	Polyspace Specification
	enclosed in parentheses, unless it is used as the operand of # or ##.	
16-0-7	Undefined macro identifiers shall not be used in #if or #elif preprocessor directives, except as operands to the defined operator.	
16-0-8	If the # token appears as the first token on a line, then it shall be immediately followed by a preprocessing token.	
16-1-1	The defined preprocessor operator shall only be used in one of the two standard forms.	
16-1-2	All #else, #elif and #endif preprocessor directives shall reside in the same file as the #if or #ifdef directive to which they are related.	
16-2-1	The preprocessor shall only be used for file inclusion and include guards.	The rule is raised for #ifdef/#define if the file is not an include file.
16-2-2	C++ macros shall only be used for: include guards, type qualifiers, or storage class specifiers.	
16-2-3	Include guards shall be provided.	
16-2-4	The ', ", /* or // characters shall not occur in a header file name.	
16-2-5	The \ character should not occur in a header file name.	
16-2-6	The #include directive shall be followed by either a <filename> or "filename" sequence.	
16-3-1	There shall be at most one occurrence of the # or ## operators in a single macro definition.	
16-3-2	The # and ## operators should not be used.	

Library Introduction

N.	MISRA Definition	Polyspace Specification
17-0-1	Reserved identifiers, macros and functions in the standard library shall not be defined, redefined or undefined.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
17-0-2	The names of standard library macros and objects shall not be reused.	
17-0-5	The setjmp macro and the longjmp function shall not be used.	

Language Support Library

N.	MISRA Definition	Polyspace Specification
18-0-1	The C library shall not be used.	
18-0-2	The library functions atof, atoi and atol from library <cstdlib> shall not be used.	
18-0-3	The library functions abort, exit, getenv and system from library <cstdlib> shall not be used.	The option `-dialect iso` must be used to detect violations, for example, `exit`.
18-0-4	The time handling functions of library <ctime> shall not be used.	
18-0-5	The unbounded functions of library <cstring> shall not be used.	
18-2-1	The macro offsetof shall not be used.	
18-4-1	Dynamic heap memory allocation shall not be used.	
18-7-1	The signal handling facilities of <csignal> shall not be used.	

Diagnostic Library

N.	MISRA Definition	Polyspace Specification
19-3-1	The error indicator errno shall not be used.	

Input/output Library

N.	MISRA Definition	Polyspace Specification
27-0-1	The stream input/output library <cstdio> shall not be used.	

MISRA C++ Rules Not Checked

Language Independent Issues

N.	MISRA Definition	Polyspace Specification
0–1–3	A project shall not contain unused variables.	
0-1-4	A project shall not contain non-volatile POD variables having only one use.	
0-1-5	A project shall not contain unused type declarations.	
0-1-6	A project shall not contain instances of non-volatile variables being given values that are never subsequently used.	

N.	MISRA Definition	Polyspace Specification
0-1-8	All functions with void return type shall have external side effects.	
0-1-9	There shall be no dead code.	Not checked by the coding rules checker. Can be enforced through detection of dead code during analysis.
0-1-11	There shall be no unused parameters (named or unnamed) in nonvirtual functions.	
0-1-12	There shall be no unused parameters (named or unnamed) in the set of parameters for a virtual function and all the functions that override it.	
0-2-1	An object shall not be assigned to an overlapping object.	
0-3-1	Minimization of run-time failures shall be ensured by the use of at least one of: (a) static analysis tools/techniques; (b) dynamic analysis tools/techniques; (c) explicit coding of checks to handle run-time faults.	
0-3-2	If a function generates error information, then that error information shall be tested.	
0-4-1	Use of scaled-integer or fixed-point arithmetic shall be documented.	
0-4-2	Use of floating-point arithmetic shall be documented.	
0-4-3	Floating-point implementations shall comply with a defined floating-point standard.	

General

N.	MISRA Definition	Polyspace Specification
1-0-2	Multiple compilers shall only be used if they have a common, defined interface.	

N.	MISRA Definition	Polyspace Specification
1-0-3	The implementation of integer division in the chosen compiler shall be determined and documented.	

Lexical Conventions

N.	MISRA Definition	Polyspace Specification
2-2-1	The character set and the corresponding encoding shall be documented.	
2-7-2	Sections of code shall not be "commented out" using C-style comments.	
2-7-3	Sections of code should not be "commented out" using C++ comments.	

Standard Conversions

N.	MISRA Definition	Polyspace Specification
4-10-1	ULL shall not be used as an integer value.	
4-10-2	Literal zero (0) shall not be used as the null-pointer-constant.	

Expressions

N.	MISRA Definition	Polyspace Specification
5-0-13	The condition of an if-statement and the condition of an iteration- statement shall have type bool.	
5-0-16	A pointer operand and any pointer resulting from pointer arithmetic using that operand shall both address elements of the same array.	
5-0-17	Subtraction between pointers shall only be applied to pointers that address elements of the same array.	

N.	MISRA Definition	Polyspace Specification
5-17-1	The semantic equivalence between a binary operator and its assignment operator form shall be preserved.	

Declarations

N.	MISRA Definition	Polyspace Specification
7-1-1	A variable which is not modified shall be const qualified.	
7-1-2	A pointer or reference parameter in a function shall be declared as pointer to const or reference to const if the corresponding object is not modified.	
7-2-1	An expression with enum underlying type shall only have values corresponding to the enumerators of the enumeration.	
7-4-1	All usage of assembler shall be documented.	

Classes

N.	MISRA Definition	Polyspace Specification
9-3-3	If a member function can be made static then it shall be made static, otherwise if it can be made const then it shall be made const.	
9-6-1	When the absolute positioning of bits representing a bit-field is required, then the behavior and packing of bit-fields shall be documented.	

Templates

N.	MISRA Definition	Polyspace Specification
14-5-1	A non-member generic function shall only be declared in a namespace that is not an associated namespace.	

N.	MISRA Definition	Polyspace Specification
14-7-1	All class templates, function templates, class template member functions and class template static members shall be instantiated at least once.	
14-7-2	For any given template specialization, an explicit instantiation of the template with the template-arguments used in the specialization shall not render the program ill-formed.	

Exception Handling

N.	MISRA Definition	Polyspace Specification
15-0-1	Exceptions shall only be used for error handling.	
15-1-1	The assignment-expression of a throw statement shall not itself cause an exception to be thrown.	
15-3-1	Exceptions shall be raised only after start-up and before termination of the program.	
15-3-4	Each exception explicitly thrown in the code shall have a handler of a compatible type in all call paths that could lead to that point.	
15-5-3	The terminate() function shall not be called implicitly.	

Preprocessing Directives

N.	MISRA Definition	Polyspace Specification
16-6-1	All uses of the #pragma directive shall be documented.	

Library Introduction

N.	MISRA Definition	Polyspace Specification
17-0-3	The names of standard library functions shall not be overridden.	
17-0-4	All library code shall conform to MISRA C++.	

Polyspace JSF C++ Checker

The Polyspace JSF C++ checker helps you comply with the Joint Strike Fighter® Air Vehicle C++ coding standards (JSF++). These coding standards were developed by Lockheed Martin® for the Joint Strike Fighter program. They are designed to improve the robustness of C++ code, and improve maintainability.

6

When JSF++ rules are violated, the Polyspace JSF C++ checker enables Polyspace software to provide messages with information about the rule violations. Most messages are reported during the compile phase of an analysis.

Note: The Polyspace JSF C++ checker is based on JSF++:2005. For more information on these coding standards, see Joint Strike Fighter Air Vehicle C++ Coding Standards for the System Development and Demonstration Program.

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JSF C++ Coding Rules

In this section...

Supported JSF C++ Coding Rules

Code Size and Complexity

N.	JSF++ Definition	Polyspace Specification
1	Any one function (or method) **will** contain no more than 200 logical source lines of code (L-SLOCs).	Message in report file: *<function name>* has *<num>* logical source lines of code.
3	All functions **shall** have a cyclomatic complexity number of 20 or less.	Message in report file: *<function name>* has cyclomatic complexity number equal to *<num>*

Environment

N.	JSF++ Definition	Polyspace Specification
8	All code **shall** conform to ISO/IEC 14882:2002(E) standard C++.	Reports the compilation error message
9	Only those characters specified in the C++ basic source character set **will** be used.	
11	Trigraphs **will not** be used.	
12	The following digraphs **will not** be used: <%, %>, <:, :>, %:, %:%:.	Message in report file: The following digraph will not be used: *<digraph>* Reports the digraph. If the rule level is set to warning, the digraph will be allowed even if it is not supported in -dialect iso
13	Multi-byte characters and wide string literals **will not** be used.	Report L'c' and L"string" and use of wchar_t.
14	Literal suffixes **shall** use uppercase rather than lowercase letters.	
15	Provision **shall** be made for run-time checking (defensive programming).	Done with checks in the software.

Libraries

N.	JSF++ Definition	Polyspace Specification
17	The error indicator errno **shall not** be used.	errno should not be used as a macro or a global with external "C" linkage.
18	The macro offsetof, in library <stddef.h>, **shall not** be used.	offsetof should not be used as a macro or a global with external "C" linkage.
19	<locale.h> and the setlocale function **shall not** be used.	setlocale and localeconv should not be used as a macro or a global with external "C" linkage.
20	The setjmp macro and the longjmp function **shall not** be used.	setjmp and longjmp should not be used as a macro or a global with external "C" linkage.
21	The signal handling facilities of <signal.h> **shall not** be used.	signal and raise should not be used as a macro or a global with external "C" linkage.
22	The input/output library <stdio.h> **shall not** be used.	all standard functions of <stdio.h> should not be used as a macro or a global with external "C" linkage.
23	The library functions atof, atoi and atol from library <stdlib.h> **shall not** be used.	atof, atoi and atol should not be used as a macro or a global with external "C" linkage.
24	The library functions abort, exit, getenv and system from library <stdlib.h> **shall not** be used.	abort, exit, getenv and system should not be used as a macro or a global with external "C" linkage.
25	The time handling functions of library <time.h> **shall not** be used.	clock, difftime, mktime, asctime, ctime, gmtime, localtime and strftime should not be used as a macro or a global with external "C" linkage.

Pre-Processing Directives

N.	JSF++ Definition	Polyspace Specification
26	Only the following preprocessor directives **shall** be used: #ifndef, #define, #endif, #include.	

N.	JSF++ Definition	Polyspace Specification
27	`#ifndef`, `#define` and `#endif` **will** be used to prevent multiple inclusions of the same header file. Other techniques to prevent the multiple inclusions of header files **will not** be used.	Detects the patterns `#if !defined`, `#pragma once`, `#ifdef`, and missing `#define`.
28	The `#ifndef` and `#endif` preprocessor directives **will** only be used as defined in AV Rule 27 to prevent multiple inclusions of the same header file.	Detects any use that does not comply with AV Rule 27. Assuming 35/27 is not violated, reports only `#ifndef`.
29	The `#define` preprocessor directive **shall not** be used to create inline macros. Inline functions shall be used instead.	Rule is split into two parts: the definition of a macro function (29.def) and the call of a macrofunction (29.use). Messages in report file: • `29.1 : The #define preprocessor directive shall not be used to create inline macros.` • `29.2 : Inline functions shall be used intead of inline macros`
30	The `#define` preprocessor directive **shall not** be used to define constant values. Instead, the `const` qualifier **shall** be applied to variable declarations to specify constant values.	Reports `#define` of simple constants.
31	The `#define` preprocessor directive **will** only be used as part of the technique to prevent multiple inclusions of the same header file.	Detects use of `#define` that are not used to guard for multiple inclusion, assuming that rules 35 and 27 are not violated.
32	The `#include` preprocessor directive **will** only be used to include header (*.h) files.	

Header Files

N.	JSF++ Definition	Polyspace Specification
33	The `#include` directive **shall** use the `<filename.h>` notation to include header files.	
35	A header file **will** contain a mechanism that prevents multiple inclusions of itself.	
39	Header files (`*.h`) **will not** contain non-const variable definitions or function definitions.	Reports definitions of global variables / function in header.

Style

N.	JSF++ Definition	Polyspace Specification
40	Every implementation file shall include the header files that uniquely define the inline functions, types, and templates used.	Reports when type, template, or inline function is defined in source file. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
41	Source lines **will** be kept to a length of 120 characters or less.	
42	Each expression-statement **will** be on a separate line.	Reports when two consecutive expression statements are on the same line.
43	Tabs **should** be avoided.	
44	All indentations will be at least two spaces and be consistent within the same source file.	Reports when a statement indentation is not at least two spaces more than the statement containing it. Does not report bad indentation between opening braces following if/else, do/while, for, and while statements. NB: in final release it will accept any indentation
46	User-specified identifiers (internal and external) **will not** rely on significance of more than 64 characters.	

N.	JSF++ Definition	Polyspace Specification
47	Identifiers **will not** begin with the underscore character '_'.	
48	Identifiers **will not** differ by: • Only a mixture of case • The presence/absence of the underscore character • The interchange of the letter 'O'; with the number '0' or the letter 'D' • The interchange of the letter 'I'; with the number '1' or the letter 'l' • The interchange of the letter 'S' with the number '5' • The interchange of the letter 'Z' with the number 2 • The interchange of the letter 'n' with the letter 'h'	Checked regardless of scope. Not checked between macros and other identifiers. Messages in report file: • `Identifier "Idf1" (file1.cpp line l1 column c1) and "Idf2" (file2.h line l2 column c2) only differ by the presence/absence of the underscore character.` • `Identifier "Idf1" (file1.cpp line l1 column c1) and "Idf2" (file2.h line l2 column c2) only differ by a mixture of case.` • `Identifier "Idf1" (file1.cpp line l1 column c1) and "Idf2" (file2.h line l2 column c2) only differ by letter 'O', with the number '0'.`
50	The first word of the name of a class, structure, namespace, enumeration, or type created with `typedef` **will** begin with an uppercase letter. All others letters **will** be lowercase.	Messages in report file: • `The first word of the name of a class will begin with an uppercase letter.` • `The first word of the namespace of a class will begin with an uppercase letter.` Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

N.	JSF++ Definition	Polyspace Specification
51	All letters contained in function and variables names **will** be composed entirely of lowercase letters.	Messages in report file: • `All letters contained in variable names will be composed entirely of lowercase letters.` • `All letters contained in function names will be composed entirely of lowercase letters.`
52	Identifiers for constant and enumerator values **shall** be lowercase.	Messages in report file: • `Identifier for enumerator value shall be lowercase.` • `Identifier for template constant parameter shall be lowercase.`
53	Header files **will** always have file name extension of "`.h`".	`.H` is allowed if you set the option `-dos`.
53.1	The following character sequences **shall** not appear in header file names: `'`, `\`, `/*`, `//`, or `"`.	
54	Implementation files **will** always have a file name extension of ".cpp".	Not case sensitive if you set the option `-dos`.
57	The public, protected, and private sections of a class **will** be declared in that order.	
58	When declaring and defining functions with more than two parameters, the leading parenthesis and the first argument **will** be written on the same line as the function name. Each additional argument will be written on a separate line (with the closing parenthesis directly after the last argument).	Detects that two parameters are not on the same line, The first parameter should be on the same line as function name. Does not check for the closing parenthesis.

N.	JSF++ Definition	Polyspace Specification
59	The statements forming the body of an if, else if, else, while, do ... while or for statement **shall** always be enclosed in braces, even if the braces form an empty block.	Messages in report file: • `The statements forming the body of an if statement shall always be enclosed in braces.` • `The statements forming the body of an else statement shall always be enclosed in braces.` • `The statements forming the body of a while statement shall always be enclosed in braces.` • `The statements forming the body of a do ... while statement shall always be enclosed in braces.` • `The statements forming the body of a for statement shall always be enclosed in braces.`
60	Braces ("`{}`") which enclose a block **will** be placed in the same column, on separate lines directly before and after the block.	Detects that statement-block braces should be in the same columns.
61	Braces ("`{}`") which enclose a block **will** have nothing else on the line except comments.	
62	The dereference operator '*' and the address-of operator '&' will be directly connected with the type-specifier.	Reports when there is a space between type and "*" "&" for variables, parameters and fields declaration.

N.	JSF++ Definition	Polyspace Specification
63	Spaces will not be used around '.' or '->', nor between unary operators and operands.	Reports when the following characters are not directly connected to a white space: • . • ->; • ! • ~ • - • ++ • — **Note:** A violation will be reported for "." used in float/double definition.

Classes

N.	JSF++ Definition	Polyspace Specification
67	Public and protected data **should** only be used in structs - not classes.	
68	Unneeded implicitly generated member functions shall be explicitly disallowed.	Reports when default constructor, assignment operator, copy constructor or destructor is not declared.
71.1	A class's virtual functions shall not be invoked from its destructor or any of its constructors.	Reports when a constructor or destructor directly calls a virtual function.
74	Initialization of nonstatic class members **will** be performed through the member initialization list rather than through assignment in the body of a constructor.	All data should be initialized in the initialization list except for array. Does not report that an assignment exists in `ctor` body. Message in report file: `Initialization of nonstatic class members "<field>" will be`

N.	JSF++ Definition	Polyspace Specification
		`performed through the member initialization list.`
75	Members of the initialization list **shall** be listed in the order in which they are declared in the class.	
76	A copy constructor and an assignment operator **shall** be declared for classes that contain pointers to data items or nontrivial destructors.	Messages in report file: • `no copy constructor and no copy assign` • `no copy constructor` • `no copy assign` Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
77.1	The definition of a member function **shall not** contain default arguments that produce a signature identical to that of the implicitly-declared copy constructor for the corresponding class/structure.	Does not report when an explicit copy constructor exists.
78	All base classes with a virtual function **shall** define a virtual destructor.	
79	All resources acquired by a class shall be released by the class's destructor.	Reports when the number of "new" called in a constructor is greater than the number of "delete" called in its destructor. **Note:** A violation is raised even if "new" is done in a "if/else".

N.	JSF++ Definition	Polyspace Specification
81	The assignment operator shall handle self-assignment correctly	Reports when copy assignment body does not begin with “`if (this != arg)`” A violation is not raised if an empty `else` statement follows the `if`, or the body contains only a return statement. A violation is raised when the `if` statement is followed by a statement other than the return statement.

N.	JSF++ Definition	Polyspace Specification

82	An assignment operator **shall** return a reference to `*this`.	The following operators should return `*this` on method, and `*first_arg` on plain function.
		
		`operator=`
		`operator+=`
		`operator-=`
		`operator*=`
		`operator >>=`
		`operator <<=`
		`operator /=`
		`operator %=`
		`operator |=`
		`operator &=`
		`operator ^=`
		`prefix operator++`
		`prefix operator--`
		
		Does not report when no return exists.
		
		No special message if type does not match.
		
		Messages in report file:
		
		• `An assignment operator shall return a reference to *this.`
		• `An assignment operator shall return a reference to its first arg.`

83	An assignment operator shall assign all data members and bases that affect the class invariant (a data element representing a cache, for example, would not need to be copied).	Reports when a copy assignment does not assign all data members. In a derived class, it also reports when a copy assignment does not call inherited copy assignments.

N.	JSF++ Definition	Polyspace Specification
88	Multiple inheritance **shall** only be allowed in the following restricted form: `n` interfaces plus `m` private implementations, plus at most one protected implementation.	Messages in report file: • `Multiple inheritance on public implementation shall not be allowed: <public_base_class> is not an interface.` • `Multiple inheritance on protected implementation shall not be allowed : <protected_base_class_1>` • `<protected_base_class_2>` are not interfaces.
88.1	A stateful virtual base **shall** be explicitly declared in each derived class that accesses it.	
89	A base class **shall not** be both virtual and nonvirtual in the same hierarchy.	
94	An inherited nonvirtual function **shall not** be redefined in a derived class.	Does not report for destructor. Message in report file: `Inherited nonvirtual function %s shall not be redefined in a derived class.`
95	An inherited default parameter **shall never** be redefined.	
96	Arrays **shall not** be treated polymorphically.	Reports pointer arithmetic and array like access on expressions whose pointed type is used as a base class.
97	Arrays **shall not** be used in interface.	Only to prevent array-to-pointer-decay, Not checked on private methods

N.	JSF++ Definition	Polyspace Specification
97.1	Neither operand of an equality operator (== or `!=`) **shall** be a pointer to a virtual member function.	Reports == and `!=` on pointer to member function of polymorphic classes (cannot determine statically if it is virtual or not), except when one argument is the null constant.

Namespaces

N.	JSF++ Definition	Polyspace Specification
98	Every nonlocal name, except `main()`, **should** be placed in some namespace.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
99	Namespaces **will not** be nested more than two levels deep.	

Templates

N.	JSF++ Definition	Polyspace Specification
104	A template specialization **shall** be declared before its use.	Reports the actual compilation error message.

Functions

N.	JSF++ Definition	Polyspace Specification
107	Functions **shall** always be declared at file scope.	
108	Functions with variable numbers of arguments **shall not** be used.	
109	A function definition should not be placed in a class specification unless the function is intended to be inlined.	Reports when "inline" is not in the definition of a member function inside the class definition.
110	Functions with more than 7 arguments **will not** be used.	
111	A function **shall not** return a pointer or reference to a non-static local object.	Simple cases without alias effect detected.
113	Functions **will** have a single exit point.	Reports first return, or once per function.

N.	JSF++ Definition	Polyspace Specification
114	All exit points of value-returning functions **shall** be through return statements.	
116	Small, concrete-type arguments (two or three words in size) **should** be passed by value if changes made to formal parameters should not be reflected in the calling function.	Report constant parameters references with `sizeof <= 2 * sizeof(int)`. Does not report for copy-constructor.
119	Functions **shall** not call themselves, either directly or indirectly (i.e. recursion shall not be allowed).	Direct recursion is reported statically. Indirect recursion reported through the software. Message in report file: `Function <F> shall not call directly itself.`
121	Only functions with 1 or 2 statements **should** be considered candidates for inline functions.	Reports inline functions with more than 2 statements.

Comments

N.	JSF++ Definition	Polyspace Specification
126	Only valid C++ style comments (//) **shall** be used.	
133	Every source file will be documented with an introductory comment that provides information on the file name, its contents, and any program-required information (e.g. legal statements, copyright information, etc).	Reports when a file does not begin with two comment lines. **Note**: This rule cannot be annotated in the source code.

Declarations and Definitions

N.	JSF++ Definition	Polyspace Specification
135	Identifiers in an inner scope **shall not** use the same name as an identifier in an outer scope, and therefore hide that identifier.	Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

N.	JSF++ Definition	Polyspace Specification
136	Declarations should be at the smallest feasible scope.	Reports when: • A global variable is used in only one function. • A local variable is not used in a statement (`expr`, `return`, `init` ...) of the same level of its declaration (in the same block) or is not used in two sub-statements of its declaration. **Note:** • Non-used variables are reported. • Initializations at definition are ignored (not considered an access)
137	All declarations at file scope should be static where possible.	
138	Identifiers **shall not** simultaneously have both internal and external linkage in the same translation unit.	
139	External objects will not be declared in more than one file.	Reports all duplicate declarations inside a translation unit. Reports when the declaration localization is not the same in all translation units.
140	The register storage class specifier **shall not** be used.	
141	A class, structure, or enumeration **will not** be declared in the definition of its type.	

Initialization

N.	JSF++ Definition	Polyspace Specification
142	All variables **shall** be initialized before use.	Done with Non-initialized variable checks in the software.

N.	JSF++ Definition	Polyspace Specification
144	Braces **shall** be used to indicate and match the structure in the non-zero initialization of arrays and structures.	This covers partial initialization.
145	In an enumerator list, the '=' construct **shall not** be used to explicitly initialize members other than the first, unless all items are explicitly initialized.	Generates one report for an enumerator list.

Types

N.	JSF++ Definition	Polyspace Specification
147	The underlying bit representations of floating point numbers **shall not** be used in any way by the programmer.	Reports on casts with float pointers (except with `void*`).
148	Enumeration types shall be used instead of integer types (and constants) to select from a limited series of choices.	Reports when non enumeration types are used in switches.

Constants

N.	JSF++ Definition	Polyspace Specification
149	Octal constants (other than zero) **shall not** be used.	
150	Hexadecimal constants **will** be represented using all uppercase letters.	
151	Numeric values in code **will not** be used; symbolic values will be used instead.	Reports direct numeric constants (except integer/float value `1, 0`) in expressions, non `-const` initializations. and switch cases. char constants are allowed. Does not report on templates non-type parameter. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
151.1	A string literal shall not be modified.	Report when a `char*`, `char[]`, or `string` type is used not as `const`.

N.	JSF++ Definition	Polyspace Specification
		A violation is raised if a string literal (for example, " ") is cast as a non `const`.

Variables

N.	JSF++ Definition	Polyspace Specification
152	Multiple variable declarations **shall not** be allowed on the same line.	

Unions and Bit Fields

N.	JSF++ Definition	Polyspace Specification
153	Unions **shall not** be used.	
154	Bit-fields **shall** have explicitly unsigned integral or enumeration types only.	
156	All the members of a structure (or class) **shall** be named and shall only be accessed via their names.	Reports unnamed bit-fields (unnamed fields are not allowed).

Operators

N.	JSF++ Definition	Polyspace Specification
157	The right hand operand of a && or `||` operator shall not contain side effects.	Assumes rule 159 is not violated. Messages in report file: • `The right hand operand of a && operator shall not contain side effects.` • `The right hand operand of a || operator shall not contain side effects.`
158	The operands of a logical && or `||` **shall** be parenthesized if the operands contain binary operators.	Messages in report file: • `The operands of a logical && shall be parenthesized if the operands contain binary operators.`

<table>
<tr><th>N.</th><th>JSF++ Definition</th><th>Polyspace Specification</th></tr>
<tr><td></td><td></td><td><code>The operands of a logical || shall be parenthesized if the operands contain binary operators.</code> Exception for:
<code>X || Y || Z , Z&&Y &&Z</code></td></tr>
<tr><td>159</td><td>Operators ||, &&, and unary & shall not be overloaded.</td><td>Messages in report file: <code>Unary operator & shall not be overloaded.</code> <code>Operator || shall not be overloaded.</code> <code>Operator && shall not be overloaded.</code></td></tr>
<tr><td>160</td><td>An assignment expression shall be used only as the expression in an expression statement.</td><td>Only simple assignment, not +=, ++, etc.</td></tr>
<tr><td>162</td><td>Signed and unsigned values shall not be mixed in arithmetic or comparison operations.</td><td></td></tr>
<tr><td>163</td><td>Unsigned arithmetic shall not be used.</td><td></td></tr>
<tr><td>164</td><td>The right hand operand of a shift operator shall lie between zero and one less than the width in bits of the left-hand operand (inclusive).</td><td></td></tr>
<tr><td>164.1</td><td>The left-hand operand of a right-shift operator shall not have a negative value.</td><td>Detects constant case +. Found by the software for dynamic cases.</td></tr>
<tr><td>165</td><td>The unary minus operator shall not be applied to an unsigned expression.</td><td></td></tr>
<tr><td>166</td><td>The <code>sizeof</code> operator will not be used on expressions that contain side effects.</td><td></td></tr>
<tr><td>168</td><td>The comma operator shall not be used.</td><td></td></tr>
</table>

Pointers and References

N.	JSF++ Definition	Polyspace Specification
169	Pointers to pointers should be avoided when possible.	Reports second-level pointers, except for arguments of main.
170	More than 2 levels of pointer indirection **shall not** be used.	Only reports on variables/parameters.
171	Relational operators shall not be applied to pointer types except where both operands are of the same type and point to: • the same object, • the same function, • members of the same object, or • elements of the same array (including one past the end of the same array).	Reports when relational operator are used on pointer types (casts ignored).
173	The address of an object with automatic storage **shall not** be assigned to an object which persists after the object has ceased to exist.	
174	The null pointer **shall not** be de-referenced.	Done with checks in software.
175	A pointer **shall not** be compared to `NULL` or be assigned `NULL`; use plain `0` instead.	Reports usage of `NULL` macro in pointer contexts.
176	A `typedef` **will** be used to simplify program syntax when declaring function pointers.	Reports non-`typedef` function pointers, or pointers to member functions for types of variables, fields, parameters. Returns type of function, cast, and exception specification.

Type Conversions

N.	JSF++ Definition	Polyspace Specification
177	User-defined conversion functions **should** be avoided.	Reports user defined conversion function, non-explicit constructor with one parameter or default value for others (even undefined ones). Does not report copy-constructor.

N.	JSF++ Definition	Polyspace Specification
		Additional message for constructor case: `This constructor should be flagged as "explicit".`
178	Down casting (casting from base to derived class) **shall** only be allowed through one of the following mechanism: • Virtual functions that act like dynamic casts (most likely useful in relatively simple cases). • Use of the visitor (or similar) pattern (most likely useful in complicated cases).	Reports explicit down casting, dynamic_cast included. (Visitor patter does not have a special case.)
179	A pointer to a virtual base class **shall not** be converted to a pointer to a derived class.	Reports this specific down cast. Allows dynamic_cast.

180	Implicit conversions that may result in a loss of information **shall not** be used.	Reports the following implicit casts :
		
		`integer => smaller integer`
		`unsigned => smaller or eq signed`
		`signed => smaller or eq un-signed`
		`integer => float`
		`float => integer`
		
		Does not report for cast to `bool` reports for implicit cast on constant done with the options `-scalar-overflows-checks signed-and-unsigned` or `-ignore-constant-overflows`
		
		Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.

181	Redundant explicit casts **will not** be used.	Reports useless cast: `cast T to T`. Casts to equivalent `typedefs` are also reported.
182	Type casting from any type to or from pointers **shall not** be used.	Does not report when Rule 181 applies.

N.	JSF++ Definition	Polyspace Specification
184	Floating point numbers **shall not** be converted to integers unless such a conversion is a specified algorithmic requirement or is necessary for a hardware interface.	Reports `float->int` conversions. Does not report implicit ones.
185	C++ style casts (`const_cast`, `reinterpret_cast`, and `static_cast`) **shall** be used instead of the traditional C-style casts.	

Flow Control Standards

N.	JSF++ Definition	Polyspace Specification
186	There **shall** be no unreachable code.	Done with gray checks in the software. Bug Finder and Code Prover check this coding rule differently. The analyses can produce different results.
187	All non-null statements **shall** potentially have a side-effect.	
188	Labels **will not** be used, except in switch statements.	
189	The `goto` statement **shall** not be used.	
190	The `continue` statement **shall not** be used.	
191	The `break` statement **shall not** be used (except to terminate the cases of a switch statement).	
192	All `if`, `else if` constructs will contain either a final `else` clause or a comment indicating why a final `else` clause is not necessary.	`else if` should contain an `else` clause.
193	Every non-empty `case` clause in a switch statement **shall** be terminated with a `break` statement.	

N.	JSF++ Definition	Polyspace Specification
194	All `switch` statements that do not intend to test for every enumeration value **shall** contain a final `default` clause.	Reports only for missing `default`.
195	A `switch` expression **will** not represent a Boolean value.	
196	Every `switch` statement **will** have at least two cases and a potential `default`.	
197	Floating point variables **shall not** be used as loop counters.	Assumes 1 loop parameter.
198	The initialization expression in a `for` loop **will** perform no actions other than to initialize the value of a single `for` loop parameter.	Reports if `loop` parameter cannot be determined. Assumes Rule 200 is not violated. The `loop variable` parameter is assumed to be a variable.
199	The increment expression in a `for` loop **will** perform no action other than to change a single loop parameter to the next value for the loop.	Assumes 1 loop parameter (Rule 198), with non class type. Rule 200 must not be violated for this rule to be reported.
200	Null initialize or increment expressions in `for` loops **will not** be used; a `while` loop will be used instead.	
201	Numeric variables being used within a *for* loop for iteration counting shall not be modified in the body of the loop.	Assumes 1 loop parameter (AV rule 198), and no alias writes.

Expressions

N.	JSF++ Definition	Polyspace Specification
202	Floating point variables **shall not** be tested for exact equality or inequality.	Reports only direct equality/inequality. Check done for all expressions.
203	Evaluation of expressions **shall not** lead to overflow/underflow.	Done with overflow checks in the software.
204	A single operation with side-effects shall only be used in the following contexts: • by itself	Reports when: • A side effect is found in a return statement

N.	JSF++ Definition	Polyspace Specification
	• the right-hand side of an assignment • a condition • the only argument expression with a side-effect in a function call • condition of a loop • switch condition • single part of a chained operation	• A side effect exists on a single value, and only one operand of the function call has a side effect.
204.1	The value of an expression shall be the same under any order of evaluation that the standard permits.	Reports when: • Variable is written more than once in an expression • Variable is read and write in sub-expressions • Volatile variable is accessed more than once **Note:** Read-write operations such as ++, are only considered as a write.
205	The volatile keyword **shall not** be used unless directly interfacing with hardware.	Reports if volatile keyword is used.

Memory Allocation

N.	JSF++ Definition	Polyspace Specification
206	Allocation/deallocation from/to the free store (heap) **shall not** occur after initialization.	Reports calls to C library functions: `malloc` / `calloc` / `realloc` / `free` and all `new`/ `delete` operators in functions or methods.

Fault Handling

N.	JSF++ Definition	Polyspace Specification
208	C++ exceptions **shall not** be used.	Reports `try`, `catch`, `throw spec`, and `throw`.

Portable Code

N.	JSF++ Definition	Polyspace Specification
209	The basic types of `int`, `short`, `long`, `float` and `double` **shall not** be used, but specific-length equivalents should be `typedef`'d accordingly for each compiler, and these type names used in the code.	Only allows use of basic types through direct `typedefs`.
213	No dependence shall be placed on C++'s operator precedence rules, below arithmetic operators, in expressions.	Reports when a binary operation has one operand that is not parenthesized and is an operation with inferior precedence level. Reports bitwise and shifts operators that are used without parenthesis and binary operation arguments.

215	Pointer arithmetic **will not** be used.	Reports:
		`p + I`
		`p - I`
		`p++`
		`p--`
		`p+=`
		`p-=`
		
		Allows `p[i]`.

JSF++ Rules Not Checked

- "Code Size and Complexity" on page 12-161
- "Rules" on page 12-161
- "Environment" on page 12-162
- "Libraries" on page 12-162
- "Header Files" on page 12-162
- "Style" on page 12-162
- "Classes" on page 12-163
- "Namespaces" on page 12-164
- "Templates" on page 12-164
- "Functions" on page 12-165

Code Size and Complexity

N.	JSF++ Definition
2	There shall not be any self-modifying code.

Rules

N.	JSF++ Definition
4	To break a "should" rule, the following approval must be received by the developer: • approval from the software engineering lead (obtained by the unit approval in the developmental CM tool)
5	To break a "will" or a "shall" rule, the following approvals must be received by the developer: • approval from the software engineering lead (obtained by the unit approval in the developmental CM tool) • approval from the software product manager (obtained by the unit approval in the developmental CM tool)
6	Each deviation from a "shall" rule shall be documented in the file that contains the deviation. Deviations from this rule shall not be allowed, AV Rule 5 notwithstanding.
7	Approval will not be required for a deviation from a "shall" or "will" rule that complies with an exception specified by that rule.

Environment

N.	JSF++ Definition
10	Values of character types will be restricted to a defined and documented subset of ISO 10646 1.

Libraries

N.	JSF++ Definition
16	Only DO-178B level A [15] certifiable or SEAL 1 C/C++ libraries shall be used with safety-critical (i.e. SEAL 1) code.

Header Files

N.	JSF++ Definition
34	Header files should contain logically related declarations only.
36	Compilation dependencies should be minimized when possible.
37	Header (include) files should include only those header files that are required for them to successfully compile. Files that are only used by the associated .cpp file should be placed in the .cpp file — not the .h file.
38	Declarations of classes that are only accessed via pointers (*) or references (&) should be supplied by forward headers that contain only forward declarations.

Style

N.	JSF++ Definition
45	All words in an identifier will be separated by the '_' character.
49	All acronyms in an identifier will be composed of uppercase letters.
55	The name of a header file should reflect the logical entity for which it provides declarations.
56	The name of an implementation file should reflect the logical entity for which it provides definitions and have a ".cpp" extension (this name will normally be identical to the header file that provides the corresponding declarations.) At times, more than one .cpp file for a given logical entity will be required. In these cases, a suffix should be appended to reflect a logical differentiation.

Classes

N.	JSF++ Definition
64	A class interface should be complete and minimal.
65	A structure should be used to model an entity that does not require an invariant.
66	A class should be used to model an entity that maintains an invariant.
69	A member function that does not affect the state of an object (its instance variables) will be declared const. Member functions should be const by default. Only when there is a clear, explicit reason should the const modifier on member functions be omitted.
70	A class will have friends only when a function or object requires access to the private elements of the class, but is unable to be a member of the class for logical or efficiency reasons.
70.1	An object shall not be improperly used before its lifetime begins or after its lifetime ends.
71	Calls to an externally visible operation of an object, other than its constructors, shall not be allowed until the object has been fully initialized.
72	The invariant for a class should be: • A part of the postcondition of every class constructor, • A part of the precondition of the class destructor (if any), • A part of the precondition and postcondition of every other publicly accessible operation.
73	Unnecessary default constructors shall not be defined.
77	A copy constructor shall copy all data members and bases that affect the class invariant (a data element representing a cache, for example, would not need to be copied).
80	The default copy and assignment operators will be used for classes when those operators offer reasonable semantics.
84	Operator overloading will be used sparingly and in a conventional manner.
85	When two operators are opposites (such as == and !=), both will be defined and one will be defined in terms of the other.
86	Concrete types should be used to represent simple independent concepts.
87	Hierarchies should be based on abstract classes.
90	Heavily used interfaces should be minimal, general and abstract.

N.	JSF++ Definition
91	Public inheritance will be used to implement “is-a” relationships.
92	A subtype (publicly derived classes) will conform to the following guidelines with respect to all classes involved in the polymorphic assignment of different subclass instances to the same variable or parameter during the execution of the system: • Preconditions of derived methods must be at least as weak as the preconditions of the methods they override. • Postconditions of derived methods must be at least as strong as the postconditions of the methods they override. In other words, subclass methods must expect less and deliver more than the base class methods they override. This rule implies that subtypes will conform to the Liskov Substitution Principle.
93	“has-a” or “is-implemented-in-terms-of” relationships will be modeled through membership or non-public inheritance.

Namespaces

N.	JSF++ Definition
100	Elements from a namespace should be selected as follows: • using declaration or explicit qualification for few (approximately five) names, • using directive for many names.

Templates

N.	JSF++ Definition
101	Templates shall be reviewed as follows: **1** with respect to the template in isolation considering assumptions or requirements placed on its arguments. **2** with respect to all functions instantiated by actual arguments.
102	Template tests shall be created to cover all actual template instantiations.
103	Constraint checks should be applied to template arguments.
105	A template definition’s dependence on its instantiation contexts should be minimized.

N.	JSF++ Definition
106	Specializations for pointer types should be made where appropriate.

Functions

N.	JSF++ Definition
112	Function return values should not obscure resource ownership.
115	If a function returns error information, then that error information will be tested.
117	Arguments should be passed by reference if NULL values are not possible: • **117.1** – An object should be passed as `const T&` if the function should not change the value of the object. • **117.2** – An object should be passed as `T&` if the function may change the value of the object.
118	Arguments should be passed via pointers if NULL values are possible: • **118.1** – An object should be passed as `const T*` if its value should not be modified. • **118.2** – An object should be passed as `T*` if its value may be modified.
120	Overloaded operations or methods should form families that use the same semantics, share the same name, have the same purpose, and that are differentiated by formal parameters.
122	Trivial accessor and mutator functions should be inlined.
123	The number of accessor and mutator functions should be minimized.
124	Trivial forwarding functions should be inlined.
125	Unnecessary temporary objects should be avoided.

Comments

N.	JSF++ Definition
127	Code that is not used (commented out) shall be deleted. **Note**: This rule cannot be annotated in the source code.
128	Comments that document actions or sources (e.g. tables, figures, paragraphs, etc.) outside of the file being documented will not be allowed.

N.	JSF++ Definition
129	Comments in header files should describe the externally visible behavior of the functions or classes being documented.
130	The purpose of every line of executable code should be explained by a comment, although one comment may describe more than one line of code.
131	One should avoid stating in comments what is better stated in code (i.e. do not simply repeat what is in the code).
132	Each variable declaration, typedef, enumeration value, and structure member will be commented.
134	Assumptions (limitations) made by functions should be documented in the function's preamble.

Initialization

N.	JSF++ Definition
143	Variables will not be introduced until they can be initialized with meaningful values. (See also AV Rule 136, AV Rule 142, and AV Rule 73 concerning declaration scope, initialization before use, and default constructors respectively.)

Types

N.	JSF++ Definition
146	Floating point implementations shall comply with a defined floating point standard. The standard that will be used is the ANSI/IEEE® Std 754 [1].

Unions and Bit Fields

N.	JSF++ Definition
155	Bit-fields will not be used to pack data into a word for the sole purpose of saving space.

Operators

N.	JSF++ Definition
167	The implementation of integer division in the chosen compiler shall be determined, documented and taken into account.

Type Conversions

N.	JSF++ Definition
183	Every possible measure should be taken to avoid type casting.

Expressions

N.	JSF++ Definition
204	A single operation with side-effects shall only be used in the following contexts: **1** by itself **2** the right-hand side of an assignment **3** a condition **4** the only argument expression with a side-effect in a function call **5** condition of a loop **6** switch condition **7** single part of a chained operation

Memory Allocation

N.	JSF++ Definition
207	Unencapsulated global data will be avoided.

Portable Code

N.	JSF++ Definition
210	Algorithms shall not make assumptions concerning how data is represented in memory (e.g. big endian vs. little endian, base class subobject ordering in derived classes, nonstatic data member ordering across access specifiers, etc.).
210.1	Algorithms shall not make assumptions concerning the order of allocation of nonstatic data members separated by an access specifier.
211	Algorithms shall not assume that shorts, ints, longs, floats, doubles or long doubles begin at particular addresses.
212	Underflow or overflow functioning shall not be depended on in any special way.

N.	JSF++ Definition
214	Assuming that non-local static objects, in separate translation units, are initialized in a special order shall not be done.

Efficiency Considerations

N.	JSF++ Definition
216	Programmers should not attempt to prematurely optimize code.

Miscellaneous

N.	JSF++ Definition
217	Compile-time and link-time errors should be preferred over run-time errors.
218	Compiler warning levels will be set in compliance with project policies.

Testing

N.	JSF++ Definition
219	All tests applied to a base class interface shall be applied to all derived class interfaces as well. If the derived class poses stronger postconditions/invariants, then the new postconditions /invariants shall be substituted in the derived class tests.
220	Structural coverage algorithms shall be applied against flattened classes.
221	Structural coverage of a class within an inheritance hierarchy containing virtual functions shall include testing every possible resolution for each set of identical polymorphic references.

Checking Coding Rules

Activate Coding Rules Checker

This example shows how to activate the coding rules checker before you start a verification. This activation enables Polyspace Code Prover to search for coding rule violations. You can view the coding rule violations in your verification results.

1 Open project configuration.
2 On the **Configuration** pane, select **Coding Rules**.
3 Select the check box for the type of coding rules that you want to check.

   For C code, you can check compliance with:

   - MISRA C:2004
   - MISRA AC AGC
   - MISRA C:2012

     If you have generated code, use the **Use generated code requirements** option to use the MISRA C:2012 categories for generated code.
   - Custom coding rules

   For C++ code, you can check compliance with:

   - MISRA C++: 2008
   - JSF C++
   - Custom coding rules
4 For each rule type that you select, from the drop-down list, select the subset of rules to check.

MISRA C:2004

Option	Description
`required-rules`	All required MISRA C:2004 coding rules.
`all-rules`	AllMISRA C:2004 coding rules (required and advisory).
`SQO-subset1`	A small subset of MISRA C:2004 rules. In Polyspace Code Prover, observing these rules can reduce the number of unproven results.

Option	Description
SQO-subset2	A second subset of rules that include the rules in SQO-subset1 and contain some additional rules. In Polyspace Code Prover, observing the additional rules can further reduce the number of unproven results.
custom	A set of MISRA C:2004 coding rules that you specify.

MISRA AC AGC

Option	Description
OBL-rules	All required MISRA AC AGC coding rules.
OBL-REC-rules	All required and recommended MISRA AC AGC coding rules.
all-rules	All required, recommended, and readability coding rules.
SQO-subset1	A small subset of MISRA AC AGC rules. In Polyspace Code Prover, observing these rules can reduce the number of unproven results.
SQO-subset2	A second subset of MISRA AC AGC rules that include the rules in SQO-subset1 and contain some additional rules. In Polyspace Code Prover, observing the additional rules can further reduce the number of unproven results.
custom	A set of MISRA AC AGC coding rules that you specify.

MISRA C:2012

Option	Description
mandatory	All mandatory MISRA C:2012 coding rules. If you have generated code, also use the **Use generated code requirements** option categorization for generated code.

Option	Description
`mandatory-required`	All mandatory and required MISRA C:2012 coding rules. If you have generated code, also use the **Use generated code requirements** option categorization for generated code.
`all`	All MISRA C:2012 coding rules (mandatory, required, and advisory).
`SQO-subset1`	A small subset of MISRA C rules. In Polyspace Code Prover, observing these rules can reduce the number of unproven results.
`SQO-subset2`	A second subset of rules that include the rules in `SQO-subset1` and contain some additional rules. In Polyspace Code Prover, observing the additional rules can further reduce the number of unproven results.
`custom`	A set of MISRA C:2012 coding rules that you specify.

MISRA C++

Option	Description
`required-rules`	All required MISRA C++ coding rules.
`all-rules`	All required and advisory MISRA C++ coding rules.
`SQO-subset1`	A small subset of MISRA C++ rules. In Polyspace Code Prover, observing these rules can reduce the number of unproven results.
`SQO-subset2`	A second subset of rules with indirect impact on the selectivity in addition to `SQO-subset1`. In Polyspace Code Prover, observing the additional rules can further reduce the number of unproven results.
`custom`	A specified set of MISRA C++ coding rules.

JSF C++

Option	Description
`shall-rules`	**Shall** rules are mandatory requirements. These rules require verification.
`shall-will-rules`	All **Shall** and **Will** rules. **Will** rules are intended to be mandatory requirements. However, these rules do not require verification.
`all-rules`	All **Shall**, **Will**, and **Should** rules. **Should** rules are advisory rules.
`custom`	A set of JSF C++ coding rules that you specify.

5 If you select **Check custom rules**, specify the path to your custom rules file or click **Edit** to create one.

When rules checking is complete, the software displays the coding rule violations in purple on the **Results Summary** pane.

Related Examples

- "Select Specific MISRA or JSF Coding Rules"
- "Create Custom Coding Rules"
- "Exclude Files from Rules Checking"

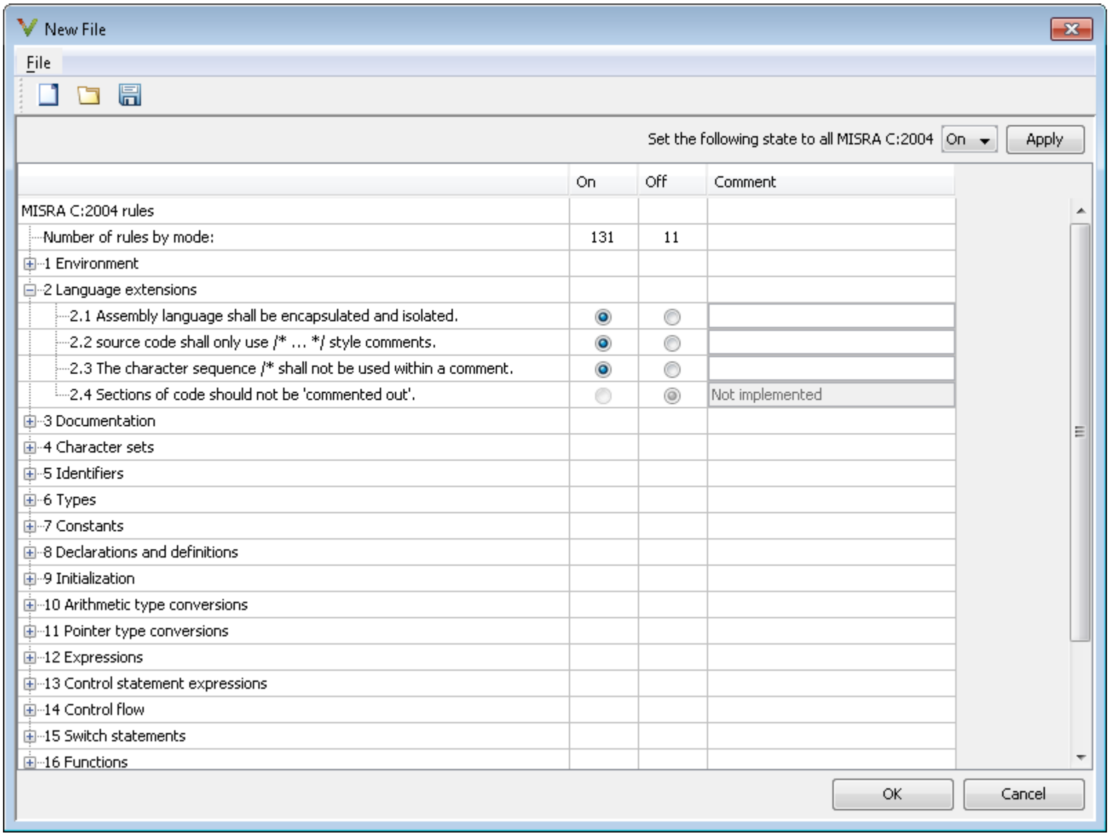
More About

- "Rule Checking"
- "Software Quality Objective Subsets (C:2004)" on page 12-11
- "Software Quality Objective Subsets (C:2012)" on page 12-57
- "Software Quality Objective Subsets (AC AGC)" on page 12-15
- "Software Quality Objective Subsets (C++)" on page 12-103

Select Specific MISRA or JSF Coding Rules

This example shows how to specify a subset of MISRA or JSF rules for the coding rules checker. If you select `custom` from the MISRA or JSF drop-down list, you must provide a file that specifies the rules to check.

1. Open project configuration.
2. In the **Configuration** tree view, select **Coding Rules**.
3. Select the check box for the type of coding rules you wish to check
4. From the corresponding drop-down list, select `custom`. The software displays a new field for your custom file.
5. To the right of this field, click **Edit**. A New File window opens, displaying a table of rules.



Select **On** for the rules you want to check.

6 Click **OK** to save the rules and close the window.

The **Save as** dialog box opens.

7 In the **File** field, enter a name for the rules file.

8 Click **OK** to save the file and close the dialog box.

The full path to the rules file appears. To reuse this rules file for other projects, type this path name or use the  icon in the New File window.

Related Examples

- “Activate Coding Rules Checker”
- “Create Custom Coding Rules”

More About

- “Rule Checking”

Create Custom Coding Rules

This example shows how to create a custom coding rules file. You can use this file to check names or text patterns in your source code with reference to custom rules that you specify. For each rule, you specify a pattern in the form of a regular expression. The software compares the pattern against identifiers in the source code and determines whether the custom rule is violated.

Save Example Code

Save the following code in a file `printInitialValue.c`:

```
#include <stdio.h>

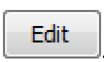
typedef struct {
int a;
int b;
} collection;

void main()
{
 collection myCollection={0,0};
 printf("Initial values in the collection are %d
                    and %d.",myCollection.a,myCollection.b);
}
```

Create Coding Rules File

1 Create a Polyspace project. Add `printInitialValue.c` to the project.

2 On the **Configuration** pane, select **Coding Rules**. Select the **Check custom rules** box.

3 Click 

.

   The New File window opens, displaying a table of rule groups.

4 From the drop-down list **Set the following state to all Custom C**, select `Off`. Click **Apply**.

5 Expand the **Structs** node. For the option **4.3 All struct fields must follow the specified pattern**:

Column Title	Action
On	Select .
Convention	Enter `All struct fields must begin with s_ and have capital letters.`
Pattern	Enter `s_[A-Z0-9_]`
Comment	Leave blank. This column is for comments that appear in the coding rules file alone.

Review Coding Rule Violations

1. Save the file and run the verification. On the **Results Summary** pane, you see two violations of rule 4.3. Select the first violation.

   a. On the **Source** pane, the line `int a;` is marked.

   b. On the **Check Details** pane, you see the error message you had entered, `All struct fields must begin with s_ and have capital letters.`

2. Right-click on the **Source** pane and select **Open Source File**. The file `printInitialValue.c` opens in the **Code Editor** pane or an external text editor depending on your **Preferences**.

3. In the file, replace all instances of `a` with `s_A` and `b` with `s_B`. Rerun the verification.

   The custom rule violations no longer appear on the **Results Summary** pane.

Related Examples

- "Activate Coding Rules Checker"
- "Select Specific MISRA or JSF Coding Rules"
- "Exclude Files from Rules Checking"

More About

- "Rule Checking"
- "Format of Custom Coding Rules File"

Format of Custom Coding Rules File

In a custom coding rules file, each rule appears in the following format:

```
N.n off|on
convention=violation_message
pattern=regular_expression
```

- *N.n* — Custom rule number, for example, 1.2.
- `off` — Rule is not considered.
- `on` — The software checks for violation of the rule. After verification, it displays the coding rule violation on the **Results Summary** pane.
- *violation_message* — Software displays this text in an XML file within the *Results*/`Polyspace-Doc` folder.
- *regular_expression* — Software compares this text pattern against a source code identifier that is specific to the rule. See "Custom Naming Convention Rules" on page 12-4.

  The keywords `convention=` and `pattern=` are optional. If present, they apply to the rule whose number immediately precedes these keywords. If `convention=` is not given for a rule, then a standard message is used. If `pattern=` is not given for a rule, then the default regular expression is used, that is, `.*`.

  Use the symbol # to start a comment. Comments are not allowed on lines with the keywords `convention=` and `pattern=`.

  The following example contains three custom rules: 1.1, 8.1, and 9.1.

```
# Custom rules configuration file
1.1  off          # Disable custom rule number 1.1
8.1  on       # Violation of custom rule 8.1 produces a warning
convention=Global constants must begin by G_ and must be in capital letters.
pattern=G_[A-Z0-9_]*
9.1  on    # Non-adherence to custom rule 9.1 produces a warning
convention=Global variables should begin by g_.
pattern=g_.*
```

Related Examples

- "Create Custom Coding Rules"

Exclude Files from Rules Checking

This example shows how to exclude certain files from coding rules checking. The files are still included during Code Prover verification.

1. Open the project configuration.
2. In the **Configuration** tree view, select **Inputs & Stubbing**.
3. Select the **Files and folders to ignore** check box.
4. From the corresponding drop-down list, select one of the following:

   - `all-headers` (default) — Excludes header files in the Include folders of your project. For example `.h` or `.hpp` files.
   - `all` — Excludes all include files in the Include folders of your project. For example, if you are checking a large code base with standard or Visual headers, excluding include folders can significantly improve the speed of code analysis.
   - `custom` — Excludes files or folders specified in the **File/Folder** view. To add files to the custom **File/Folder** list, select  to choose the files and folders to exclude. To remove a file or folder from the list of excluded files and folders, select the row. Then click .

See Also

"Files and folders to ignore (C)"

Related Examples

- "Activate Coding Rules Checker"

More About

- "Rule Checking"

Allow Custom Pragma Directives

This example shows how to exclude custom pragma directives from coding rules checking. MISRA C rule 3.4 requires checking that all pragma directives are documented within the documentation of the compiler. However, you can allow undocumented pragma directives to be present in your code.

1. Open project configuration.
2. In the **Configuration** tree view, select **Coding Rules**.
3. To the right of **Allowed pragmas**, click .

   In the **Pragma** view, the software displays an active text field.
4. In the text field, enter a pragma directive.
5. To remove a directive from the **Pragma** list, select the directive. Then click .

Related Examples

- "Activate Coding Rules Checker"

More About

- "Rule Checking"

Specify Boolean Types

This example shows how to specify data types you want Polyspace to consider as Boolean during MISRA C rules checking. The software applies this redefinition only to data types defined by `typedef` statements. The use of this option may affect the checking of MISRA C:2004 rules 12.6, 13.2, 15.4, and MISRA C:2012 rules 14.4, 16.7.

1. Open project configuration.
2. In the **Configuration** tree view, select **Coding Rules**.
3. To the right of **Effective boolean types**, click .

   In the **Type** view, the software displays an active text field.
4. In the text field, specify the data type that you want Polyspace to treat as Boolean.
5. To remove a data type from the **Type** list, select the data type. Then click .

Related Examples

- "Activate Coding Rules Checker"

More About

- "Rule Checking"

Review Coding Rule Violations

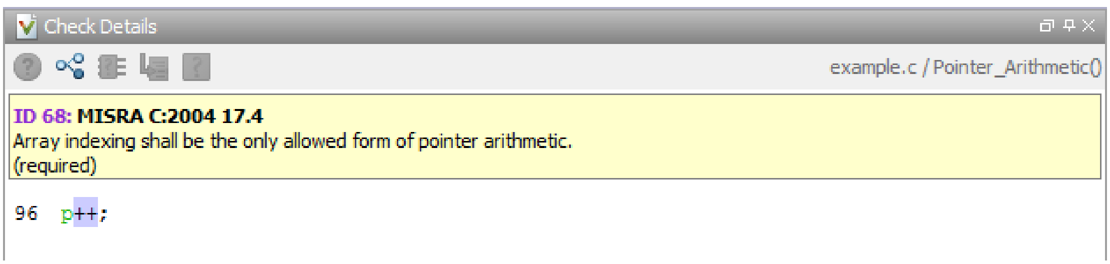
This example shows how to review coding rule violations in the Results Manager perspective once code analysis is complete. After analysis, the **Results Summary** pane displays the rule violations with a

- symbol for predefined coding rules such as MISRA C:2004.
- symbol for custom coding rules.

1 Select a coding-rule violation on the **Results Summary** pane.

   - The predefined rules such as MISRA or JSF are indicated by .
   - The custom rules are indicated by .

2 On the **Check Details** pane, view the location and description of the violated rule. In the source code, the line containing the violation appears highlighted.



3 Review the violation. On the **Results Summary** pane, select a **Classification** to describe the severity of the issue:

   - `High`
   - `Medium`
   - `Low`
   - `Not a defect`

4 Select a **Status** to describe how you intend to address the issue:

   - `Fix`
   - `Improve`
   - `Investigate`

- `Justify with annotations`
- `No Action Planned`
- `Other`
- `Restart with different options`
- `Undecided`

   You can also define your own statuses.

5. In the comment box, enter additional information about the violation.
6. To open the source file that contains the coding rule violation, on the **Source** pane, right-click the code with the purple check. From the context menu, select **Open Source File**. The file opens in the **Code Editor** pane or an external text editor depending on your **Preferences**.
7. Fix the coding rule violation.
8. When you have corrected the coding rule violations, run the analysis again.

Related Examples

- "Activate Coding Rules Checker"
- "Filter and Group Coding Rule Violations"

Filter and Group Coding Rule Violations

This example shows how to use filters in the **Results Summary** pane to focus on specific kinds of coding rule violations. By default, the software displays all coding rule violations and run-time checks.

Group Violations

1. On the **Results Summary** pane, select **Group by** > **Family**.

   The rules are grouped by numbers. Each group corresponds to a certain code construct.
2. Expand the group nodes to select an individual coding rule violation.

Filter Violations

1. On the **Results Summary** pane, place your cursor on the **Check** column header. Click the filter icon that appears.
2. From the context menu, clear the **All** check box.
3. Select the violated rule numbers that you want to focus on.
4. Click **OK**.

Related Examples

- "Activate Coding Rules Checker"
- "Review Coding Rule Violations"
- "Organize Results Using Filters and Groups"

Generate Coding Rules Report

This example shows how to generate and view a coding rules report after verification.

Generate Report

1. In the Results Manager perspective, select **Reporting** > **Run Report**.
2. In the Run Report dialog box, from the **Select Reports** menu, select `CodingRules`.
3. Specify **Output folder** and **Output format**.
4. Select **Run Report**.

Open Existing Report

1. In the Results Manager perspective, select **Reporting** > **Open Report**.
2. In the Open Report dialog box, navigate to the folder that contains the coding rules report.

   The default location is in *`ResultFolder`*`\Polyspace-Doc`
3. Select the report and click **OK**.

View Report

In the coding rules report, you can view the following information:

- **Summary for all Files** — Lists number of violations in each file.
- **Summary for Enabled Rules** — For each rule, lists the:
  - Rule number.
  - Rule description.
  - Number of times the rule is broken.
- **Violations** — For each file that Polyspace checked for coding rule violations, lists each violation along with the:
  - Rule description.
  - Unique ID for the violation. Use this ID to find the violation on the **Results Summary** pane.
  - Function where the rule violation is found.
  - Line and column number.

  - Review information you enter such as **Class**, **Status** and **Comment**.
- **Configuration Settings** — Lists analysis options used for the verification, along with coding rules that Polyspace checked.

Related Examples

- "Activate Coding Rules Checker"
- "Customize Report Templates"

Software Quality with Polyspace Metrics

Software Quality with Polyspace Metrics

Polyspace Metrics is a Web-based tool for software development managers, quality assurance engineers, and software developers, to do the following in software projects:

- Evaluate software quality metrics
- Monitor the variation of code metrics, coding rule violations, and run-time checks through the lifecycle of a project
- View defect numbers, run-time reliability of the software, review progress, and the status of the code with respect to software quality objectives.

If you are a development manager or a quality assurance engineer, through a Web browser, you can:

- View software quality information about your project. See “Open Polyspace Metrics” on page 14-9.
- Observe trends over time, by project or module. See “Review Overall Progress” on page 14-16.
- Compare metrics of one project version with those of another. See “Compare Project Versions” on page 14-23.

If you have the Polyspace product installed on your computer, you can drill down to coding rule violations and run-time checks in the Polyspace verification environment. This feature allows you to:

- Review coding rule violations
- Review run-time checks and, if required, classify these checks as defects

In addition, if you think that coding rule violations and run-time checks can be justified, you can mark them as justified and enter comments. See “Review Results” on page 14-25.

If you are a software developer, Polyspace Metrics allows you to focus on the latest version of the project that you are working on. You can use the view filters and drill-down functionality to go to code defects, which you can then fix. See “Fix Defects” on page 14-28.

Polyspace calculates metrics that are used to determine whether your code fulfills predefined software quality objectives. You can redefine these software quality objectives. See “Customize Software Quality Objectives”.

Set Up Verification to Generate Metrics

You can run, either manually or automatically, verifications that generate metrics. In each case, Polyspace uses a metrics computation engine to evaluate metrics for your code, and stores these metrics in a results repository.

Before you run a verification manually, in the Project Manager perspective:

1. On the **Configuration** pane, select **Distributed Computing**.
2. Select **Batch**.
3. Select the **Add to results repository** check box.

To set up scheduled, automatic verification runs, see "Specify Automatic Verification" on page 14-3.

The software saves generated metrics in the following XML file:

`Results_Folder``/Polyspace-Doc/Code_Metrics.xml`
See "Results Folder".

Specify Automatic Verification

You can configure verifications to start automatically and periodically, for example, at a specific time every night. At the end of each verification, the software stores results in the repository and updates the project metrics. You can also configure the software to send you an email at the end of the verification. This email will contain:

- Links to results
- An attached log file if the verification produces compilation errors
- A summary of new findings, for example, new coding rule violations, and new potential and actual run-time errors

To configure automatic verification, you must create an XML file `Projects.psproj` that has the following elements:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Polyspace Metrics Automatic Verification Project File -->
<Configuration>
  <Project>
    <Options>
    </Options>
```

```
    <LaunchingPeriod>
    </LaunchingPeriod>
    <Commands>
    </Commands>
    <Users>
      <User>
      </User>
    </Users>
  </Project>
  <SmtpConfiguration>
  </SmtpConfiguration>
</Configuration>
```

Configure the verification by providing data for the elements (and their attributes) within `Configuration`. See "Element and Attribute Data for Projects.psproj" on page 14-4.

After creating `Projects.psproj`, on the Polyspace Metrics server, place the file in the results repository. For example:

```
/var/Polyspace/results-repository
```

Element and Attribute Data for Projects.psproj

The following topics describe the data required to configure automatic verification.

Project

Specify the following attributes:

- `name` — Your project name.
- `language` — `C` or `CPP`.
- `verificationKind` — Mode, which is either `INTEGRATION` or `UNIT-BY-UNIT`.
- `product` — Product name, which is either `BUG-FINDER` or `CODE-PROVER`.

For example,

```
<Project name="Demo_C" language="C" verificationKind="INTEGRATION"
 product="CODE-PROVER">
```

The Project element also contains the following elements:

- "Options" on page 14-5
- "LaunchingPeriod" on page 14-5

- "Commands" on page 14-6
- "Users" on page 14-6

Options

Specify a list of the Polyspace options required for your verification, with the exception of `-unit-by-unit`, `-results-dir`, `-prog` and `-verif-version`. If these four options are present, they are ignored.

The following is an example.

```
<Options>
  -O2
  -to pass2
  -target sparc
  -temporal-exclusions-file sources/temporal_exclusions.txt
  -entry-points tregulate,proc1,proc2,server1,server2
  -critical-section-begin Begin_CS:CS1
  -critical-section-end End_CS:CS1
  -misra2 all-rules
  -includes-to-ignore sources/math.h
  -D NEW_DEFECT
</Options>
```

LaunchingPeriod

For the starting time of the verification, specify five attributes:

- `hour`. Any integer in the range 0–23.
- `minute`. Any integer in the range 0–59.
- `month`. Any integer in the range 1–12.
- `day`. Any integer in the range 1–31.
- `weekDay`. Any integer in the range 1–7, where 1 specifies Monday.

Use `*` to specify all values in range, for example, `month="*"` specifies a verification every month.

Use `-` to specify a range, for example, `weekDay="1-5"` specifies Monday to Friday.

You can also specify a list for each attribute. For example, `day="1,15"` specifies the first and the fifteenth day of the month.

Default: If you do not specify attribute data for `LaunchingPeriod`, then a verification is started each week day at midnight.

The following is an example.

```
<LaunchingPeriod hour="12" minute="20" month="*" weekDay="1-5">
```

Commands

You can provide a list of optional commands. There must be only one command per line, and these commands must be executable on the computer that starts the verification.

- `GetSource`. A command to retrieve source files from the configuration management system, or the file system of the user. Executed in a temporary folder on the client computer, which is also used to store results from the compilation phase of the verification. This temporary folder is removed after the verification is spooled to the Polyspace server.

  For example:

  ```
  <GetSource>
    cvs co –r 1.4.6.4 myProject
    mkdir sources
    cp –fvr myProject/*.c sources
  </GetSource>
  ```

  You can also use:

  ```
  <GetSource>
    find /……/myProject –name “*.cpp” | tee sources_list.txt
  </GetSource>
  ```
  and add `-sources-list-file` *`sources_list`*`.txt` to the `options` list.
- `GetVersion`. A command to retrieve the version identifier of your project. Polyspace uses the version identifier as a parameter for `-verif-version`.

  For example:

  ```
  <GetVersion>
    cd /…../myProject ; cvs status Makefile 2>/dev/null | grep 'Sticky Tag:'
    | sed 's/Sticky Tag://'  | awk '{print $1"-"$3}'| sed 's/).*$//'
  </GetVersion>
  ```

Users

A list of users, where each user is defined using the element “User” on page 14-6.

User

Define a user using three elements:

- `FirstName`. First name of user.

- `LastName`. Last name of user.
- `Mail`. Use the attributes `resultsMail` and `compilationFailureMail` to specify conditions for sending an email at the end of verification. Specify the email address in the element.
    - `resultsMail`. You can use any of the following values:
        - `ALWAYS`. Default. Email sent at the end of each automatic verification (even if the verification does not produce new run-time checks or coding rule violations).
        - `NEW-CERTAIN-FINDINGS`. Email sent only if verification produces new red, gray, NTC, or NTL checks.
        - `NEW-POTENTIAL-FINDINGS`. Email sent only if verification produces new orange check.
        - `NEW-CODING-RULES-FINDINGS`. Email sent only if verification produces new coding rule violation or warning.
        - `ALL-NEW-FINDINGS`. Email sent if verification produces a new run-time check or coding rule violation.
    - `compilationFailureMail`. Either Yes (default) or No. If Yes, email sent when automatic verification fails because of a compilation failure.

  The following is an example of `Mail`.

```
<Mail resultsMail="NEW-POTENTIAL-FINDINGS|NEW-CODING-RULES-FINDINGS"
compilationFailureMail="yes">
 user_id@yourcompany.com
</Mail>
```

SmtpConfiguration

This element is mandatory for sending email, and you must specify the following attributes:

- `server`. Your Simple Mail Transport Protocol (SMTP) server.
- `port`. SMTP server port. Optional, default is 25.

For example:

```
<SmtpConfiguration server="smtp.yourcompany.com" port="25">
```

Example of Projects.psproj

The following is an example of `Projects.psproj`:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Polyspace Metrics Automatic Verification Project File -->
<Configuration>
<Project name="Demo_C" language="C" verificationKind="INTEGRATION"
product="CODE-PROVER">
  <Options>
    -O2
    -to pass2
    -target sparc
    -temporal-exclusions-file sources/temporal_exclusions.txt
    -entry-points tregulate,proc1,proc2,server1,server2
    -critical-section-begin Begin_CS:CS1
    -critical-section-end End_CS:CS1
    -misra2 all-rules
    -includes-to-ignore sources/math.h
    -D NEW_DEFECT
  </Options>
  <LaunchingPeriod hour="12" minute="20" month="*" weekDay="1-5">
  </LaunchingPeriod>
  <Commands>
    <GetSource>
      /bin/cp -vr /yourcompany/home/auser/tempfolder/Demo_C_Studio/sources/ .
    </GetSource>
    <GetVersion>
    </GetVersion>
  </Commands>
  <Users>
    <User>
      <FirstName>Polyspace</FirstName>
      <LastName>User</LastName>
      <Mail resultsMail="ALWAYS"
    compilationFailureMail="yes">userid@yourcompany.com</Mail>
    </User>
  </Users>
</Project>
<SmtpConfiguration server="smtp.yourcompany.com" port="25">
</SmtpConfiguration>
</Configuration>
```

Open Polyspace Metrics

1 In the address bar of your Web browser, enter the following URL:

protocol`://` *ServerName*`:` *PortNumber*

- *protocol* is either `http` (default) or `https`.
- *ServerName* is the name or IP address of your Polyspace Metrics server.
- *PortNumber* is the Web server port number (default 8080)

To use HTTPS, you must set up the configuration file and the **Metrics configuration** preferences. For more information, see "Configure Web Server for HTTPS".

2 Select the **Projects** tab.

You can save the project index page as a bookmark for future use. You can also save as bookmarks any Polyspace Metrics pages that you subsequently navigate to.

To refresh the page at any point, click 

.

At the top of each column, use the filters to shorten the list of displayed projects. For example:

- In the **Project** filter, if you enter `demo_`, the browser displays a list of projects with names that begin with `demo_`.
- From the drop-down list for the **Language** filter, if you select `C`, the browser displays only C projects, if you select `C++`, the browser displays only C++ projects.

If a new verification has been carried out for a project since your last visit to the project index page, then the icon  appears before the name of the project.

If you place your cursor anywhere on a project row, in a box on the left of the window, you see the following project information:

- **Language** — For example, `Ada`, `C`, `C++`.
- **Mode** — Either `Integration` or `Unit by Unit`.
- **Last Run Name** — Identifier for last verification performed.
- **Number of Runs** — Number of verifications performed in project.

In a project row, click the **Project** name to go to the **Summary** view for that project.

Organize Polyspace Metrics Projects

The Polyspace Metrics project index allows you to display projects as categories, a useful feature when you have a large number of projects to manage. You can:

- Create multiple-level project categories.
- Move projects between categories by dragging and dropping projects.
- Rename and remove categories. When you remove a category, the software does not delete the projects within the category but moves the projects back to the parent or root level.

To create a root-level project category:

1. On the Polyspace Metrics project index, right-click a project.
2. From the context menu, select **Create Project Category**. The Add To Category dialog box opens.
3. In **Enter the name of the project category** field, enter the required name, for example, `MyNewCategory`. Then click **OK**.
4. To add projects to this new category, drag and drop the required projects into this category.

To create a subroot-level category:

1. Right-click a project category.
2. From the context menu, select **Create Project Category**. The Add To Category dialog box opens.
3. In **Enter the name of the project category** field, enter the required name, for example, `SubCategory1`. If you decide that you do not want a subroot category, but want a new root category instead, select the **Create a root project category** check box. Then click **OK**.
4. To add projects to this new category, drag and drop the required projects into this category.

To rename a project category:

1. Right-click the project category.
2. From the context menu, select **Rename Project Category**. The category name becomes editable.

3. Enter the new name for your category. Press **Return**.
4. A message dialog box opens requesting confirmation. Click **OK**. The software updates the category name.

To remove a project category:

1. Right-click the project category.
2. From the context menu, select **Delete Project Category**. If the project category is a:

   - Root-level project category, the software moves all projects to the root level and removes the project category and all associated subroot categories.
   - Subroot-level category, the software moves all projects within the subroot category to the parent level and removes the subroot category.

Note: The software does not delete projects when removing project categories.

You can move projects back to the root level from project categories without removing the project categories:

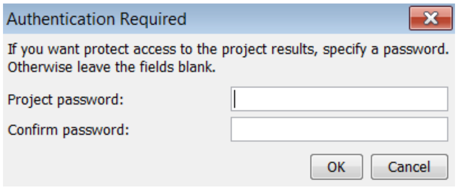
1. From within project categories, select the projects that you want to move to the root level.
2. Right-click the selected projects. From the context menu, select **Move to Root**. The software moves the projects back to the root level.

Protect Access to Project Metrics

You can restrict access to the metrics for a project by specifying a password:

- When you run a verification with Polyspace Metrics enabled or upload results to Polyspace Metrics:

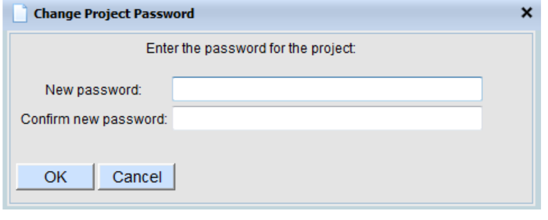
  1. The Authentication Required dialog box opens.

  2. In the **Project password** and **Confirm password** fields, enter your password.
  3. Click **OK**.

- After the creation of a project:

  1. From the Polyspace Metrics project index, right-click the project.
  2. From the context menu, select **Change/Set Password**. The Change Project Password dialog box opens.

  3. In the **New password** and **Confirm new password** fields, enter your password.
  4. Click **OK**. The software displays the password-restricted icon next to the project.

From the command line, you can use the `-password` option. For example:

```
polyspace-results-repository.exe -prog psdemo_model_link_sl -password my_passwd
```

Note: The password for a Polyspace Metrics project is encrypted. The Web data transfer is not encrypted. The password feature minimizes unintentional data corruption, but it does not provide data security. However, data transfers between a Polyspace Code Prover local host and the remote verification MJS host are always encrypted. To use a secure Web data transfer with HTTPS, see “Configure Web Server for HTTPS”.

After you enter your password, the project pages are accessible for a session that lasts 30 minutes. Access is available for this period of time, even if you close your Web browser.

If you return to the Polyspace Metrics project index, the session ends. If you click 

during a session, the project pages are accessible for another 30 minutes.

Web Browser Support

Polyspace Metrics supports the following Web browsers:

- Internet Explorer® version 7.0, or later
- Firefox® version 3.6, or later
- Google® Chrome version 12.0, or later
- Safari for Mac version 6.1.4 and 7.0.4

To use Polyspace Metrics, you must install on your computer Java, version 1.4 or later.

For the Firefox Web browser, you must manually install the required Java plug-in. For example, if your computer uses the Linux operating system:

1. Create a Firefox folder for plug-ins:

   ```
   mkdir ~/.mozilla/plugins
   ```

2. Go to this folder:

   ```
   cd ~/.mozilla/plugins
   ```

3. Create a symbolic link to the Java plug-in, which is available in the Java Runtime Environment folder of your MATLAB installation:

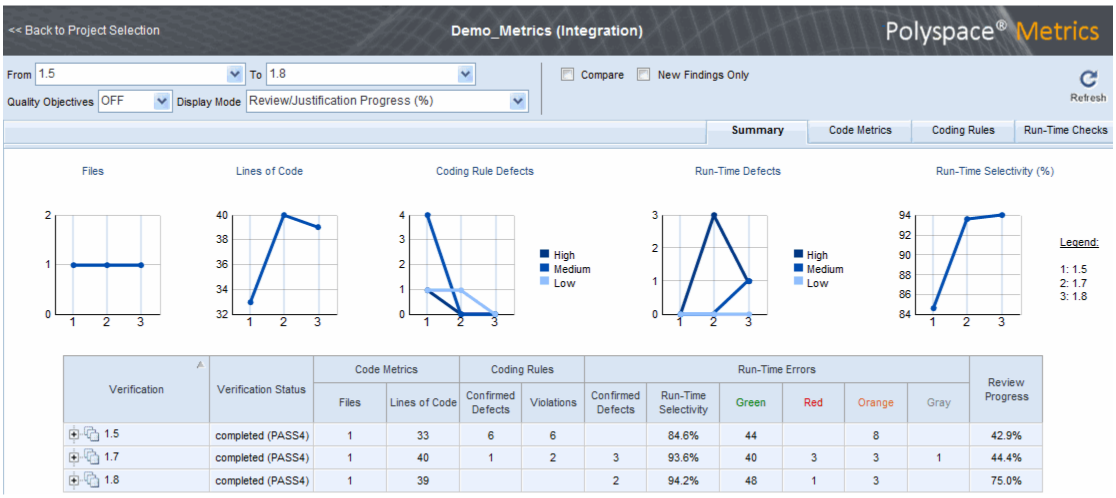
   ```
   ln -s MATLAB_Install/sys/java/jre/glnxa64/jre/lib/amd64/libnpjp2.so
   ```

Review Overall Progress

For a development manager or quality assurance engineer, the Polyspace Metrics **Summary** view provides useful high-level information, including quality trends, over the course of a project.

To obtain the **Summary** view for a project:

1. Open the Polyspace Metrics project index. See "Open Polyspace Metrics" on page 14-9.
2. Click anywhere in the row that contains your project. You see the **Summary** view.



At the top of the **Summary** view, use the **From** and **To** filters to specify the project versions that you want to examine. By default, the **From** and **To** fields specify the earliest and latest project versions respectively.

In addition, by default, the **Quality Objectives** filter is `OFF`, and the **Display Mode** is `Review/Justification Progress (%)`.

Below the filters, you see:

- Plots that reveal how the number of verified files, lines of code, defects, and run-time selectivity vary over the different versions of your project

- A table containing summary information about your project versions.

  If you have projects with two or more file modules in the Polyspace verification environment, by default, Polyspace Metrics displays verification results using the same module structure. However, Polyspace Metrics also allows you to create or delete file modules. See “Create File Module and Specify Quality Level” on page 14-21.

With the default filter settings, you can monitor progress in terms of coding rule violations and run-time checks that quality assurance engineers or developers have reviewed.

You can also monitor progress in terms of software quality objectives. You may, for example, want to find out whether the latest version fulfills quality objectives.

To display software quality information, from the **Quality Objectives** drop-down list, select `ON` .

Verification	Verification status	Code Metrics		Coding Rules		Run-Time Errors		Software Quality Objectives					
		Files	Lines of Code	Confirmed Defects	Violations	Confirmed Defects	Run-Time Reliability	Overall Status	Level	Review Progress	Code Metrics Over Threshold	Justified Coding Rules	Justified Run-Time Errors
V4	completed (PASS4)	6	463		4	3	99.4%	FAIL	SQO-4	85.7%	8	_	95.8%
V3	completed (PASS4)	6	463		4		89.9%	FAIL	Exhaustive	0.0%	8	25.0%	5.6%
V2	completed (PASS4)				4	3	88.2%	FAIL	SQO-2	23.1%	_	0.0%	55.6%
V1	completed (PASS4)				10		87.9%						

Under **Software Quality Objectives**, you look at **Review Progress** for the latest version (`V4`), which indicates that the review of verification results is incomplete (only 85.7% reviewed). You also see that the Overall Status is `FAIL`. This status indicates that, although the review is incomplete, the project code fails to meet software quality objectives for the quality level `SQO-4`. With this information, you may conclude that you cannot release version `V4` to your customers.

When Polyspace Metrics adds the results for a new project version to the repository, Polyspace Metrics also imports comments from the previous version. For this reason, you rarely see the review progress metric at 0% after verification of the first project version.

Note: You may want to find out whether your code fulfills software quality objectives at another quality level, for example, `SQO-3`. **Under Software Quality Objectives**, in the **Level** cell, select `SQO-3` from the drop-down list.

There are seven quality levels, which are based on predefined software quality objectives. You can customize these software quality objectives and modify the way quality is evaluated. See “Customize Software Quality Objectives”.

To investigate further, under **Run-Time Errors**, in the **Confirmed Defects** cell, you click the link 3. This action takes you to the **Run-Time Checks** view, where you see an expanded view of check information for each file in the project.

Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Runtime Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Runtime Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	Review Progress
V4	3	99.4%	272	66.7%	3	100.0%	6	100.0%	27	100.0%	6	FAIL	SQO-4	100.0%
__polyspace__stdstubs.c		100.0%	14	100.0%	1	100.0%		100.0%	2	100.0%		PASS	SQO-4	100.0%
example.c	2	99.0%	83	0.0%	1	100.0%	2	100.0%	8	100.0%	3	FAIL	SQO-4	100.0%
initialisations.c	1	97.7%	41	100.0%		100.0%	1	100.0%	1	100.0%		PASS	SQO-4	100.0%
main.c		100.0%	9	100.0%		100.0%	1	100.0%	3	100.0%	2	PASS	SQO-4	100.0%
single_file_analysis.c		100.0%	82	100.0%	1	100.0%	2	100.0%	8	100.0%	1	PASS	SQO-4	100.0%
tasks1.c		100.0%	26	100.0%		100.0%		100.0%	3	100.0%		PASS	SQO-4	100.0%
tasks2.c		100.0%	17	100.0%		100.0%		100.0%	2	100.0%		PASS	SQO-4	100.0%

To view a check in the Polyspace verification environment, in the relevant cell, click the numeric value for the check. The Polyspace product opens with the Results Manager perspective displaying verification information for this check.

Note: If you update check information through the Results Manager (see “Review Results” on page 14-25), when you return to Polyspace Metrics, click **Refresh** to incorporate this updated information.

If you want to view check information with reference to check type, from the **Group by** drop-down list, select `Run-Time Categories` .

Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Runtime Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Runtime Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	Checks	Quality Status	Level	Review Progress
V4	3	99.4%	272	66.7%	3	100.0%	6	100.0%	27	100.0%	6	FAIL	SQO-4	100.0%
ASRT - failure of user asse		100.0%		100.0%	1	100.0%		100.0%	6			PASS	SQO-4	100.0%
COR (Scalar) - failure of co		100.0%	13	100.0%		100.0%						PASS	SQO-4	100.0%
IDP - pointer within bounds	1	91.7%	9	0.0%	1	100.0%		100.0%	2			FAIL	SQO-4	100.0%
IRV - function returns an in		100.0%	34	100.0%		100.0%		100.0%				PASS	SQO-4	100.0%
NIP - non-initialized global p		100.0%	16	100.0%		100.0%		100.0%				PASS	SQO-4	100.0%
NIV - non-initialized global v		100.0%	32	100.0%		100.0%		100.0%				PASS	SQO-4	100.0%
NIVL - non-initialized local v	1	99.2%	115	100.0%		100.0%		100.0%	8			PASS	SQO-4	100.0%
NTC - non termination of ca		100.0%								100.0%	5	PASS	SQO-4	100.0%
NTL - non termination of loo		100.0%								100.0%	1	PASS	SQO-4	100.0%
OBAI - array index within b		100.0%	1	100.0%	1	100.0%		100.0%	1			PASS	SQO-4	100.0%
OVFL (Float) - overflow	1	100.0%	6	100.0%		100.0%		100.0%	3			PASS	SQO-4	100.0%
OVFL (Scalar) - overflow		100.0%	31	100.0%		100.0%		100.0%	6			PASS	SQO-4	100.0%
UNFL (Float) - underflow				100.0%		100.0%		100.0%				PASS	SQO-4	100.0%
UNFL (Scalar) - underflow				100.0%		100.0%		100.0%				PASS	SQO-4	100.0%
UNR - unreachable code		100.0%				100.0%	6					PASS	SQO-4	100.0%
ZDV (Float) - denominator r		100.0%	2	100.0%		100.0%		100.0%	1			PASS	SQO-4	100.0%
ZDV (Scalar) - denominator		100.0%	13	100.0%		100.0%		100.0%				PASS	SQO-4	100.0%

Returning to the **Summary** view, under **Coding Rules** and in the **Violations** cell, you also see that there are coding rule violations. You may want to review these violations. See "Review Results" on page 14-25.

Display Metrics for Single Project Version

To display metrics for a single project version:

1. In the **From** field, from the drop-down list, select the required project version.
2. In the **To** field, from the drop-down list, select the same project version.
3. In **# items** field, enter the maximum number of files for which you want information displayed.

   The software displays:

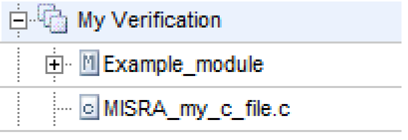
   - Bar charts with file defect information, ordering the files according to the number of defects in each file
   - A table with information about the selected project version

Create File Module and Specify Quality Level

You can group files into a module and specify a quality level for the module, which applies to all files within the module. By grouping your files in different modules, you can specify different quality levels for your files.

To create a module of files:

1. Select a tab, for example, **Summary**.
2. In the **Verification** column, expand the node corresponding to the verification that you are interested. You see the verified files.
3. Select the files that you want to place in a module.
4. Right-click the selected files, and, from the context menu, select **Add To Module**. The Add to Module dialog box opens.
5. In the text field, enter the name for your new module, for example, `Example_module`. Click **OK**. You see a new node.



To specify a quality level for the module:

1. Select the row containing the module.
2. Under **Software Quality Objectives**, click the **Level** cell.
3. From the drop-down list, select the quality level for your module.

To remove files from a module:

1. Expand the node corresponding to the module.
2. Select the files that you want to remove from the module.
3. Right-click your selection, and from the context menu, select **Remove From Module**. The software removes the files from the module. If you remove all files from the module, the software also removes the module from the tree.

Note: You can drag and drop files into and out of folders. For example, you can select `MISRA_my_c_file.c` and drag the file to `Example_module`.

Compare Project Versions

You can compare metrics of two versions of a project.

1. In the **From** drop-down list, select one version of your project.
2. In the **To** drop-down list, select a newer version of your project.
3. Select the **Compare** check box.

In each view, for example, **Summary**, you see metric differences and tooltip messages that indicate whether the newer version is an improvement over the older version.

1.0 vs 2.0	Verification Status	Code Metrics			Coding Rules			Run-Time Errors							Overall Trend
		Files	Lines of Code	All Metrics Trend	Confirmed Defects	Violations	All Metrics Trend	Confirmed Defects	Run-Time Selectivity	Green	Red	Orange	Gray	All Metrics Trend	
2.0 (delta)	completed (PASS	6	853 (+1)			286 (-4)			96.8% (+0.1%)	682 (+22)	13 (-4)	23	3 (+3)		
__polyspace_	completed (PASS								99.5%	213		1			
dataflow.c	completed (PASS		164			39			92.7%	76		6			
dynamicmemo	completed (PASS		156 (+1)			77 (+1)			97.3% (-0.6%)	141 (+3)	1 (-1)	4 (+1)			
numeric.c	completed (PASS		217			54 (-2)			99.1% (+0.2%)	97 (+18)	6 (-2)	1	3 (+3)		
other.c	completed (PASS		87			23			72.4%	20	1	8			
programming.	completed (PASS		117			60 (-3)			96.9% (+1.5%)	62 (+1)	0 (-1)	2 (-1)			
staticmemory.	completed (PASS		112			33			98.7%	73	5	1			

Review New Findings

You can specify a project version and focus on the differences between the verification results of your specified version and the previous verification. For example, consider a project with versions `1.0`, `1.1`, `1.2`, `2.0`, and `2.1`.

1. In the **To** field, specify a version of your project, for example, `2.0`.
2. Select the **New Findings Only** check box. In the **From** field, you see `1.2` in dimmed lettering, which is the previous verification. The charts and tables now show the changes in results with respect to the previous verification.

To manage the content of the bar charts, in the **# items** field, enter the maximum number of files for which you want information displayed. The software displays file defect information, ordering the files according to the number of defects in each file.

Review Results

This example shows how to review results beginning from the Polyspace Metrics interface. To review results, you must have Polyspace installed on your local computer.

1 In the Polyspace Metrics interface, click the **Summary** tab.

Verification	Verification Status	Code Metrics		Coding Rules		Run-Time Errors						Review Progress
		Files	Lines of Code	Confirmed Defects	Violations	Confirmed Defects	Run-Time Selectivity	Green	Red	Orange	Gray	
1.0	completed (PASS4)	6	428		43		92.2%	260	4	23	6	0.0%
example.c	completed (PASS4)		125		7		90.5%	82	2	9	2	0.0%
initialisations.c	completed (PASS4)		59		13		97.7%	41		1	1	0.0%
main.c	completed (PASS4)		42		4		78.6%	9	1	3	1	0.0%
single_file_analysis	completed (PASS4)		72		8		91.4%	82	1	8	2	0.0%
tasks1.c	completed (PASS4)		80		3		96.6%	28		1		0.0%
tasks2.c	completed (PASS4)		50		8		94.7%	18		1		0.0%

2 To see details about run-time errors, on the **Run-Time Errors** column, click a cell value.

Verification	Confirmed Defects	Run-Time Selectivity	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)					Non-terminating Constructs		Review Progress
			Checks	Reviewed	Checks	Reviewed	Checks	Reviewed	Checks	Path-Related Issues	Bounded Input Issues	Unbounded Input Issues	Reviewed	Checks	
1.0		92.2%	260	0.0%	3	0.0%	6	0.0%	23	1		6	0.0%	1	0.0%
example.c		90.5%	82	0.0%	2	0.0%	2	0.0%	9			4			0.0%
initialisations.c		97.7%	41			0.0%	1	0.0%	1	1					0.0%
main.c		78.6%	9			0.0%	1	0.0%	3				0.0%	1	0.0%
single_file_analysis.c		91.4%	82	0.0%	1	0.0%	2	0.0%	8			2			0.0%
tasks1.c		96.6%	28					0.0%	1						0.0%
tasks2.c		94.7%	18					0.0%	1						0.0%

3 To see a breakdown of the errors in a file by checks, expand a filename node.

Verification	Confirmed Defects	Run-Time Selectivity	Green Code	Systematic Run-Time Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Run-Time Errors (Orange Checks)					Non-terminating Constructs	
			Checks	Reviewed	Checks	Reviewed	Checks	Reviewed	Checks	Path-Related Issues	Bounded Input Issues	Unbounded Input Issues	Reviewed	Checks
1.0		92.2%	260	0.0%	3	0.0%	6	0.0%	23	1		6	0.0%	1
example.c		90.5%	82	0.0%	2	0.0%	2	0.0%	9			4		
ASRT - User assertion		0.0%						0.0%	1					
IDP - Illegally dereferenced pointer		88.9%	7	0.0%	1			0.0%	1			1		
IRV - Initialized return value		100.0%	14											
NIP - Non-initialized pointer		100.0%	12											
NIV - Non-initialized variable		100.0%	3											

Tip To expand all subnodes under a node, right-click the node and select **Expand All Nodes**.

4. If a check produces a red error, the check has a value under the **Systematic Runtime Errors (Red Checks)** column. Click this value to view the check in the Polyspace verification environment.

   For instance, if you click the **Systematic Runtime Errors (Red Checks)** value on the **IDP** row in `example.c`, the **Illegally dereferenced pointer** check in that file appears in the Polyspace verification environment.
5. In the Polyspace verification environment, on the **Results Summary** pane, enter review information such as:

   - **Classification**: If you choose the classifications `High`, `Medium` or `Low`, when you save the classification, the software updates the **Confirmed Defects** column in Polyspace Metrics.
   - **Status**: If you choose a review status, when you save the status, the software updates the **Review Progress** column in Polyspace Metrics.
   - **Comment**
6. Save the review information. The software saves this information to a local folder. To change this local folder, select **Tools** > **Preferences** and enter the location under the **Server Configuration** tab.

   If you want to save the information to the local folder *and* the Polyspace Metrics repository, on the Results Manager toolbar, select **Metrics** > **Save comments to Metrics**.

Save Review Comments

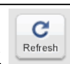
By default, when you save your project (**Ctrl+S**), the software saves your comments and justifications to a local folder. To specify the folder location, select **Tools** > **Preferences** and enter the location under the **Server Configuration** tab.

If you want to save your comments and justifications to a local folder *and* the Polyspace Metrics repository, on the Results Manager toolbar, select **Metrics** > **Save comments to Metrics**.

This default behavior allows you to upload your review comments and justifications only when you are satisfied that your review is, for example, correct and complete.

If you want the software to save your comments and justifications to the local folder *and* the Polyspace Metrics repository whenever you save your project (**Ctrl+S**):

1. Select **Tools** > **Preferences** > **Server configuration**.
2. Select the check box **Save justifications in the Polyspace Metrics repository**.

Note: In Polyspace Metrics, click 

to view updated information.

Fix Defects

If you are a software developer, you can begin to fix defects in code when, for example:

- In the **Summary** view, **Review Progress** shows 100%
- Your quality assurance engineer informs you

You can use Polyspace Metrics to access defects that you must fix.

Within the **Summary** view, under **Run-Time Errors**, click any cell value. This action takes you to the **Run-Time Checks** view.

You want to fix defects that are classified as defects.

Verification	Confirmed Defects	Run-Time Selectivity	Green Code	Systematic Runtime Errors (Red Checks)	
			Checks	Reviewed	Checks
V4	4	93.2%	272	100.0%	3
__polyspace__stc	1	97.7%	14	100.0%	1
example.c	2	92.2%	83	100.0%	1
initialisations.c	1	97.8%	41	100.0%	
main.c		85.0%	9	100.0%	
single_file_analys		91.7%	82	100.0%	1
tasks1.c		89.7%	26	100.0%	
tasks2.c		89.5%	17	100.0%	

In the **Confirmed Defects** column, click a non-zero cell value. For example, if you click 2, Polyspace Code Prover opens with the checks visible in the **Results Summary** tab.

Double-click the row containing a check. In the **Check Details** pane, you see information about this check. You can now go to the source code and fix the defect.

Predefined SQO Levels

The Software Quality Objectives or SQOs are a set of thresholds that generate a **Quality Status** of **PASS** or **FAIL** for your verification results. You can use a predefined SQO level or define your own SQOs. Following are the quality thresholds specified by each predefined SQO.

SQO Level 1

Metric	Threshold Value
Comment density of a file	20
Number of paths through a function	80
Number of `goto` statements	0
Cyclomatic complexity	10
Number of calling functions	5
Number of calls	7
Number of parameters per function	5
Number of instructions per function	50
Number of call levels in a function	4
Number of `return` statements in a function	1
Language scope, an indicator of the cost of maintaining or changing functions. Calculated as follows: `(N1+N2) / (n1+n2)` • *n1* — Number of different operators • *N1* — Total number of operators • *n2* — Number of different operands • *N2* — Total number of operands	4
Number of recursions	0
Number of direct recursions	0

Metric	Threshold Value
Number of unjustified violations of the following MISRA C:2004 rules: • 5.2 • 8.11, 8.12 • 11.2, 11.3 • 12.12 • 13.3, 13.4, 13.5 • 14.4, 14.7 • 16.1, 16.2, 16.7 • 17.3, 17.4, 17.5, 17.6 • 18.4 • 20.4	0
Number of unjustified violations of the following MISRA C:2012 rules: • 8.8, 8.11, and 8.13 • 11.1, 11.2, 11.4, 11.5, 11.6, and 11.7 • 14.1 and 14.2 • 15.1, 15.2, 15.3, and 15.5 • 17.1 and 17.2 • 18.3, 18.4, 18.5, and 18.6 • 19.2 • 21.3	0

Metric	Threshold Value
Number of unjustified violations of the following MISRA C++ rules: • 2-10-2 • 3-1-3, 3-3-2, 3-9-3 • 5-0-15, 5-0-18, 5-0-19, 5-2-8, 5-2-9 • 6-2-2, 6-5-1, 6-5-2, 6-5-3, 6-5-4, 6-6-1, 6-6-2, 6-6-4, 6-6-5 • 7-5-1, 7-5-2, 7-5-4 • 8-4-1 • 9-5-1 • 10-1-2, 10-1-3, 10-3-1, 10-3-2, 10-3-3 • 15-0-3, 15-1-3, 15-3-3, 15-3-5, 15-3-6, 15-3-7, 15-4-1, 15-5-1, 15-5-2 • 18-4-1	0

SQO Level 2

In addition to all the requirements of SQO Level 1, this level includes the following thresholds:

Metric	Threshold Value
Number of unjustified red checks	0
Number of unjustified “Non-terminating call” and “Non-terminating loop” checks	0

SQO Level 3

In addition to all the requirements of SQO Level 2, this level includes the following thresholds:

Metric	Threshold Value
Number of unjustified gray “Unreachable code” checks	0

SQO Level 4

In addition to all the requirements of SQO Level 3, this level includes the following thresholds:

Metric	Threshold Value
Percentage of justified orange checks, calculated as (green checks + *justified* orange checks) / (green checks + *all* orange checks)	“C++ specific checks”: 50
	“Correctness condition”: 60
	“Division by zero”: 80
	“Exception handling”: 50
	“Function returns a value”: 80
	“Illegally dereferenced pointer”: 60
	“Initialized return value”: 80
	“Non-initialized local variable”: 80
	“Non-initialized pointer”: 60
	“Non-initialized variable”: 60
	“Non-null this-pointer in method”: 50
	“Object oriented programming”: 50
	“Out of bounds array index”: 80
	“Overflow”: 60
	“Shift operations”: 80
	“User assertion”: 60

SQO Level 5

In addition to all the requirements of SQO Level 4, this level includes the following thresholds:

Metric	Threshold Value
Number of unjustified violations of the following MISRA C:2004 rules: • 6.3 • 8.7 • 9.2, 9.3 • 10.3, 10.5 • 11.1, 11.5 • 12.1, 12.2, 12.5, 12.6, 12.9, 12.10 • 13.1, 13.2, 13.6 • 14.8, 14.10 • 15.3 • 16.3, 16.8, 16.9 • 19.4, 19.9, 19.10, 19.11, 19.12 • 20.3	0
Number of unjustified violations of the following MISRA C:2012 rules: • 8.8, 8.11, and 8.13 • 11.1, 11.2, 11.4, 11.5, 11.6, 11.7, and 11.8 • 12.1 and 12.3 • 13.2 and 13.4 • 14.1, 14.2 and 14.4 • 15.1, 15.2, 15.3, 15.5, 15.6 and 15.7 • 16.4 and 16.5 • 17.1,17.2, and 17.4 • 18.3, 18.4, 18.5, and 18.6 • 19.2 • 20.4, 20.6, 20.7, 20.9, and 20.11 • 21.3	0

Metric	Threshold Value
Number of unjustified violations of the following MISRA C++ rules: • 3-4-1, 3-9-2 • 4-5-1 • 5-0-1, 5-0-2, 5-0-7, 5-0-8, 5-0-9, 5-0-10, 5-0-13, 5-2-1, 5-2-2, 5-2-7, 5-2-11, 5-3-3, 5-2-5, 5-2-6, 5-3-2, 5-18-1 • 6-2-1, 6-3-1, 6-4-2, 6-4-6, 6-5-3 • 8-4-3, 8-4-4, 8-5-2, 8-5-3 • 11-0-1 • 12-1-1, 12-8-2 • 16-0-5, 16-0-6, 16-0-7, 16-2-2, 16-3-1	0
Percentage of justified orange checks, calculated as `(green checks + justified orange checks) / (green checks + all orange checks)`	"C++ specific checks": 70
	"Correctness condition": 80
	"Division by zero": 90
	"Exception handling": 70
	"Function returns a value": 90
	"Illegally dereferenced pointer": 70
	"Initialized return value": 90
	"Non-initialized local variable": 90
	"Non-initialized pointer": 70
	"Non-initialized variable": 70
	"Non-null this-pointer in method": 70
	"Object oriented programming": 70
	"Out of bounds array index": 90
	"Overflow": 80
	"Shift operations": 90
	"User assertion": 80

SQO Level 6

In addition to all the requirements of SQO Level 5, this level includes the following thresholds:

Metric	Threshold Value
Percentage of justified orange checks, calculated as `(green checks + justified orange checks) / (green checks + all orange checks)`	"C++ specific checks": 90
	"Correctness condition": 100
	"Division by zero": 100
	"Exception handling": 90
	"Function returns a value": 100
	"Illegally dereferenced pointer": 80
	"Initialized return value": 100
	"Non-initialized local variable": 100
	"Non-initialized pointer": 80
	"Non-initialized variable": 80
	"Non-null this-pointer in method": 90
	"Object oriented programming": 90
	"Out of bounds array index": 100
	"Overflow": 100
	"Shift operations": 100
	"User assertion": 100

SQO Exhaustive

In addition to all the requirements of SQO Level 1, this level includes the following thresholds. The thresholds for coding rule violations apply only if you check for coding rule violations.

Metric	Threshold Value
Number of unjustified MISRA C and MISRA C++ coding rule violations	0

Metric	Threshold Value
Number of unjustified red checks	0
Number of unjustified “Non-terminating call” and “Non-terminating loop” checks	0
Number of unjustified gray “Unreachable code” checks	0
Percentage of justified orange checks, calculated as `(green checks + `*`justified`*` orange checks) / (gre`	100

For information on the rationales behind these levels, see Software Quality Objectives for Source Code.

Related Examples

- “Customize Software Quality Objectives”

Customize Software Quality Objectives

This example shows how to customize the software quality objectives (SQO-s) that your results are compared against. When you run verification to produce metrics, Polyspace uses predefined SQO-s to generate a **Quality Status** of **PASS** or **FAIL** for your results. However, you can define your own SQO-s.

Define Custom SQO

1 Save the following content in an XML file. Name the file `Custom-SQO-Definitions.xml`.

```
<?xml version="1.0" encoding="UTF-8"?>
<MetricsDefinitions>
    <!-- Copyright 2010-2014 The MathWorks, Inc. -->

    <SQO ID="Custom_SQO_Level" ApplicableProduct="Code Prover">
        <comf>20</comf>
        <path>80</path>
        <goto>0</goto>
        <vg>10</vg>
        <calling>5</calling>
        <calls>7</calls>
        <param>5</param>
        <stmt>50</stmt>
        <level>4</level>
        <return>1</return>
        <vocf>4</vocf>
        <ap_cg_cycle>0</ap_cg_cycle>
        <ap_cg_direct_cycle>0</ap_cg_direct_cycle>
        <Num_Unjustified_Violations>Custom_MISRA_Rules_Set
</Num_Unjustified_Violations>
        <Num_Unjustified_Red>0</Num_Unjustified_Red>
        <Num_Unjustified_NT_Constructs>0
</Num_Unjustified_NT_Constructs>
        <Num_Unjustified_Gray>0</Num_Unjustified_Gray>
        <Percentage_Proven_Or_Justified>
Custom_Runtime_Checks_Set</Percentage_Proven_Or_Justified>
    </SQO>

    <CodingRulesSet ID="Custom_MISRA_Rules_Set">
        <Rule Name="MISRA_C_5_2">0</Rule>
        <Rule Name="MISRA_C_17_6">0</Rule>
    </CodingRulesSet>
```

```
    <RuntimeChecksSet ID="Custom_Runtime_Checks_Set">
        <Check Name="OBAI">80</Check>
        <Check Name="IDP">60</Check>
    </RuntimeChecksSet>

</MetricsDefinitions>
```

2 Save this XML file in the folder where remote analysis data is stored, for example, `C:\Users\JohnDoe\AppData\Roaming\Polyspace_RLDatas`.

   If you want to change the folder location, select **Metrics** > **Metrics and Remote Server Settings**.

3 Modify the content of this file to specify your own quality thresholds. For more information, see “Elements in Custom SQO File”.

4 For specifying coding rules, begin the rule name with the appropriate string followed by the rule number. Use _ instead of a decimal point in the rule number.

Rule	String	Rule numbers
MISRA C	`MISRA_C_`	“MISRA C:2004 Coding Rules”
MISRA C++	`MISRA_Cpp_`	“MISRA C++ Coding Rules”
JSF C++	`JSF_Cpp_`	“JSF C++ Coding Rules”
Custom coding rules	`Custom_`	“Custom Naming Convention Rules”

5 For specifying checks, use the appropriate check acronym. For more information, see “Check Acronyms”.

Use Custom SQO

To apply the custom SQO to your results:

1 Open your results in the Polyspace Metrics web interface.

- If you started the verification from your desktop, you can open the web interface from the Polyspace user interface. Select the result file on the **Project Browser** pane. Select **Metrics** > **Open Metrics**.
- If the verification was started from another desktop, open the web interface directly in your web browser. For more information, see “Open Polyspace Metrics”.

2 From the **Quality Objectives** drop down list in the upper left corner, select `ON`.

3 Under the **Level** column below **Software Quality Objectives**, select the cell corresponding to the result you want. From the drop down list, select `Custom-SQO-Level`.

   The software compares the thresholds you had specified against your results and updates the **Quality Status** column with **PASS** or **FAIL**.

Elements in Custom SQO File

The following tables list the XML elements that can be added to the custom SQO file. The content of each element specifies a threshold against which the software compares verification results. For each element, the table lists the metric to which the threshold applies. Here, HIS refers to the Hersteller Initiative Software.

HIS Metrics

Element	Metric
`comf`	Comment density of a file
`path`	Number of paths through a function
`goto`	Number of `goto` statements
`vg`	Cyclomatic complexity
`calling`	Number of calling functions
`calls`	Number of calls
`param`	Number of parameters per function
`stmt`	Number of instructions per function
`level`	Number of call levels in a function
`return`	Number of `return` statements in a function
`vocf`	Language scope, an indicator of the cost of maintaining or changing functions. Calculated as follows: *(N1+N2) / (n1+n2)* • *n1* — Number of different operators • *N1* — Total number of operators • *n2* — Number of different operands

Element	Metric

	• *N2* — Total number of operands
	
	The computation is based on the preprocessed source code. Consider the following code.
	
	`int f(int i)`
	`  {`
	`    if (i == 1)`
	`      return i;`
	`    else`
	`      return i * g(i-1);`
	`  }`
	The code contains the following:
	
	• Distinct operators — `int`, `(`, `)`, `{`, `if`, `==`, `return`, `else`, `*`, `-`, `;`, and `}`
	• Number of operators —12
	• Number of operator occurrences —19
	• Distinct operands — `f`, `i`, `1`, and `g`
	• Number of operands — 4
	• Number of operand occurrences — 9
	
	Therefore, the language scope for the code is `VOCF = (19 + 9) / (12 + 4)`, that is, `1.8`.

`ap_cg_cycle`	Number of recursions
`ap_cg_direct_cycle`	Number of direct recursions
`Num_Unjustified_Violations`	Number of unjustified violations of MISRA C rules specified by entries under the element `CodingRulesSet`
`Num_Unjustified_Red`	Number of unjustified red checks
`Num_Unjustified_NT_Constructs`	Number of unjustified “Non-terminating call” and “Non-terminating loop” checks
`Num_Unjustified_Gray`	Number of unjustified gray “Unreachable code” checks

Element	Metric
`Percentage_Proven_Or_Justified`	Percentage of justified orange checks, calculated as `(green checks + `*`justified`*` orange checks) / (green checks + a`

Non-HIS Metrics

Element	Description of metric
`fco`	Estimated function coupling, which is calculated as follows: `SOC - DFF + 1` • `SOC` — Sum (over all file functions) of calls within body of each function • `DFF` — Number of defined file functions Does not take into account member functions of a template class or template functions. Computed metric reflects coupling of non-template functions only.
`flin`	Number of lines within function body
`fxln`	Number of execution lines within function body A variable declaration with initialization is treated as a statement, but not as an execution line of function body.
`ncalls`	Number of calls within function body Includes explicit and implicit calls to constructors.
`pshv`	Number of protected shared variables
`unpshv`	Number of unprotected shared variables

Polyspace Metrics Assumptions

Polyspace makes the following assumptions when calculating metrics:

- Polyspace does not evaluate metrics for template functions or member functions of a template class.
- A `catch` statement is treated as a control flow statement that generates two paths and increments cyclomatic complexity by one.
- Explicit and implicit calls to constructors are taken into account in the computation of the number of distinct calls (`calls`).
- The computation of the number of call graph cycles does not take into account template functions or member functions of a template class.

Status Acronyms

When you click a link, StatusAcronym elements are passed to the Polyspace verification environment. This feature allows you to define, through your Polyspace server, additional items for the drop-down list of the **Status** field in **Check Review**.

Polyspace Metrics provides the following default elements:

```
<StatusAcronym Justified="yes" Name="Justify with code/model annotations"/>
<StatusAcronym Justified="yes" Name="No action planned"/>
```

The **Name** attribute specifies the name that appears on the **Status** field drop-down list. If you specify the Justify attribute to be yes, then when you select the item, for example, No action planned, the software automatically selects the **Justified** check box. If you do not specify the Justify attribute, then the **Justified** check box is not selected automatically.

You can remove the default elements and create new StatusAcronym elements, which are available to users of your Polyspace server.

Code Metrics

The following table provides descriptions of the metrics that you see in the **Code Metrics** view.

Level	Metric name	Description	HIS metric?
Project	**Files**	Number of source files.	No
	Header Files	Directly and indirectly included header files, including Polyspace internal header files and the header files included by these internal files. The number of included headers shows how many header files are verified for the current project.	No
	Recursions	Call graph recursions. Number of call cycles over one or more functions. If one function is at the same time directly recursive (it calls itself) and indirectly recursive, the call cycle is counted only once. Call cycle through pointer is not considered.	Yes
	Direct Recursions	Number of direct recursions.	Yes
	Protected Shared Variables	Number of protected shared variables. Only Polyspace Code Prover provides this metric using information from `PASS0` of the verification.	No
	Non-Protected Shared Variables	Number of unprotected shared variables. Only Polyspace Code Prover provides this metric using information from `PASS0` of the verification.	No
File	**Lines**	Number of lines. Physical lines including comment and blank lines	No

Level	Metric name	Description	HIS metric?
	Lines of Code	Number of lines without comment, that is, lines excluding blank or comment lines. A line that contains code and comment is counted. See "Number of Lines of Code Calculation" on page 14-57.	No
	Comment Density	Relationship of the number of comments (outside and within functions) to the number of statements. An internal comment is a comment that begins and/or ends with the source code line; otherwise a comment is considered external. In the comment density calculation, the comments in the header file (before the first preprocessing directive or the first token in the source file) are ignored. Two comments that are not separated by a token are considered as one occurrence. The number of statements within a file is the number of semicolons in the preprocessed source code except within `for` loops, structure or union field definitions, comments, literal strings, preprocessing directives, or parameters lists in the scope of K & R style function declarations. The comment density is: number of external comment occurrences / number of statements	Yes

Level	Metric name	Description	HIS metric?
	Estimated Function Coupling	Inter-file dependency. Metric is equal to: sum of call occurrences – number of functions defined in the file + 1. The function coupling is calculated in a preprocessed file.	No
Function	**Lines Within Body**	Total number of lines in a function body, including blank and comment lines: number of lines between the first `{` and the last `}` of a function body. The number of lines within a function body is calculated in the preprocessed file. If a function body contains an `#include` directive, the included file source code is taken into account in the calculation of the lines of this function. The preprocessing directives lines are taken into account in the calculation of the lines.	No
	Executable Lines	Total number of lines with source code tokens between a function body '`{`' and '`}`' that are not declarations (w/o static initializer), comments, braces, or preprocessing directives. The number of execution lines within a function body is calculated in a preprocessed file. If the function body contains an `#include` directive, the included file source code is taken into account in the calculation of the execution lines of this function.	No

Level	Metric name	Description	HIS metric?
	Cyclomatic Complexity	Number of decisions + 1. The `?:` operator is considered a decision, but the combination of `&&` `||` is considered to be only one decision.	Yes

Level	Metric name	Description	HIS metric?

	Language Scope	The language scope is an indicator of the cost of maintaining or changing functions.
		
		Metric value = (N1+N2) / (n1+n2)
		
		where:
		
		n1 = number of different operators
		
		N1 = sum of all operators
		
		n2 = number of different operands
		
		N2 = sum of all operands
		
		The computation is based on the preprocessed source code.
		Consider the following code.
		
		`int f(int i)`
		`{`
		` if (i == 1)`
		`   return i;`
		` else`
		`  return i * g(i-1);`
		`}`
		
		In this code, the:
		
		• Distinct operators are `int`, `(`, `)`,`{`, `if`, `==`, `return`, `else`, `*`, `-`, `;`, `}`
		• Number of operators is 12
		• Number of operator occurrences is 17
		• Distinct operands are `f`, `i`, `1`, `g`
		• Number of operands is 4
		• Number of operand occurrences is 9
		
		For this example, the metric value is:
		
		`1.8 ((17 + 9) / (12 + 4))`
			Yes

<table>
<tr><th>Level</th><th>Metric name</th><th>Description</th><th>HIS metric?</th></tr>
<tr><td></td><td>Paths</td><td>Estimated static path count.

The following code contains one path.<pre>
switch (n)
     {
      case 1:
      case 2:
      case 3:
      case 4:
      default:
        break;
      }
</pre>The following code contains two paths.<pre>
switch (n)
     {
      case 1:
      case 2:
        break;
      case 3:
      case 4:
      default:
        break;
      }
</pre>Implicit <code>else</code> is considered as one path.

This value is not computed when a <code>goto</code> exists within the function body.</td><td>Yes</td></tr>
<tr><td></td><td>Calling Functions</td><td>Number of distinct callers of a function. Call through pointer is not considered.</td><td>Yes</td></tr>
<tr><td></td><td>Called Functions</td><td>Number of distinct functions called by a function. Call through pointer is not considered. See description for Call Occurences</td><td>Yes</td></tr>
</table>

<table>
<tr><th>Level</th><th>Metric name</th><th>Description</th><th>HIS metric?</th></tr>
<tr><td></td><td>Call Occurences</td><td>Number of call occurrences within function body.

Similar to Called Functions except that each call of a function is counted.

Consider the following code.
<pre>
int callee_1() {return 0;}
int callee_2() {return 0;}

int get()
{
  return callee_1() + callee_1() + callee_2() + c
}
</pre>
For this code, the Called Functions value is 2 but the Call Occurences value is 4.</td><td>No</td></tr>
</table>

Level	Metric name	Description	HIS metric?
	Instructions	Number of instructions per function, which is a measure of function complexity. Let STMT(*function_code_element*) represent the metric value for *function_code_element*. The following applies: STMT (*simple_statement*) = 1 STMT (*empty_statement*) = 0 STMT (*label*) = 0 STMT (*block*) = STMT (*block_body*) STMT (*declaration_without_initializer*) = 0; STMT (*declaration_with_initializer)* = 1; STMT (*other_statements*) = 1 where *other_statements* are `break`, `continue`, `do-while`, `for`, `goto`, `if`, `return`, `switch`, `while`.	Yes

<table>
<tr><th>Level</th><th>Metric name</th><th>Description</th><th>HIS metric?</th></tr>
<tr><td></td><td>Call Levels</td><td>

Maximum depth of nesting of control flow structures such as `if`, `switch`, `for` or `while` inside a function body.

In the following code, the function `foo` has a call level of 3.

```
int foo(int &x, int &y)
{
  int ret = 0;
  if (x == 0)
  /* call level 1 */
  {
   ret = 0;
  }
  else if (x >= y )
  /* call level 2 */
  {
   ret = 0;
  }
  else
  {
   while(x<y)
   /* call level 3 */
   {
    x+=2;
    ret++;
   }
  }
 return ret;
}
```

If there are no control flow structures, the call level is 1.

To improve code readability, reduce this metric. For instance, in the above code, you can convert the content of the `else` branch into a separate function and call that function from the `else` branch. This action reduces the call level to 2.

</td><td>Yes</td></tr>
</table>

Level	Metric name	Description	HIS metric?
	Function Parameters	Number of parameters per function. A measure of the complexity of the function interface. Ellipsis (`...`) parameter is ignored.	Yes
	Goto Statements	Number of `goto` statements within a function. `break` and `continue` are not counted as `goto` statements. If this value is > 0, the number of **Paths** cannot be computed.	Yes
	Return Points	Number of `return` points within a function. Number of explicit `return` statements within a function body. The following function has zero return points: `void f(void) {},` The following function has one return point: `void f(void) {return;}`	Yes

Run-Time Checks

Some of the columns on the **Run-Time Checks** tab are described below. You can group the information in the columns by **Files** or **Run-Time Categories**.

Name	Description
Run-Time Selectivity	Percentage of checks that returned either red or green.
Checks	Number of checks of a certain color
Reviewed	Red, gray or orange checks for which you have performed the following actions in the Polyspace user interface: • You have entered review information such as **Classification** and **Status**. • You have saved the review information in the Polyspace Metrics repository using the  button. Depending on your **Display Mode**, this metric is: • Expressed as a number or percentage. • Replaced by the **To Review** metric.
Path-Related Issues	Number of checks in a function body that are orange because a fraction of calls to the function cause a run-time error. For more information, see "Path".
Bounded Input Issues	Number of checks in a function body that are orange because a fraction of the inputs to the function cause a run-time error. The checks come under the category **Bounded Input Issues** if you restrict the inputs using **Data Range Specifications**. For more information, see "Bounded Input Values".

Name	Description
Unbounded Input Issues	Number of checks in a function body that are orange because a fraction of the inputs to the function cause a run-time error. The checks come under the category **Unbounded Input Issues** if you do not restrict the input values. For more information, see “Unbounded Input Values”.
Review Progress	Checks that you have reviewed. This column aggregates the information in the three **Reviewed** columns. Depending on your **Display Mode**, this metric is: • Expressed as a number or percentage. • Replaced by the **Remaining Review Work** column.

Related Examples

- “Review Results”

More About

- “Code Metrics”
- “Data Range Specifications”

Number of Lines of Code Calculation

For the following code, the line count in a text editor is 15 lines.

```
#include <stddef.h>

unsigned char v1,v2,v3;

unsigned char myfunc(void)
{
  if(v1>v2)
  {
     v3=v2
    + v1;
  }

  return v3;
}
```

Polyspace Metrics calculates the following:

- Number of lines — 14
- Number of lines of code — 11
- Number of lines within body — 7
- Executables lines — 4

The verification log file displays the following:

- Lines of code — 14
- Lines of code without comments — 11

Administer Results Repository

In this section...

Administer Repository Through Web Browser

To rename a project:

1. In your Polyspace Metrics project index, right-click the row with the project that you want to rename.
2. From the context menu, select **Rename Project**.
3. In the **Project** field, enter the new name.

To delete a project:

1. In your Polyspace Metrics project index, right-click the row with the project that you want to delete.
2. From the context menu, select **Delete Project from Repository**.

To rename a verification:

1. Select the **Summary** view for your project.
2. In the **Verification** column, right-click the verification that you want to rename.
3. From the context menu, select **Rename Run**.
4. In the **Project** field, edit the text to rename the verification.

To delete a verification:

1. Select the **Summary** view for your project.
2. In the **Verification** column, right-click the verification that you want to delete.
3. From the context menu, select **Delete Run from Repository**.

Administer Repository From Command Line

You can run the following batch command with various options.

```
MATLAB_Install/polyspace/bin/polyspace-results-repository[.exe]
```

- To rename a project or version, use the following options:

  ```
  [-f] [-server hostname] -rename [-prog old_prog -new-prog new_prog]
  [-verif-version old_version -new-verif-version new_version]
  ```

  - *hostname* — Polyspace server. `localhost` if you run the command directly on the server.
  - *old_prog* — Current project name
  - *new_prog* — New project name
  - *old_version* — Old version name
  - *new_version* — New version name
  - `-f` — Specifies that confirmation is not requested
- To delete a project or version, use the following options:

  ```
  [-f] [—server hostname] -delete -prog prog [-verif-version version]
  [-unit-by-unit|-integration]
  ```

  - *hostname* — Polyspace server. `localhost` if you run the command directly on the server.
  - *prog* — Project name
  - *version* — Version name. If omitted, all versions are deleted
  - `unit-by-unit|-integration` — Delete only unit-by-unit or integration verifications
  - `-f` — Specifies that confirmation is not requested
- To get information about other commands, for example, retrieve a list of projects or versions, and download and upload results, use the `-h` option.

Renaming and Deleting Verifications From the Command Line

To change the name of the project `psdemo_model_link_sl` to `Track_Quality`:

```
polyspace-results-repository.exe -prog psdemo_model_link_sl
-new-prog Track_Quality -rename
```

To delete the fifth verification run with version `1.0` of the project `Track_Quality`:

```
polyspace-results-repository.exe -prog Track_Quality -verif-version 1.0
-run-number 5 -delete
```

To rename verification `1.2` as `1.0`:

```
polyspace-results-repository.exe -prog Track_Quality -verif-version 1.2
-new-verif-version 1.0 -rename
```

To rename the fourth verification run with version `1.0` as version `0.4`:

```
polyspace-results-repository.exe -prog Track_Quality -verif-version 1.0
-run-number 4 -new-verif-version 0.4 -rename
```

Backup Results Repository

To preserve your Polyspace Metrics data, create a backup copy of the results repository *`PolyspaceRLDatas`*`/results-repository` — *`PolyspaceRLDatas`* is the path to the folder where Polyspace stores data generated by remote verifications. See "Set Up Polyspace Metrics".

For example, on a Linux system, do the following:

1. `$cd` *`PolyspaceRLDatas`*
2. `$zip -r` *`Path_to_backup_folder`*`/results-repository.zip results-repository`

If you want to restore data from the backup copy:

1. `$cd` *`PolyspaceRLDatas`*
2. `$unzip` *`Path_to_backup_folder`*`/results-repository.zip`

Configure Model for Code Analysis

Model Configuration for Code Generation and Analysis

To facilitate Polyspace code analysis and the review of results:

- There are certain settings that you should apply to your model before generating code. See “Recommended Model Settings for Code Analysis” on page 15-4.
- The Polyspace plug-in for Simulink software allows you to check your model configuration before starting the Polyspace software. See “Check Simulink Model Settings” on page 15-5
- You can constrain signals in your model to lie within specified ranges. See “Specify Signal Ranges”.
- You can highlight blocks that you know contain checks or coding rule violations. See “Annotate Blocks for Known Errors or Coding-Rule Violations” on page 15-10.

Configure Simulink Model

To configure a Simulink model for code generation and analysis:

1. Open Model Explorer.
2. From the Model Hierarchy tree, expand the model node.
3. Select **Configuration** > **Code Generation**, which displays Code Generation configuration parameters.
4. Select the **General** tab, and then set the **System target file** to an Embedded Coder `.tlc` file. For example, `ert.tlc (Embedded Coder)` or `autosar.tlc (Embedded Coder)`.
5. In the **Report** tab, select:
   - **Create code-generation report**
   - **Code-to-model** navigation.
6. In the **Templates** tab, clear **Generate an example main program**.
7. In the **Interface** tab, select **Suppress error status in real-time model data structure**.
8. Click **Apply**.
9. Select **Configuration** > **Solver**, which displays Solver configuration parameters.
10. In the **Solver options** section, set:
    - **Type** to `Fixed-step`.
    - **Solver** to `discrete (no continuous states)`.
11. Click **Apply**.
12. Select **Configuration** > **Optimization**, which displays Optimization configuration parameters. Then:
    - On the **General** tab, in the **Data initialization** section, select the **Remove root level I/O zero initialization** check box.
    - On the **General** tab, clear the **Use memset to initialize floats and doubles to 0.0** check box
    - On the **Signals and Parameters** tab, in the **Simulation and code generation** section, select the **Inline parameters** check box.
13. Save your model.

Recommended Model Settings for Code Analysis

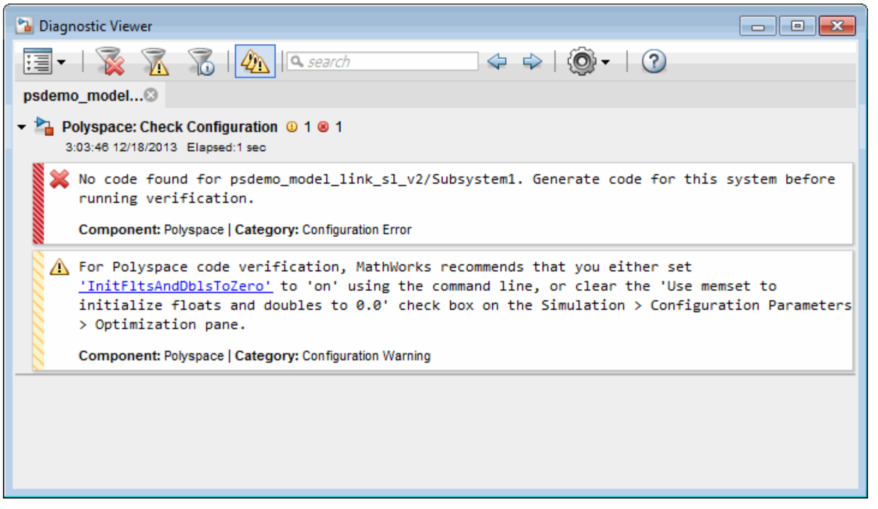
For Polyspace analyses, you should configure your model with the following settings before generating code.

Parameter	Recommended value	How you specify value in Configuration Parameters dialog box	If you do not use recommended value...
`InitFltsAndDblsToZero`	`'on'`	Select check box **Optimization** > **Use memset to initialize floats and doubles to 0.0**	Warning
`InlineParams`	`'on'`	Select check box **Optimization** > **Signals and Parameters** > **Inline parameters**	Warning
`MatFileLogging`	`'off'`	Clear check box **Code Generation** > **Interface** > **MAT-file logging**	Warning
`Solver`	`'FixedStepDiscrete`	In **Solver** > **Solver**, select `discrete (no continuous states)` from drop-down list.	Warning
`SystemTargetFile`	An Embedded Coder Target Language Compiler (TLC) file	In **Code Generation** > **System target file**, specify an Embedded Coder target file. For example `ert.tlc` or `autosar.tlc`.	Error
`GenerateComments`	`'on'`	Select check box **Code Generation** > **Comments** > **Include Comments**	Error
`ZeroExternalMemoryAtStartup`	`'off'` when **Configuration Parameters** > **Polyspace** > **Data Range Management** > **Output** is `Global assert`	Clear check box **Optimization** > **Remove root level I/O zero initialization**	Warning

Check Simulink Model Settings

With the Polyspace plug-in, you can check your model settings before starting an analysis.

1. From the Simulink model window, select **Code** > **Polyspace** > **Options**. The Configuration Parameters dialog box opens, displaying the **Polyspace** pane.
2. Click **Check configuration**. If your model settings are not optimal for Polyspace, the software displays warning messages with recommendations.



You can also set the configuration check to run before you run an analysis.

If you alter your model settings, rebuild the model to generate fresh code. If the generated code version does not match your model version, the software produces warnings when you run the analysis.

Related Examples

- “Check Simulink Model Settings Before Analysis” on page 15-8

More About

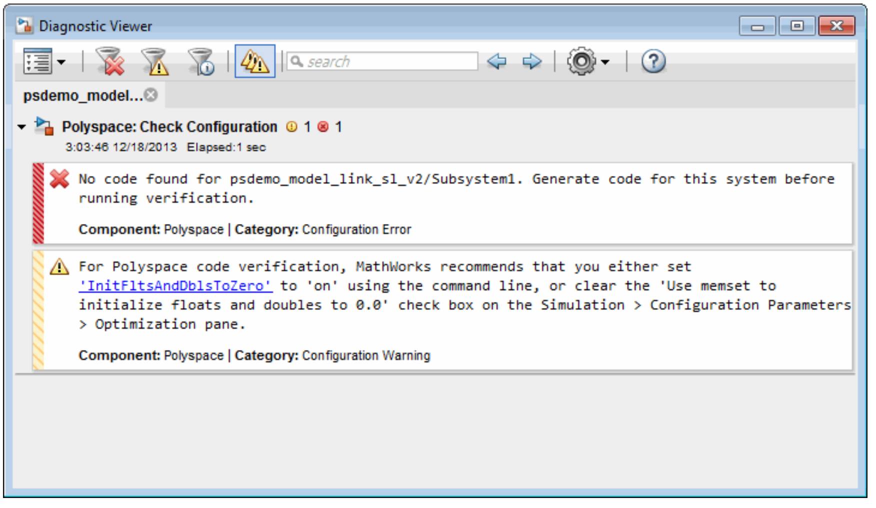
- “Recommended Model Settings for Code Analysis” on page 15-4

Check Simulink Model Settings Before Code Generation

Before generating code, you can check your model settings against the "Recommended Model Settings for Code Analysis" on page 15-4.

1 From the Simulink model window, select **Code** > **C/C++ Code** > **Code Generation Options**. The Configuration Parameters dialog box opens, displaying the **Code Generation** pane.
2 Select **Set Objectives**.
3 From the **Set Objective – Code Generation Advisor** window, add the `Polyspace` objective and any others that you want to check.
4 From the **Check model before generating code** drop-down list, select either:
   - `On (stop for warnings)`
   - `On (proceed with warnings)`
5 Select **Build** or **Generate Code**.

   The software runs a configuration check. If your configuration check finds errors or warnings, the **Diagnostics Viewer** displays the issues and recommendations.



If you select:

- `On (stop for warnings)`, the process stops for either errors or warnings without generating code.
- `On (proceed with warnings)` — the process stops for errors, but continues generating code if the configuration only has warnings.

Related Examples

- "Check Simulink Model Settings Before Analysis" on page 15-8
- "Check Simulink Model Settings" on page 15-5

More About

- "Recommended Model Settings for Code Analysis" on page 15-4

Check Simulink Model Settings Before Analysis

With the Polyspace plug-in, you can check your model settings before starting an analysis:

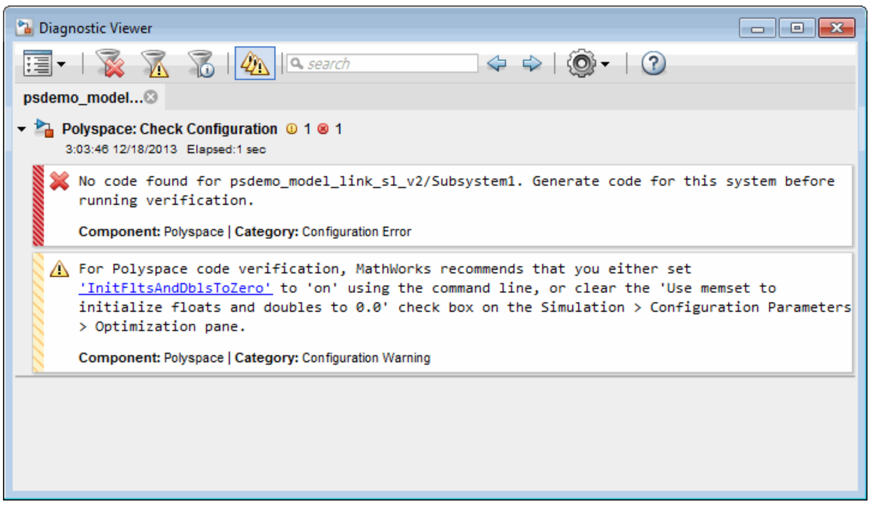
1 From the Simulink model window, select **Code** > **Polyspace** > **Options**. The Configuration Parameters dialog box opens, displaying the **Polyspace** pane.

2 From the **Check configuration before verification** menu, select either:

   - `On (stop for warnings)` — will
   - `On (proceed with warnings)`

3 Select **Run verification**.

   The software runs a configuration check. If your configuration check finds errors or warnings, the **Diagnostics Viewer** displays the issues and recommendations.



If you select:

- `On (stop for warnings)`, the analysis stops for either errors or warnings.
- `On (proceed with warnings)` — the analysis stops for errors, but continues the code analysis if the configuration only has warnings.

If you alter your model settings, rebuild the model to generate fresh code. If the generated code version does not match your model version, the software produces warnings when you run the analysis.

Related Examples

- “Check Simulink Model Settings” on page 15-5

More About

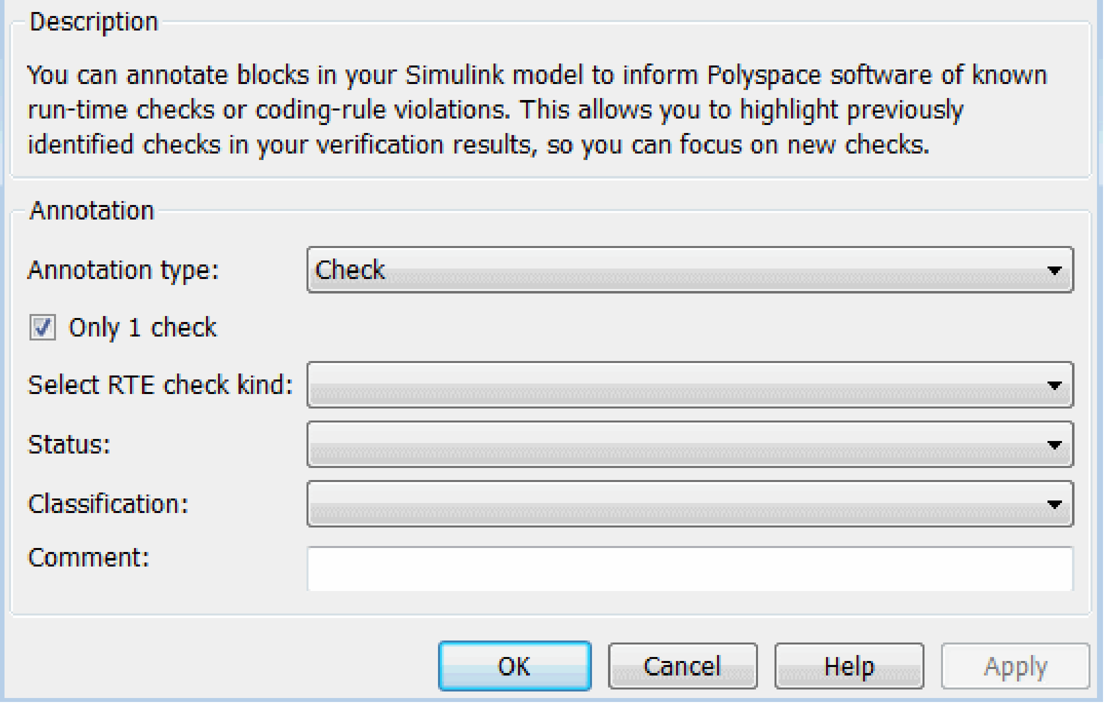
- “Recommended Model Settings for Code Analysis” on page 15-4

Annotate Blocks for Known Errors or Coding-Rule Violations

You can annotate individual blocks in your Simulink model to inform Polyspace software of known defects, run-time checks, or coding-rule violations. This allows you to highlight and categorize previously identified results, so you can focus on reviewing new results.

The Polyspace Results Manager perspective displays the information that you provide with block annotations.

1. In the Simulink model window, right-click the block you want to annotate.
2. From the context menu, select **Polyspace** > **Annotate Selected Block** > **Edit**. The Polyspace Annotation dialog box opens.



3. From the **Annotation type** drop-down list, select one of the following:

   - `Check` — To indicate a Code Prover run-time error

- `Defect` — To indicate a Bug Finder defect
- `MISRA-C` — To indicate a MISRA C coding rule violation
- `MISRA-C++` — To indicate a MISRA C++ coding rule violation
- `JSF` — To indicate a JSF C++ coding rule violation

4 If you want to highlight only one kind of result, select **Only 1 check** and the relevant error or coding rule from the **Select RTE check kind** (or **Select defect kind**, **Select MISRA rule**, **Select MISRA C++ rule**, or **Select JSF rule**) drop-down list.

   If you want to highlight a list of checks, clear **Only 1 check**. In the **Enter a list of checks** (or **Enter a list of defects**, or **Enter a list of rule numbers**) field, specify the errors or rules that you want to highlight.

5 Select a **Status** to describe how you intend to address the issue:

- `Fix`
- `Improve`
- `Investigate`
- `Justify with annotations`

  (This status also marks the result as justified.)
- `No Action Planned`

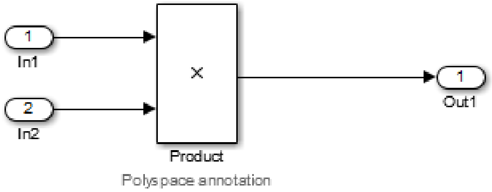
  (This status also marks the result as justified.)
- `Other`
- `Restart with different options`
- `Undecided`

6 Select a **Classification** to describe the severity of the issue:

- `High`
- `Medium`
- `Low`
- `Not a defect`

7 In the **Comment** field, enter additional information about the check.

8 Click **OK**. The software adds the Polyspace annotation is to the block.


1
In1
2
In2
×
Product
Polyspace annotation
1
Out1

Model Link for Polyspace Code Prover

Install Polyspace Plug-In for Simulink

By default, when you install Polyspace R2013b or later, the Simulink plug-in is installed and connected to MATLAB.

If you model on a previous version of Simulink and MATLAB, you can also connect the Polyspace plug-in on this previous version. That way you use the latest verification software with your preferred version of Embedded Coder or TargetLink®. However, if you use a cross-version of Polyspace and MATLAB, local batch analyses can only be submitted from the Polyspace environment. or using the `pslinkrun` command.

The Simulink plug-in supports the four previous releases of MATLAB. For example, the R2014b version of the Polyspace plug-in supports MATLAB R2012b, R2013a, R2013b, R2014a, and R2014b

---

Note: To install a newer version of Polyspace on MATLAB R2013b or later, you must install MATLAB without the corresponding version of Polyspace.

---

1. Using an account with read/write privileges, open the older version of MATLAB.
2. If you have a previous version of Polyspace connected, execute the `pslinksetup('uninstall')` command to disconnect it. This command does not work with MATLAB R2013b or later (see preceding Note).
3. Restart MATLAB.
4. Change your **Current Folder** to *`matlabroot`*`\polyspace\toolbox\pslink\pslink`. *`matlabroot`* is the Simulink plug-in that you want to connect, for example, `C:\Program Files\MATLAB\R2014b`.
5. Execute the `pslinksetup('install')` command to connect the new version of Polyspace.

More About

- “Troubleshoot Back to Model”

Specify Signal Ranges

If you constrain signals in your Simulink model to lie within specified ranges, Polyspace software automatically applies these constraints during verification of the generated code. This can reduce the number of orange checks in your verification results.

You can specify a range for a model signal by:

- Applying constraints through source block parameters. See "Specify Signal Range through Source Block Parameters" on page 16-3.
- Constraining signals through the base workspace. See "Specify Signal Range through Base Workspace" on page 16-4.

Note: You can also manually define data ranges using the DRS feature in the Polyspace verification environment. If you manually define a DRS file, the software automatically appends any signal range information from your model to the DRS file. However, manually defined DRS information overrides information generated from the model for all variables.

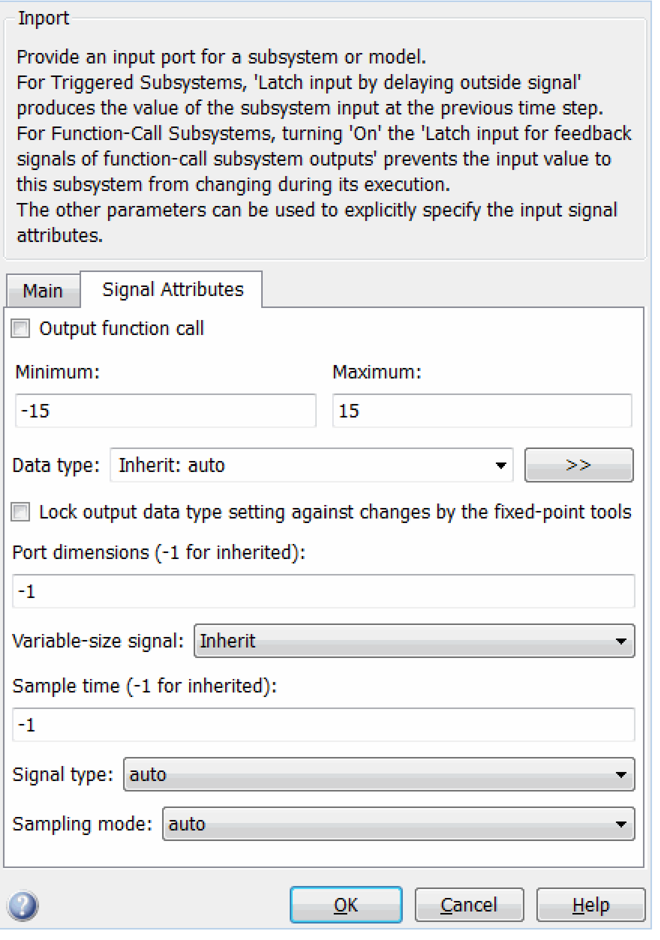
Specify Signal Range through Source Block Parameters

You can specify a signal range by applying constraints to source block parameters.

Specifying a range through source block parameters is often easier than creating signal objects in the base workspace, but must be repeated for each source block. For information on using the base workspace, see "Specify Signal Range through Base Workspace" on page 16-4.

To specify a signal range using source block parameters:

1. Double-click the source block in your model. The Source Block Parameters dialog box opens.
2. Select the **Signal Attributes** tab.
3. Specify the **Minimum** value for the signal, for example, -15.
4. Specify the **Maximum** value for the signal, for example, 15.



5 Click **OK**.

Specify Signal Range through Base Workspace

You can specify a signal range by creating signal objects in the MATLAB workspace. This information is used to initialize each global variable to the range of valid values, as defined by the min-max information in the workspace.

Note: You can also specify a signal range by applying constraints to individual source block parameters. This method can be easier than creating signal objects in the base workspace, but must be repeated for each source block. For more information, see "Specify Signal Range through Source Block Parameters" on page 16-3.

To specify an input signal range through the base workspace:

1. Configure the signal to use, for example, the `ExportedGlobal` storage class:

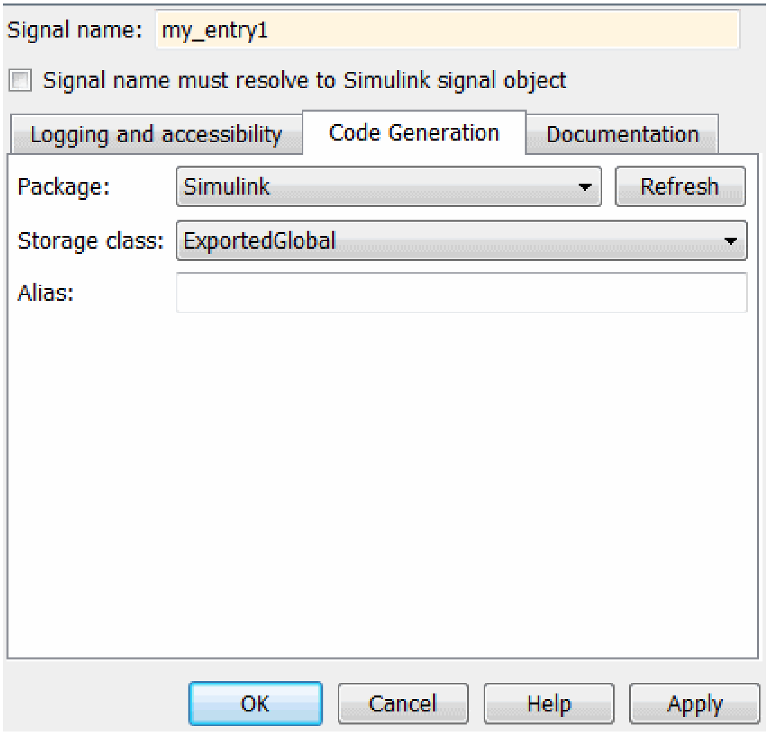
   a. Right-click the signal. From the context menu, select **Properties**. The Signal Properties dialog box opens.

   b. In the **Signal name** field, enter a name, for example, `my_entry1`.

   c. Select the **Code Generation** tab.

   d. From the **Package** drop-down menu, select `Simulink`.

   e. In the **Storage class** drop-down menu, select `ExportedGlobal`.



f Click **OK**, which applies your changes and closes the dialog box.

Note: For information about supported storage classes, see "Data Range Specifications".

---

2 Using Model Explorer, specify the signal range:

a Select **Tools** > **Model Explorer** to open Model Explorer.

b From the **Model Hierarchy** tree, select **Base Workspace**.

c Click the `Add Simulink Signal` button to create a signal. Rename this signal, for example, `my_entry1`.

d Set the **Minimum** value for the signal, for example, to `-15`.

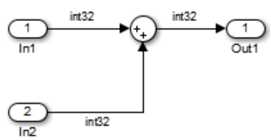
e Set the **Maximum** value for the signal, for example, to `15`.

f From the **Storage class** drop-down list, select `ExportedGlobal`.

g Click **Apply**.

Annotate Code to Justify Polyspace Checks

A verification of Embedded Coder generated code might highlight overflows for certain operations that are legitimate because of the way Embedded Coder implements these operations. Consider the following model and the corresponding generated code.




```
32 /* Sum: '<Root>/Sum' incorporates:
33   *  Inport: '<Root>/In1'
34   *  Inport: '<Root>/In2'
35   */
36  qY_0 = sat_add_U.In1 + sat_add_U.In2;
37  if ((sat_add_U.In1 < 0) && ((sat_add_U.In2 < 0) && (qY_0 >= 0))) {
38    qY_0 = MIN_int32_T;
39  } else {
40   if ((sat_add_U.In1 > 0) && ((sat_add_U.In2 > 0) && (qY_0 <= 0))) {
41     qY_0 = MAX_int32_T;
42    }
43  }
```

Embedded Coder software recognizes that the largest built-in data type is 32-bit. It is not possible to saturate the results of the additions and subtractions using `MIN_INT32` and `MAX_INT32`, and a bigger single-word integer data type. Instead the software detects the results overflow and the direction of the overflow, and saturates the result.

If you do not provide justification for the addition operator on line 36, a Polyspace verification generates an orange check that indicates a potential overflow. The verification does not take into account the saturation function of lines 37 to 43. In addition, the trace-back functionality of Polyspace Code Prover does not identify the reason for the orange check.

To justify overflows from operators that are legitimate, on the **Configuration Parameters** > **Code Generation** > **Comments** pane:

- Under **Overall control**, select the **Include comments** check box.
- Under **Auto generate comments**, select the **Operator annotations check box**.

When you generate code, the Embedded Coder software annotates the code with comments for Polyspace. For example:

```
/* Sum: '<Root>/Sum' incorporates:
  *  Inport: '<Root>/In1'
  *  Inport: '<Root>/In2'
  */
 qY_0 = sat_add_U.In1 +/*MW:OvOk*/ sat_add_U.In2;
```

When you run a verification using Polyspace Code Prover, the software uses the annotations to justify the operator-related orange checks and assigns the `Not a defect` classification to the checks.

Configure Data Range Settings

There are two approaches to code verification, which can produce results that are slightly different:

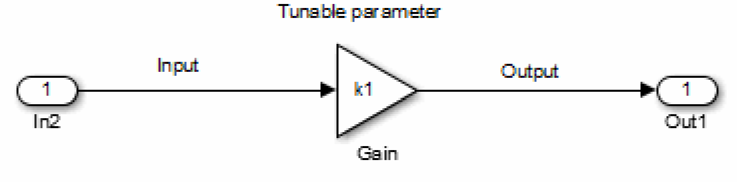
- **Contextual Verification** — Prove code does not generate run-time errors under predefined working conditions. This limits the scope of the verification to specific variable ranges, and verifies the code within these ranges.
- **Robustness Verification —** Prove code generate run-time errors for all verification conditions, including “abnormal” conditions for which the code was not designed. This can be thought of as “worst case” verification.

For more information, see:

- “Provide Context for C Code Verification”
- Data Range Specifications for Embedded Coder
- Data Range Specifications for TargetLink

Note: The software supports data range management only with Simulink Version 7.4 (R2009b) or later.

You perform contextual or robustness verification by the way you specify data ranges for model inputs, outputs, and tunable parameters within the model.



To specify data range settings for your model:

1 From the Simulink model window, select **Code** > **Polyspace** > **Options**. The Configuration Parameters dialog box opens, displaying the **Polyspace Model Link** pane.

2 In the Data Range Management section, specify how you want the verification to treat:

   a **Input** — Select one of the following:

      - `Use specified minimum and maximum values` (Default) — Apply data ranges defined in blocks or base workspace to increase the precision of the verification. See “Specify Signal Ranges”.
      - `Unbounded inputs` — Assume all inputs are full-range values (`min...max`)

   b **Tunable parameters** — Select one of the following:

      - `Use calibration data` (Default) — Use value of constant parameter specified in code.
      - `Use specified minimum and maximum values` — Use a parameter range defined in the block or base workspace. See “Specify Signal Ranges”. If no range is defined, use full range (`min...max`).

   c **Output** — Select one of the following:

      - `No verification` (Default) — No assertion ranges on outputs.
      - `Verify outputs are within minimum and maximum values` — Use assertion ranges on outputs.

      Note: This mode is incompatible with the Automatic Orange Tester.

In general, you should use the following combinations:

- To maximize verification precision, select `Use specified minimum and maximum values` for **Input** and **Tunable parameters**.
- To verify the extreme cases of program execution, select `Unbounded inputs` for **Input** and `Use calibration data` for **Tunable parameters**.

Main Generation for Model Verification

When you run a verification, the software automatically reads the following information from the model:

- `initialize()` functions
- `terminate()` functions
- `step()` functions
- List of parameter variables
- List of input variables

The software then uses this information to generate a `main` function that:

1. Initializes parameters using the Polyspace option `-variables-written-before-loop`.
2. Calls initialization functions using the option `-functions-called-before-loop`.
3. Initializes inputs using the option `-variables-written-in-loop`.
4. Calls the `step` function using the option `-functions-called-in-loop`.
5. Calls the `terminate` function using the option `-functions-called-after-loop`.

If the `codeInfo` for the model does not contain the names of the inputs, the software considers all variables as entries, except for parameters and outputs.

For C++ code that is generated with Embedded Coder, the `initialize()`, `step()`, and `terminate()` functions are either class methods or have global scope. These different scopes contain the associated variables.

- For class methods in the generated code, the variables that are written before and in the loop refer to the class members.
- For functions with global scope, the associated variables are also in the global scope.

`main` for Generated Code

The following example shows the `main` generator options that the software uses to generate the `main` function for code generated from a Simulink model.

```
init parameters    \\ -variables-written-before-loop
init_fct()          \\ -functions-called-before-loop
```

```
  while(1){         \\ start main loop
  init inputs       \\ -variables-written-in-loop
  step_fct()        \\ -functions-called-in-loop
}
terminate_fct()     \\ -functions-called-after-loop
```

Embedded Coder Considerations

In this section...

Default Options

For Embedded Coder code, the software sets the following verification options by default:

```
-sources path_to_source_code
-desktop
-D PST_ERRNO
-D main=main_rtwec
-I matlabroot\polyspace\include
-I matlabroot\extern\include
-I matlabroot\rtw\c\libsrc
-I matlabroot\simulink\include
-I matlabroot\sys\lcc\include
-functions-to-stub=[rtIsNaN,rtIsInf,rtIsNaNF,rtIsInfF]
-OS-target no-predefined-OS
-results-dir results
```

Note: *matlabroot* is the MATLAB installation folder.

Data Range Specification

You can constrain inputs, parameters, and outputs to lie within specified data ranges for Embedded Coder and AUTOSAR with Embedded Coder. See "Configure Data Range Settings" on page 16-10.

The software automatically creates a Polyspace "Data Range Specifications" file using information from the MATLAB workspace and block parameters.

You can also manually define a DRS file using the Project Manager perspective of the Polyspace verification environment. If you define a DRS file, the software appends the automatically generated information to the DRS file you create. Manually defined DRS information overrides automatically generated information for all variables.

The software supports the automatic generation of data range specifications for the following kinds of generated code:

- Code from standalone models
- Code from configured function prototypes
- Reusable code
- Code generated from referenced models and submodels

The software supports the automatic generation of data range specifications for only the following signal and parameter storage classes:

- `SimulinkGlobal`
- `ExportedGlobal`
- `Struct (Custom)`

Recommended Polyspace options for Verifying Generated Code

For Embedded Coder code, the software automatically specifies values for the following verification options:

- `-main-generator`
- `-functions-called-in-loop`
- `-functions-called-before-loop`
- `-functions-called-after-loop`
- `-variables-written-in-loop`
- `-variables-written-before-loop`

In addition, for the option `-server`, the software uses the value specified in the **Send to Polyspace server** check box on the **Polyspace** pane. These values override the corresponding option values in the **Configuration** pane of the Project Manager.

You can specify other verification options for your Polyspace Project through the Polyspace **Configuration** pane. To open this pane:

1 In the Simulink model window, select **Code** > **Polyspace** > **Options** . The **Polyspace Model Link** pane opens.

2 Click **Configure**. The Project Manager opens, displaying the Polyspace **Configuration** pane.

The following table describes options that you should specify in your Polyspace project before verifying code generated by Embedded Coder software.

Option	Recommended Value	Comments
Macros > **Preprocessor definitions** `-D`	See Comments	Defines macro compiler flags used during compilation. Use one `-D` for each line of the Embedded Coder generated `defines.txt` file. Polyspace Model Link™ SL does not do this by default.
Target & Compiler > **Target operating system** `-OS-target`	`Visual`	Specifies the operating system target for Polyspace stubs. This information allows the verification to use system definitions during preprocessing to analyze the included files.
Target & Compiler > **Target processor type** `-target`	`i386`	Specifies the target processor type. This allows the verification to consider the size of fundamental data types and the endianess of the target machine. You can configure and specify generic targets. For more information, see “Target Processor Configuration”.
Environment Settings > **Code from DOS or Windows file system** `-dos`	On	You must select this option if the contents of the include or source directory comes from a DOS or Windows file system. The option allows the verification to deal with upper/lower case sensitivity and control characters issues. Concerned files are: • **Header files** – All include folders specified (`-I` option)

Option	Recommende Value	Comments
		• **Source files** – All source files selected for the verification (`-sources` option)
Check Behavior > Allow negative operands for left shifts `-allow-negative-operand-in-shift`	On	Allows a shift operation on a negative number. According to the ANSI standard, such a shift operation on a negative number is illegal. For example, -2 << 2 If you select this option, Polyspace considers the operation to be valid. For the given example, -2 << 2 = -8
Verification Assumptions > Ignore float rounding `-ignore-float-rounding`	On	Specifies how the verification rounds floats. If this option is not selected, the verification rounds floats according to the IEEE 754 standard – simple precision on 32-bits targets and double precision on targets that define double as 64-bits. When you select this option, the verification performs exact computation. Selecting this option can lead to results that differ from "real life," depending on the actual compiler and target. Some paths may be reachable (or not reachable) for the verification while they are not reachable (or are reachable) for the actual compiler and target. However, this option reduces the number of unproven checks caused by float approximation.

Option	Recommended Value	Comments
Precision > Precision level `-O`	2	Specifies the precision level for the verification. Higher precision levels provide higher selectivity at the expense of longer verification time. Begin with the lowest precision level. You can then address red errors and gray code before rerunning the Polyspace verification using higher precision levels. Benefits: A higher precision level contributes to a higher selectivity rate, making results review more efficient and hence making bugs in the code easier to isolate. The precision level specifies the algorithms used to model the program state space during verification: • `-O0` corresponds to static interval verification. • `-O1` corresponds to complex polyhedron model of domain values. • `-O2` corresponds to more complex algorithms to closely model domain values (a mixed approach with integer lattices and complex polyhedrons). • `-O3` is suitable only for units smaller than 1,000 lines of code. For such code, selectivity may reach as high as 98%, but verification may take up to an hour per 1,000 lines of code.

Option	Recommended Value	Comments
Precision > Verification level `-to`	See comments	Specifies the phase after which the verification stops. **`C source compliance checking`** – For C code, when checking coding rule compliance only. **`C++ source compliance checking`** – For C++ code, when checking coding rule compliance only. **`Software safelty analysis level 0`** – When verifying code for the first time. **`Software safelty analysis level 4`** – When performing subsequent verifications of code. Each verification phase improves the selectivity of your results, but increases the overall verification time. Improved selectivity can make results review more efficient, and hence make bugs in the code easier to isolate. Begin by running `-to pass0` (`Software Safety Analysis level 0`) You can then address red errors and gray code before relaunching verification using higher integration levels.

Hardware Mapping Between Simulink and Polyspace

The software automatically imports target word lengths and byte ordering (endianess) from Simulink model hardware configuration settings. The software maps **Device vendor** and **Device type** settings on the Simulink **Configuration Parameters** > **Hardware Implementation** pane to **Target processor type** settings on the Polyspace **Configuration** pane.

Note: The software creates a generic target for the verification.

TargetLink Considerations

In this section...

TargetLink Support

For Windows, Polyspace Code Prover is tested with releases 3.4 and 3.5 of the dSPACE® Data Dictionary version and TargetLink Code Generator.

As Polyspace Code Prover extracts information from the dSPACE Data Dictionary, you must regenerate the code before performing a verification.

Default Options

The following default options are set by Polyspace:

```
-I path_to_source_code
-desktop
-D PST_ERRNO
-I dspaceroot\matlab\TL\SimFiles\Generic
-I dspaceroot\matlab\TL\srcfiles\Generic
-I dspaceroot\matlab\TL\srcfiles\i86\LCC
-I matlabroot\polyspace\include
-I matlabroot\extern\include
-I matlabroot\rtw\c\libsrc
-I matlabroot\simulink\include
-I matlabroot\sys\lcc\include
-ignore-constant-overflows
-scalar-overflows-behavior wrap-around
```

Note: `dspaceroot` and `matlabroot` are the dSPACE and MATLAB tool installation directories respectively.

Data Range Specification

You can constrain inputs, parameters, and outputs to lie within specified data ranges. See “Configure Data Range Settings”.

The software automatically creates a Polyspace “Data Range Specifications” file using the dSPACE Data Dictionary for each global variable. The DRS information is used to initialize each global variable to the range of valid values as defined by the min-max information in the data dictionary. This allows Polyspace software to model every value that is legal for the system during verification. Carefully defining the min-max information in the model allows the verification to be more precise, because only the range of real values is analyzed.

Note: Boolean types are modeled having a minimum value of 0 and a maximum of 1.

You can also manually define a DRS file using the Project Manager perspective of the Polyspace Verification Environment. If you define a DRS file, the software appends the automatically generated information to the DRS file you create. Manually defined DRS information overrides automatically generated information for all variables.

DRS cannot be applied to static variables. Therefore, the compilation flags `-D static=` is set automatically. It has the effect of removing the static keyword from the code. If you have a problem with name clashes in the global name space you may need to either rename one of or variables or disable this option in Polyspace configuration.

Lookup Tables

The tool by default provides stubs for the lookup table functions. This behavior can be disabled from the Polyspace menu. The dSPACE data dictionary is used to define the range of their return values. Note that a lookup table that uses extrapolation will return full range for the type of variable that it returns.

Code Generation Options

From the TargetLink Main Dialog, it is recommended to set the option `Clean code` and deselect the option `Enable sections/pragmas/inline/ISR/user attributes`.

When installing the Polyspace Model Link TL product, the `tlcgOptions` variable has been updated with `'PolyspaceSupport', 'on'` (see variable in `'C:\dSPACE\Matlab\Tl\config\codegen\tl_pre_codegen_hook.m'` file).

Related Examples

- "Run Analysis for TargetLink" on page 18-6

External Web Sites

- dSPACE – TargetLink

Generate and Verify Code with Configured Model

You can generate Embedded Coder code from the configured model `psdemo_model_link_sl`. You can then run a Polyspace verification on the generated code.

To open `psdemo_model_link_sl` in the Simulink model window:

1. In the MATLAB Command Window, enter `psdemo_model_link_sl`.

   This command opens the `psdemo_model_link_sl` model that is compatible with your version of MATLAB (either `psdemo_model_link_sl`, `psdemo_model_link_sl_v1`, or `psdemo_model_link_sl_v2`).

To generate code and start the Polyspace verification:

1. Double-click the Reinstall the demo block to generate the legacy code related to the S-function.
2. If you want to apply data ranges to the input parameters, double-click the green block Use input constraints. To remove the data range constraints, double-click the orange block Worst case inputs.
3. Right-click the subsystem `controller`.
4. From the context-menu, select **C/C++ Code** > **Build This Subsystem**.
5. In the Build code for Subsystem dialog box, click **Build** to generate code. When the code generation is complete, the code generation report opens.
6. Right-click the subsystem `controller`. From the context menu, select **Polyspace** > **Verify Code Generated for** > **Selected Subsystem**. The verification starts.

To monitor the progress of the verification:

- If you specified server verification, select **Code** > **Polyspace** > **Open Job Monitor**. Use the Polyspace Job Monitor to monitor progress.
- If you specified client verification, you can monitor progress from the Command Window.

Once the verification is complete, to display the results:

1. Select **Code** > **Polyspace** > **Open Results** > **For Generated Code**.
2. In the Polyspace environment, select **File** > **Open Result**.

3. Use the Open Results dialog box to navigate to the specified results folder, for example, `C:\Polyspace_Results\controller`.
4. Select the results file, for example, `RTE_px_controller_LAST_RESULTS.pscp`. Then click **Open**. The software displays the results in the Results Manager perspective.

View Results in Polyspace Code Prover

When a verification completes, you can view the results using the Results Manager perspective of the Polyspace Code Prover.

To view your results:

1. From the Simulink model window, select **Code** > **Polyspace** > **Open Results**.

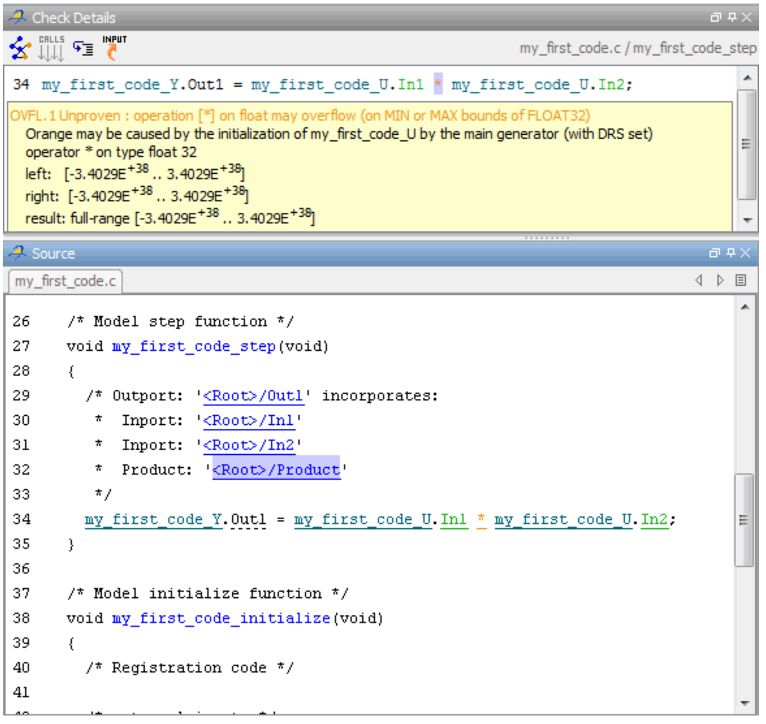
Note: If you set **Model reference verification depth** to `All` and selected **Model by model verification**, the Select the Result Folder to Open in Polyspace dialog box opens. The dialog box displays a hierarchy of referenced models from which the software generates code. To view the verification results for code generated from a specific model, select the model from the hierarchy. Then click **OK**.

You can also open results through a Model block or subsystem. From the Simulink model window, right-click the Model block or subsystem, and from the context menu, select **Polyspace** > **Open Results**.

After a few seconds, the Results Manager perspective of the Polyspace Code Prover opens.

2. On the **Results Summary** tab, click any check to review additional information.

In this example, the **Check Details** pane shows information about the orange check, and the **Source** pane shows the source code containing the orange check.



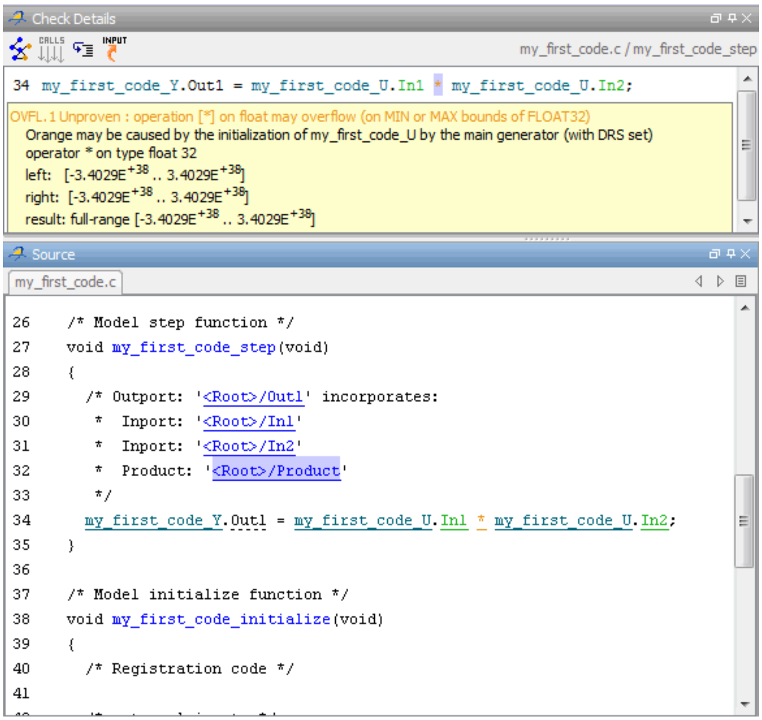
For more information on reviewing run-time checks, see “Run-Time Error Review”.

For information on specific checks, see “Run-Time Check Reference”.

Identify Errors in Simulink Models

With Polyspace Code Prover, you can trace run-time checks in your verification results directly to your Simulink model.

Consider the following example, where the **Check Details** pane shows information about an orange check, and the **Source** pane shows the source code containing the orange check.



This orange check shows a potential overflow issue when multiplying the signals from the inports `In1` and `In2`. To fix this issue, you must return to the model.

To trace this run-time check to the model:

1. Click the blue underlined link (`<Root>/Product`) immediately before the check in the **Source** pane. The Simulink model opens, highlighting the block with the error.
2. Examine the model to find the cause of the check.

In this example, the highlighted block multiplies two full-range signals, which could result in an overflow. This could be a flaw in:

- Design — If the model is supposed to be robust for the full signal range, then the issue is a design flaw. In this case, you must change the model to accommodate the full signal range. For example, you could saturate the output of the previous block, or bound the signal with a Switch block.
- Specifications — If the model is supposed to work for specific input ranges, you can provide these ranges using block parameters or the base workspace. The verification will then read these ranges from the model. See “Specify Signal Ranges”.

Applying either solution should address the issue and cause the orange check to turn green.

More About

- “Troubleshoot Back to Model”

Troubleshoot Back to Model

In this section...

Back-to-Model Links Do Not Work

You may encounter issues with the back-to-model feature if:

- Your operating system is Windows Vista™ or Windows 7; and User Account Control (UAC) is enabled or you do not have administrator privileges.
- You have multiple versions of MATLAB installed.

To reconnect MATLAB and Polyspace:

1. Close Polyspace.
2. At the MATLAB command-line, enter `PolySpaceEnableCOMserver`.

   When you open your Polyspace results, the hyper-links will highlight the relevant blocks in your model.

Your Model Already Uses Highlighting

If your model extensively uses block coloring, the coloring from this feature may interfere with the colors already in your model. To change the color of blocks when they are linked to Polyspace results use this command:

```
HILITE_DATA = struct('HiliteType', 'find', 'ForegroundColor', 'black', ...
        'BackgroundColor', color);
set_param(0, 'HiliteAncestorsData', HILITE_DATA)
```

Where *`color`* is one of the following:

- `'cyan'`
- `'magenta'`
- `'orange'`
- `'lightBlue'`

- 'red'
- 'green'
- 'blue'
- 'darkGreen'

Configure Code Analysis Options

Polyspace Configuration for Generated Code

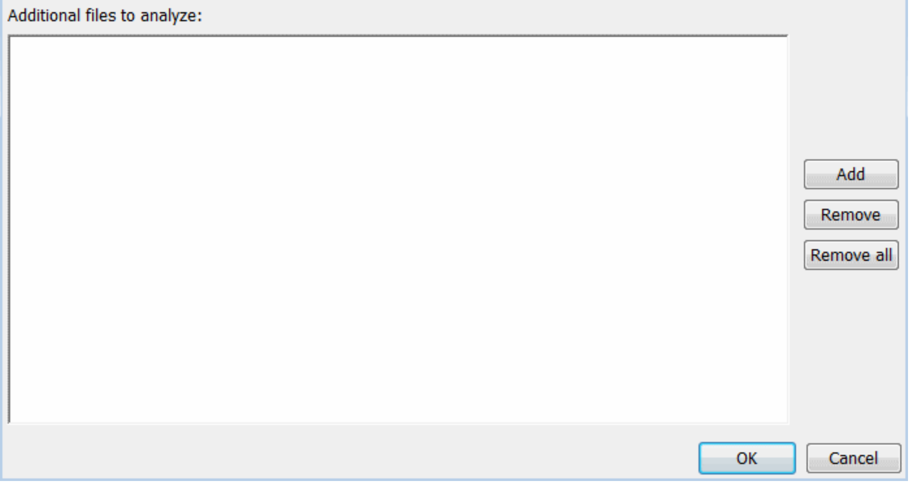
You do not have to manually create a Polyspace project or specify Polyspace options before running an analysis for your generated code. By default, Polyspace automatically creates a project and extracts the required information from your model. However, you can modify or specify additional options for your analysis:

- You may incorporate separately created code within the code generated from your Simulink model. See “Include Handwritten Code” on page 17-3.
- By default, the Polyspace analysis is contextual and treats tunable parameters as constants. You can specify a verification that considers robustness, including tunable parameters that lie within a range of values. See “Configure Data Range Settings”.
- You may customize the options for your analysis. For example, to specify the target environment or adjust precision settings. See “Configure Polyspace Analysis Options” on page 17-9 and “Recommended Polyspace options for Verifying Generated Code”.
- You may create specific configurations for batch runs. See “Create a Polyspace Configuration File Template” on page 17-12.
- If you want to analyze code generated for a 16-bit target processor, you must specify header files for your 16-bit compiler. See “Specify Header Files for Target Compiler” on page 17-14.

Include Handwritten Code

Files such as S-function wrappers are, by default, not part of the Polyspace analysis. However, you can add these files manually.

1 From the Simulink model window, select **Code** > **Polyspace** > **Options**. The Configuration Parameters dialog box opens, displaying the **Polyspace** pane.
2 Select the **Enable additional file list** check box. Then click **Select files**. The Files Selector dialog box opens.



3 Click **Add**. The Select files to add dialog box opens.
4 Use the Select files to add dialog box to:

   - Navigate to the relevant folder
   - Add the required files.

   The software displays the selected files as a list under **Additional files to analyze**.

   Note: To remove a file from the list, select the file and click **Remove**. To remove all files from the list, click **Remove all**.

5 Click **OK**.

Specify Remote Analysis

By default, the Polyspace software runs locally. To specify a remote analysis:

1. From the Simulink model window, select **Code** > **Polyspace** > **Options**. The Configuration Parameters dialog box opens, displaying the **Polyspace** pane.
2. Select **Configure**.
3. In the Polyspace Configuration window, select the **Distributed Computing** pane.
4. Select the **Batch** check box.
5. Close the configuration window and save your changes.
6. Select **Apply**.

Configure Analysis Depth for Referenced Models

From the **Polyspace** pane, you can specify the analysis of generated code with respect to model reference hierarchy levels:

- **Model reference verification depth** — From the drop-down list, select one of the following:
  - `Current model only` — Default. The Polyspace runs code from the top level only. The software creates stubs to represent code from lower hierarchy levels.
  - `1` — The software analyzes code from the top level and the next level. For subsequent hierarchy levels, the software creates stubs.
  - `2` — The software analyzes code from the top level and the next two hierarchy levels. For subsequent hierarchy levels, the software creates stubs.
  - `3` — The software analyzes code from the top level and the next three hierarchy levels. For subsequent hierarchy levels, the software creates stubs.
  - `All` — The software analyzes code from the top level and all lower hierarchy levels.
- **Model by model verification** — Select this check box if you want the software to analyze code from each model separately.

Note: The same configuration settings apply to all referenced models within a top model. It does not matter whether you open the **Polyspace** pane from the top model window (**Code** > **Polyspace** > **Options**) or through the right-click context menu of a particular Model block within the top model. However, you can run analyses for code generated from specific Model blocks. See “Run Analysis for Embedded Coder” on page 18-5.

Specify Location of Results

1. From the Simulink model window, select **Code** > **Polyspace** > **Options**. The Configuration Parameters dialog box opens with the Polyspace pane displayed.
2. In the **Output folder** field, specify the full path for your results folder. By default, the software stores results in `C:\Polyspace_Results\results_`*`model_name`*.
3. If you want to avoid overwriting results from previous analyses, select the **Make output folder name unique by adding a suffix** check box. Instead of overwriting an existing folder, the software specifies a new location for the results folder by appending a unique number to the folder name.

Check Coding Rules Compliance

You can check compliance with MISRA AC AGC and MISRA C:2004, and MISRA C:2012 coding rules directly from your Simulink model.

In addition, you can choose to run coding rules checking either with or without full code analysis.

To configure coding rules checking:

1. From the Simulink model window, select **Code** > **Polyspace** > **Options**. The **Polyspace** pane opens.
2. In the **Settings from** drop-down menu, select the type of analysis you want to perform.

   Depending on the type of code generated, different settings are available. The following tables describe the different settings.

   C Code Settings

Setting	Description
`Project configuration`	Run Polyspace using the options specified in the **Project configuration**.
`Project configuration and MISRA AC AGC checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with the MISRA AC-AGC rule set.
`Project configuration and MISRA C 2004 checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with MISRA C:2004 coding rules.
`Project configuration and MISRA C 2012 ACG checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with MISRA C:2012 coding guidelines.
`MISRA AC AGC checking`	Check compliance with the MISRA AC-AGC rule set. Polyspace stops after rules checking.

Setting	Description
`MISRA C 2004 checking`	Check compliance with MISRA C:2004 coding rules. Polyspace stops after rules checking.
`MISRA C 2012 ACG checking`	Check compliance with MISRA C:2012 coding rules using generated code categories. Polyspace stops after guideline checking.

C++ Code Settings

Setting	Description
`Project configuration`	Run Polyspace using the options specified in the **Project configuration**.
`Project configuration and MISRA C++ rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with the MISRA C ++ coding rules.
`Project configuration and JSF C ++ rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with JSF C++ coding rules.
`MISRA C++ rule checking`	Check compliance with the MISRA C++ coding rules. Polyspace stops after rules checking.
`JSF C++ rule checking`	Check compliance with JSF C++ coding rules. Polyspace stops after rules checking.

3 Click **Apply** to save your settings.

Configure Polyspace Analysis Options

From Simulink, you can specify Polyspace options to change the configuration of the Polyspace Analysis. For example, you can specify the processor type and operating system of your target device.

For descriptions of options, see “Analysis Options for C Code” or “Analysis Options for C Code”.

There are two ways to configure analysis options:

Use the Configuration Window

1. From Simulink, select **Code** > **Polyspace** > **Options**.
2. In the Polyspace parameter configuration pane, select **Configure**.
3. In the Polyspace Configuration window, set options required by your application.

   The first time you open the configuration, the software sets certain options depending on your code generator.

Link to a Configuration File

1. From Simulink, select **Code** > **Polyspace** > **Options**.
2. In the Polyspace parameter configuration pane, select **Use custom project file**.
3. In the **Use custom project file** field, enter the full path to a `.psprj` file, or click **Browse for project file** to browse for a `.psprj` file.

See Also

`pslinkoptions`

Related Examples

- “Create a Polyspace Configuration File Template” on page 17-12

- "Configure Polyspace Project Properties" on page 17-11

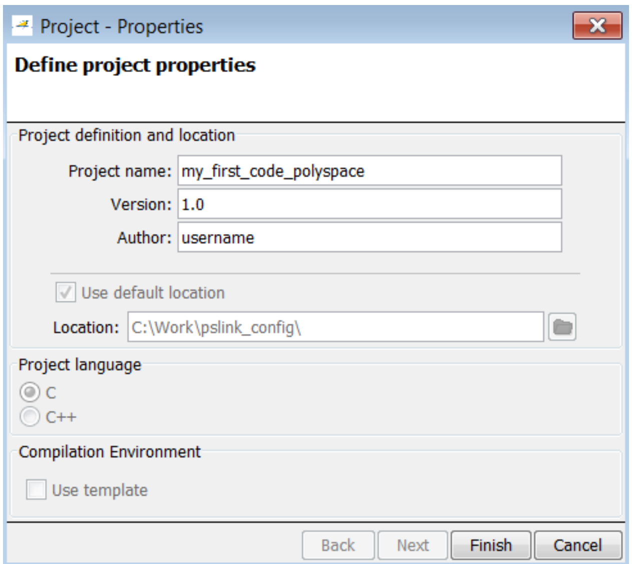
More About

- "Embedded Coder Considerations"
- "TargetLink Considerations"
- "Recommended Polyspace options for Verifying Generated Code"

Configure Polyspace Project Properties

You can specify project properties, for example, your project name, through the Polyspace Project - Properties dialog box. To open this dialog box:

1. From the Simulink model window, select **Code** > **Polyspace** > **Options**. The **Polyspace** pane opens.
2. Click **Configure**. The Polyspace configuration window opens.
3. On the Project Manager toolbar, click the **Project properties** icon .



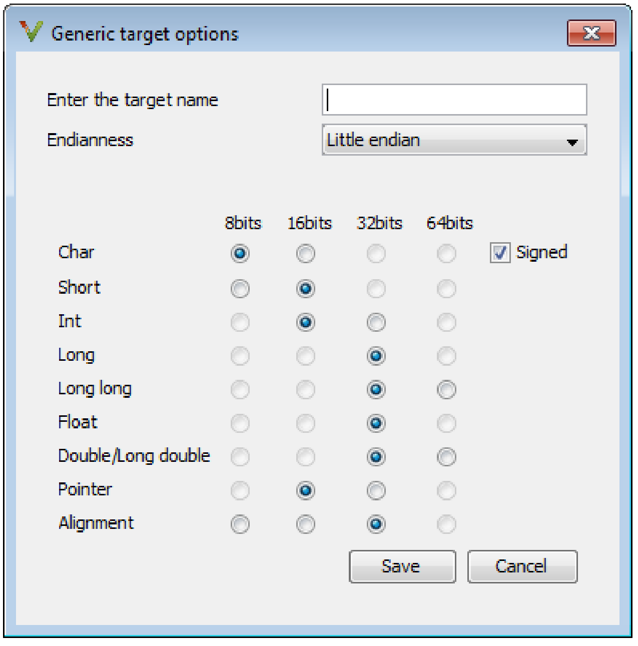
Create a Polyspace Configuration File Template

During a batch run, you may want use different configurations. At the MATLAB command-line, use “`pslinkfun('settemplate',...)`” to apply a configuration defined by a configuration file template.

To create a configuration file template:

1. In the Simulink model window, select **Code** > **Polyspace** > **Options**. The **Polyspace** pane opens.
2. Click **Configure**. The Project Manager opens, displaying the **Configuration** pane. Use this pane to customize the target and cross compiler.
3. From the **Configuration** tree, expand the **Target & Compiler** node.
4. In the **Target Environment** section, use the **Target processor type** option to define the size of data types.

   a. From the drop-down list, select `mcpu...(Advanced)`. The Generic target options dialog box opens.



Use this dialog box to create a new target and specify data types for the target. Then click **Save**.

5 From the Configuration tree, select **Target & Compiler** > **Macros**. Use the **Preprocessor definitions** section to define preprocessor macros for your cross-compiler.

   To add a macro, in the **Macros** table, click the **+** button. In the new line, enter the required text.

   To remove a macro, select the macro and click the **-** button.

   Note: If you use the LCC cross-compiler, then you must specify the `MATLAB_MEX_FILE` macro.

   ---

6 Save your changes and close the Project Manager.

7 Make a copy of the updated project configuration file, for example, `my_first_code_polyspace.psprj`.

8 Rename the copy, for example, `my_cross_compiler.psprj`. This is your new configuration file template.

To use a configuration template, run the `pslinkfun` command in the MATLAB Command Window. For example:

```
pslinkfun('settemplate','C:\Work\my_cross_compiler.psprj')
```

Specify Header Files for Target Compiler

If you want to analyze code generated for a 16-bit target processor, you must specify header files for your 16-bit compiler. The software automatically identifies the compiler from the Simulink model. If the compiler is 16-bit and you do not specify the relevant header files, the software produces an error when you try to run an analysis.

Note: For a 32-bit or 64-bit target processor, the software automatically specifies the default header file.

To specify header file folders (or header files) for your compiler:

1. Open the Polyspace **Configuration** pane. From the Simulink model window, select **Code** > **Polyspace** > **Options**. The **Polyspace** pane opens.
2. Click **Configure**. The Project Manager opens, displaying the **Configuration** pane.
3. From the **Configuration** tree, expand the **Target & Compiler** node.
4. Select **Target & Compiler** > **Environment Settings**.
5. In the **Include folders** (or **Include**) section, specify a folder (or header file) path by doing one of the following:

   - Click the **+** button. Then, in the text field, enter the folder (or file) path.
   - Click the folder button and use the Open file dialog box to navigate to the required folder (or file).

   You can remove an item from the displayed list by selecting the item and then clicking **-**.

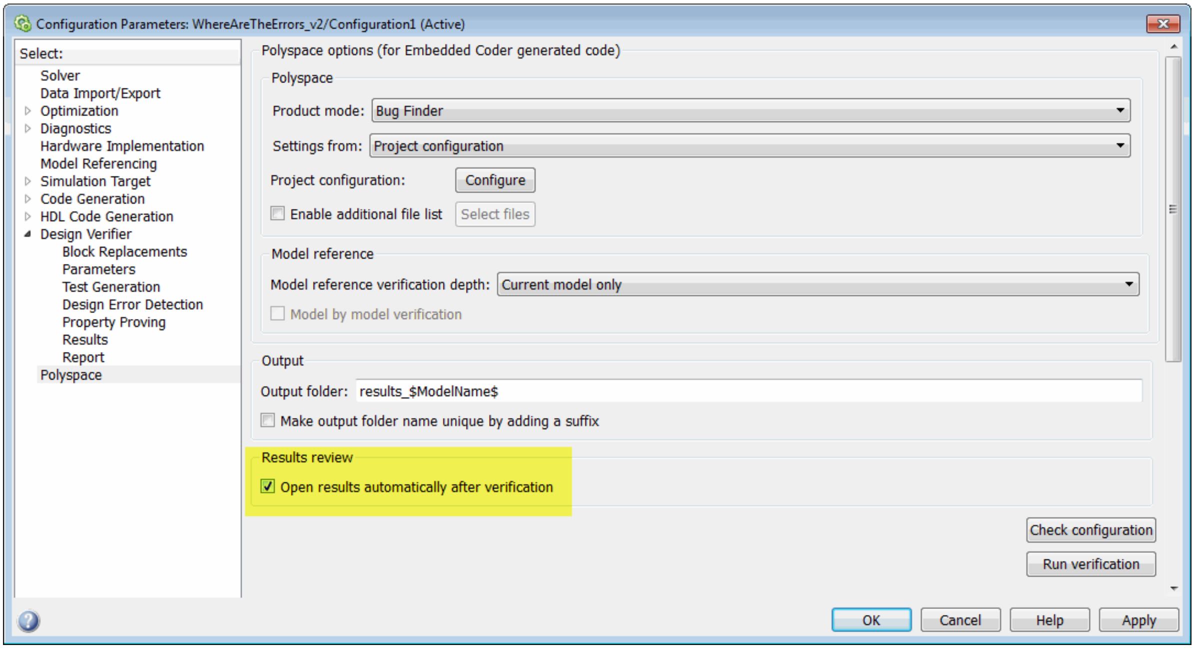
Open Polyspace Results Automatically

You can configure the software to automatically open your Polyspace results after you start the analysis. If you are doing a remote analysis, the Polyspace Metrics webpage opens. When the remote job is complete, you can download your results from Polyspace Metrics. If you are doing a local analysis, when the local job is complete, the Polyspace environment opens the results in the Results Manager perspective.

To configure the results to open automatically:

1 From the model window, select **Code** > **Polyspace** > **Options**.

   The Polyspace pane opens.



2 In the Results review section, select **Open results automatically after verification**.

3 Click **Apply** to save your settings.

Remove Polyspace Options From Simulink Model

You can remove Polyspace configuration information from your Simulink model.

For a top model:

1. Select **Code** > **Polyspace** > **Remove Options from Current Configuration**.
2. Save the model.

For a Model block or subsystem:

1. Right-click the Model block or subsystem.
2. From the context menu, select **Polyspace** > **Remove Options from Current Configuration**.
3. Save the model.

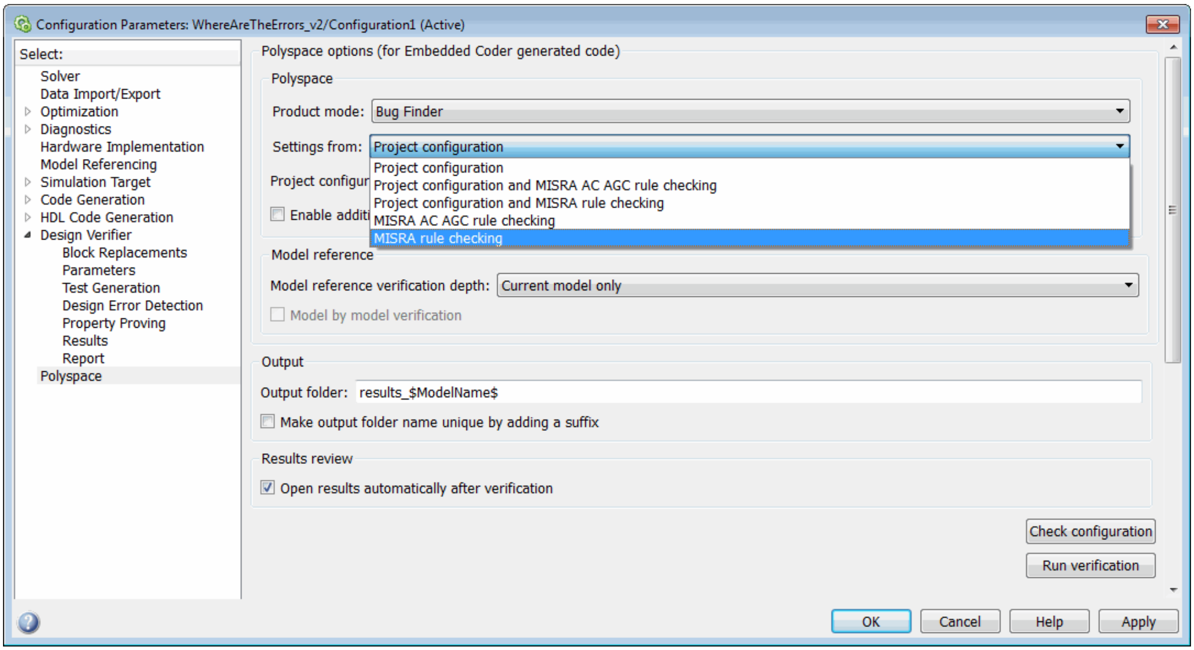
Run Polyspace on Generated Code

Specify Type of Analysis to Perform

Before running Polyspace, you can specify what type of analysis you want to run. You can choose to run code analysis, coding rules checking, or both.

To specify the type of analysis to run:

1 From the Simulink model window, select **Code** > **Polyspace** > **Options**. The **Configuration Parameter** window opens to the **Polyspace** options pane.



2 In the **Settings from** drop-down menu, select the type of analysis you want to perform.

Depending on the type of code generated, different settings are available. The following tables describe the different settings.

C Code Settings

Setting	Description
`Project configuration`	Run Polyspace using the options specified in the **Project configuration**.
`Project configuration and MISRA AC AGC rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with the MISRA AC-AGC rule set.
`Project configuration and MISRA rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with MISRA C coding rules.
`MISRA AC AGC rule checking`	Check compliance with the MISRA AC-AGC rule set. Polyspace stops after rules checking.
`MISRA rule checking`	Check compliance with MISRA C coding rules. Polyspace stops after rules checking.

C++ Code Settings

Setting	Description
`Project configuration`	Run Polyspace using the options specified in the **Project configuration**.
`Project configuration and MISRA C++ rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with the MISRA C ++ coding rules.
`Project configuration and JSF C ++ rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with JSF C++ coding rules.
`MISRA C++ rule checking`	Check compliance with the MISRA C++ coding rules. Polyspace stops after rules checking.
`JSF C++ rule checking`	Check compliance with JSF C++ coding rules. Polyspace stops after rules checking.

3 Click **Apply** to save your settings.

Run Analysis for Embedded Coder

To start Polyspace with:

- Code generated from the top model, from the Simulink model window, select **Code** > **Polyspace** > **Verify Code Generated for** > **Model**.
- All code generated as model referenced code, from the model window, select **Code** > **Polyspace** > **Verify Code Generated for** > **Referenced Model**.
- Model reference code associated with a specific block or subsystem, right-click the Model block or subsystem. From the context menu, select **Verify Code Generated for** > **Selected Subsystem**.

Note: You can also start the Polyspace software from the **Polyspace** configuration parameter pane by clicking **Run verification**.

When the Polyspace software starts, messages appear in the MATLAB Command window:

```
### Starting Polyspace verification for Embedded Coder
### Creating results folder C:\PolySpace_Results\results_my_first_code
                                           for system my_first_code
### Checking Polyspace Model-Link Configuration:
### Parameters used for code verification:
 System                : my_first_code
 Results Folder        : C:\PolySpace_Results\results_my_first_code
 Additional Files      : 0
 Remote                : 0
 Model Reference Depth : Current model only
 Model by Model        : 0
 DRS input mode        : DesignMinMax
 DRS parameter mode    : None
 DRS output mode       : None
...
```

Follow the progress of the analysis in the MATLAB Command window. If you are running a remote, batch, analysis you can follow the later stages through the Polyspace Job Monitor.

The software writes status messages to a log file in the results folder, for example `Polyspace_R2013b_my_first_code_05_16_2013-18h40.log`

Run Analysis for TargetLink

To start the Polyspace software:

1. In your model, select the Target Link subsystem.
2. In the Simulink model window select **Code** > **Polyspace** > **Verify Code Generated for** > **Selected Target Link Subsystem**.

   Messages appear in the MATLAB Command window:

```
### Starting Polyspace verification for Embedded Coder
### Creating results folder results_WhereAreTheErrors_v2
                         for system WhereAreTheErrors_v2
### Parameters used for code verification:
 System               : WhereAreTheErrors_v2
 Results Folder       : H:\Desktop\Test_Cases\ModelLink_Testers
                                  \results_WhereAreTheErrors_v2
 Additional Files     : 0
 Verifier settings    : PrjConfig
 DRS input mode       : DesignMinMax
 DRS parameter mode   : None
 DRS output mode      : None
 Model Reference Depth : Current model only
 Model by Model       : 0
```

   The exact messages depend on the code generator you use and the Polyspace product. The software writes status messages to a log file in the results folder, for example `Polyspace_R2013b_my_first_code_05_16_2013-18h40.log`

Follow the progress of the software in the MATLAB Command Window. If you are running a remote, batch analysis, you can follow the later stages through the Polyspace Job Monitor

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Note: Verification of a 3,000 block model will take approximately one hour to verify, or about 15 minutes for each 2,000 lines of generated code.

Monitor Progress

In this section...

Local Analyses

For a local Polyspace runs, you can follow the progress of the software in the MATLAB Command Window. The software also saves the status messages to a log file in the results folder. For example:

```
Polyspace_R2013b_my_first_code_05_16_2013-18h40.log
```

Remote Batch Analyses

For a remote analysis, you can follow the initial stages of the analysis in the MATLAB Command window.

Once the compilation phase is complete, you can follow the progress of the software using the Polyspace Job Monitor.

From Simulink, select **Code** > **Polyspace** > **Open Job Monitor**

For more information, see "Verification Management".

Using Polyspace Software in the Eclipse IDE

Install Polyspace Plug-In for Eclipse

In this section...

Install Polyspace Plug-In for Eclipse IDE

You can install the Polyspace plug-in only after you:

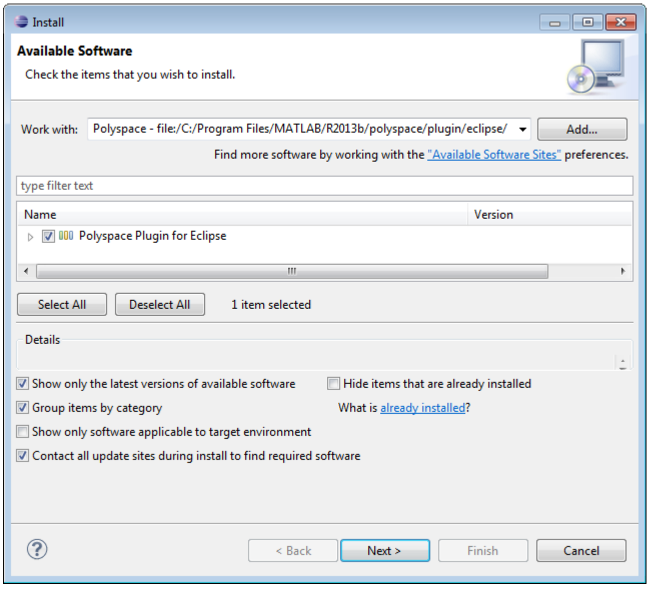
- Install and set up Eclipse Integrated Development Environment (IDE). For more information, see the Eclipse documentation at www.eclipse.org.
- Install Java 7. See Java documentation at www.java.com.
- Uninstall any previous Polyspace plug-ins. For more information, see "Uninstall Polyspace Plug-In for Eclipse IDE" on page 19-4.

To install the Polyspace plug-in:

1. From the Eclipse editor, select **Help** > **Install New Software**. The Install wizard opens, displaying the Available Software page.
2. Click **Add** to open the Add Repository dialog box.
3. In the **Name** field, specify a name for your Polyspace site, for example, `Polyspace_Eclipse_PlugIn`.
4. Click **Local**, to open the Browse for Folder dialog box.
5. Navigate to the *`MATLAB_Install`*`\matlab\polyspace\plugin\eclipse` folder. Then click **OK**.

   `MATLAB_Install` is the installation folder for the Polyspace product, for example:

   `C:\Program Files\MATLAB\R2013b`
6. Click **OK** to close the Add Repository dialog box.
7. On the Available Software page, select `Polyspace Plugin for Eclipse`.



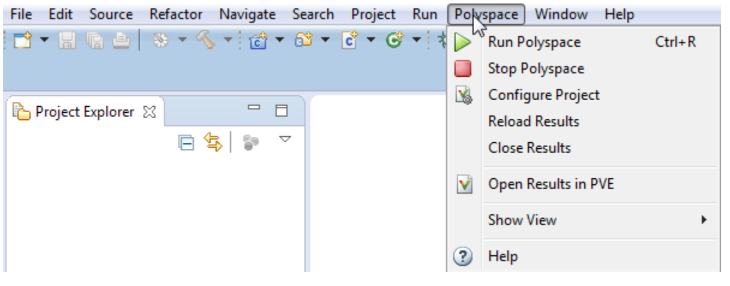
8 Click **Next**.

9 On the Install Details page, click **Next**.

10 On the Review Licenses page, review and accept the licence agreement. Then click **Finish**.

Once you install the plug-in, in the Eclipse editor, you'll see:

- A **Polyspace** menu
- A **Polyspace Run** view



Uninstall Polyspace Plug-In for Eclipse IDE

Before installing a new Polyspace plug-in, you must uninstall any previous Polyspace plug-ins:

1. In Eclipse, select **Help** > **About Eclipse**.
2. Select **Installation Details**.
3. Select the Polyspace plug-in and select **Uninstall**.

   Follow the uninstall wizard to remove the Polyspace plug-in. You must restart Eclipse for changes to take effect.

Verify Code in the Eclipse IDE

In this section...

Workflow for Code Verification in Eclipse

You can use Polyspace software to verify code that you develop within the Eclipse Integrated Development Environment (IDE).

A typical workflow is:

1. Create an Eclipse project and develop code within your project.
2. Configure verification options.
3. Start the verification.
4. Review the verification results. Fix run-time errors and restart the verification.

Install the Polyspace plug-in for Eclipse IDE before you verify code in Eclipse IDE. For more information, see "Install Polyspace Plug-In for Eclipse" on page 19-2.

Create Eclipse Project

If your source files do not belong to an Eclipse project, then create a project using the Eclipse editor:

1. Select **File** > **New** > **C Project**.
2. Clear the **Use default location** check box.
3. Click **Browse** to navigate to the folder containing your source files, for example, `C:\Test\Source_C`.
4. In the **Project name** field, enter a name, for example, `Demo_C`.
5. In the **Project Type** tree, under **Executable**, select **Empty Project** .

6. Under **Toolchains**, select your installed toolchain, for example, `MinGW GCC`.
7. Click **Finish**. An Eclipse project is created.

For information on developing code within Eclipse IDE, refer to www.eclipse.org.

Configure Polyspace Verification

To configure your verification:

1. In **Project Explorer**, select the project or files that you want to verify.
2. Select **Polyspace** > **Configure Project** to open the **Configuration** pane in the Polyspace verification environment.
3. Select your options for the verification process.
4. Select **File** > **Save** to save your options.

For more information, see "Analysis Options for C Code".

Note: Your Eclipse compiler options for include paths (`-I`) and symbol definitions (`-D`) are automatically added to the list of Polyspace analysis options.

To view the `-I` and `-D` options in the Eclipse editor :

1. Select **Project** > **Properties** to open the Properties for Project dialog box.
2. In the tree, under **C/C++ General** , select **Paths and Symbols** .
3. Select **Includes** to view the `-I` options or **Symbols** to view the `-D` options.

Start Verification

To start a Polyspace verification from the Eclipse editor:

1. Select the file, files, or class that you want to verify.
2. Either right-click and select **Run Polyspace Code Prover**, or select **Polyspace** > **Run Polyspace**.

   You can see the progress of the verification in the **Polyspace Run** view. If you see an error or warning during the compilation phase, double-click it to go to the corresponding location in the source code. Once the verification is over, the results are displayed on the **Results Summary** tab.

3 To stop a verification, select **Polyspace** > **Stop Polyspace**. Alternatively you can use the button in the **Polyspace Run** view.

For more information, see “Monitor Progress of Verification”.

Review Results

You can examine results of the verification either in Eclipse or the Polyspace verification environment.

- **Eclipse**:

  After you run a verification in Eclipse, your results open automatically on the **Results Summary** tab. Select a check to see detailed information on the **Check Details** tab. If you close Eclipse or run Polyspace on another Eclipse project, your results are closed. To reopen your results in Eclipse, select **Polyspace** > **Reload Results**.
- **Polyspace environment**:

  The results in Eclipse are overwritten every time a new verification is performed. However, Polyspace automatically imports **Status**, **Classification** and **Comment** information to the new verification. If you want to save your earlier results:

  1 Select **Polyspace** > **Open Results in PVE** to open your results in the Polyspace environment.

  2 Upload your results to Metrics by selecting **Metrics** > **Upload to Metrics**

Related Examples

- “Results Summary”
- “Check Details”
- “Run-Time Error Review”

Using Polyspace Software in Visual Studio

Install Polyspace Add-In for Visual Studio

Install Polyspace Add-In for Visual Studio

The Polyspace Add-in is supported for Visual Studio 2008, 2010. You can install the Polyspace add-in only after you:

- Install Visual Studio.
- Uninstall any previous Polyspace add-ins. For more information see "Uninstall Polyspace Add-In for Visual Studio" on page 20-3.

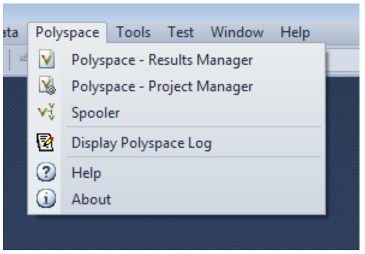
To install the Polyspace add-in:

1. In the Visual Studio editor, select **Tools** > **Options** to open the Options dialog box.
2. Select the **Environment** > **Add-in/Macros Security** pane to display the list of Visual Studio add-in folders.
3. Select the following check boxes:
   - **Allow macros to run**
   - **Allow Add-in components to load**
4. Click **Add** to open the Browse For Folder dialog box.
5. Navigate to `*MATLAB_Install*\matlab\polyspace\plugin\msvc\*VS_version*`
   - *`MATLAB_Install`* is the installation folder for the Polyspace product, for example:

     `C:\Program Files\MATLAB\R2013b`
   - *`VS_version`* corresponds to the version of Visual Studio that you have installed, for example, `2010`.
6. Click **OK** to close the Browse for Folder dialog box.
7. To close the Options dialog box, click **OK**.

You must restart Visual Studio for the changes to take effect. After you install the add-in, the Visual Studio editor has:

- A **Polyspace** menu
- A **Polyspace Log** view



Uninstall Polyspace Add-In for Visual Studio

Before installing a new Polyspace add-in, you must uninstall any previous Polyspace add-ins.

1. In the Visual Studio editor, select **Tools** > **Options** to open the Options dialog box.
2. Select the **Environment** > **Add-in/Macros Security** pane to display the list of Visual Studio add-in folders.
3. Select the Polyspace add-in and select **Remove**.
4. To close the Options dialog box, click **OK**.

   You must restart Visual Studio for the changes to take effect.

Verify Code in Visual Studio

In this section...

Code Verification in Visual Studio

You can apply the powerful code verification functionality of Polyspace software to code that you develop within the Visual Studio Integrated Development Environment (IDE).

A typical workflow is:

1. Use the Visual Studio editor to create a project and develop code within this project.
2. Set up the Polyspace verification by configuring analysis options and settings, and then start the verification.
3. Monitor the verification.
4. Review the verification results.

Before you can verify code in Visual Studio, you must install the Polyspace add-in for Visual.NET. For more information , see “Install Polyspace Add-In for Visual Studio” on page 20-2.

Create Visual Studio Project

If your source files do not belong to a Visual Studio project, you can create a project using the Visual Studio editor:

1. Select **File** > **New** > **Project** > **New** > **Project Console Win32** to create a project space
2. Enter a project name, for example, `CppExample`.

3. Save this project in a specific location, for example, `C:\Polyspace\Visual`. The software creates some files and a Project Console Win32.

To add files to your project:

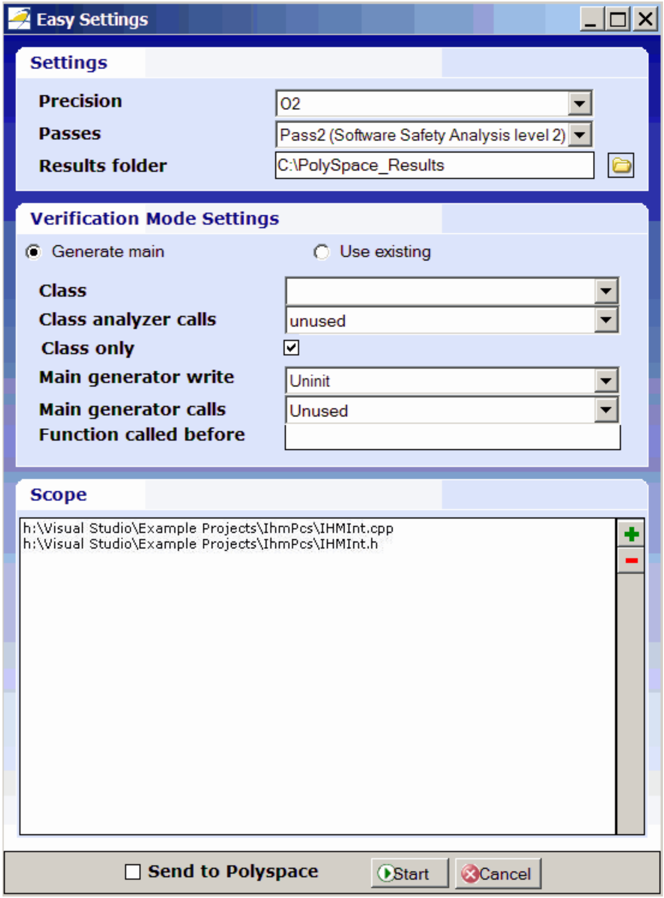
1. Select the **Browse the solution** tab.
2. Right-click the project name. From the pop-up menu, select **Add** > **Add existing element** .
3. Add the files you want to the project (for example, `CppExample`).

Verify Code in Visual Studio

To set up and start a verification:

1. In the Visual Studio **Solution Explorer** view, select one or more files that you want to verify.
2. Right-click the selection, and select **Polyspace Verification**.

   The Easy Settings dialog box opens.



3 In the Easy Settings dialog box, you can specify the following options for your verification:

- Under **Settings**, configure the following:
  - **Precision** — Precision of verification (`-O`)
  - **Passes** — Level of verification (`-to`)
  - **Results folder** – Location where software stores verification results (`-results-dir`)
- Under **Verification Mode Settings**, configure the following:

  - **Generate main** or **Use existing** — Whether Polyspace generates a `main` subprogram (`-main-generator`) or uses an existing subprogram (`-main`)
  - **Class** — Name of class to verify (`-class-analyzer`)
  - **Class analyzer calls** — Functions called by generated `main` subprogram (`-class-analyzer-calls`)
  - **Class only** — Verification of class contents only (`-class-only`)
  - **Main generator write** — Type of initialization for global variables (`-main-generator-writes-variables`)
  - **Main generator calls** — Functions (not in a class) called by generated `main` subprogram (`-main-generator-calls`)
  - **Function called before** — Function called before all functions (`-function-call-before-main`)
- Under **Scope**, you can modify the list of files and classes to verify.

For information on *how* to choose your options, see "Analysis Options for C++ Code".

Note: In the Project Manager perspective of the Polyspace verification environment, you configure options that you cannot set in the Easy Settings dialog box. See "Set Standard Polyspace Options" on page 20-11.

---

4 Click **Start** to start the verification.

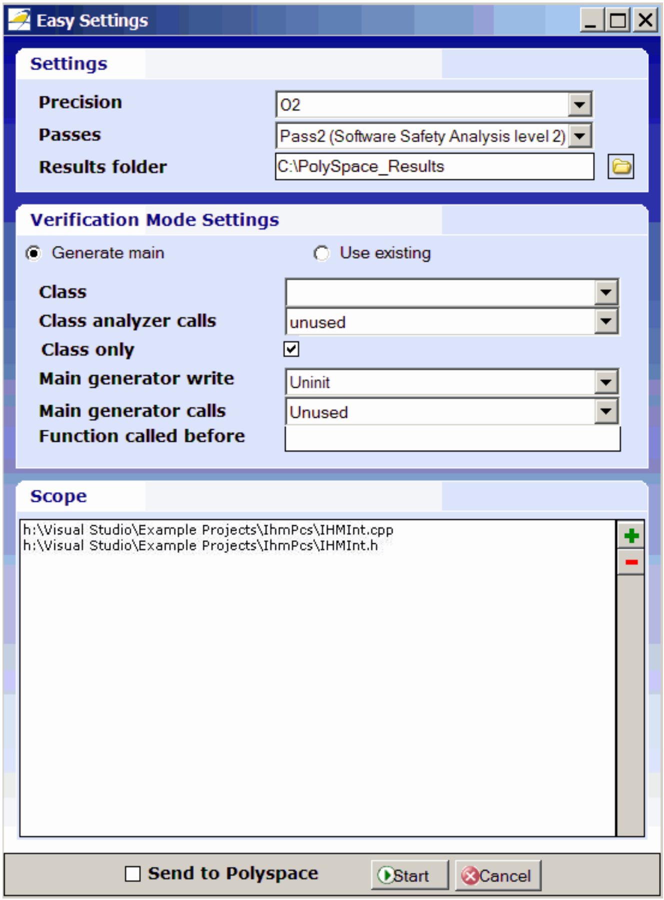
Verify Classes

In the Easy Settings dialog box, you can verify a C++ class by modifying the scope option.

To verify a class:

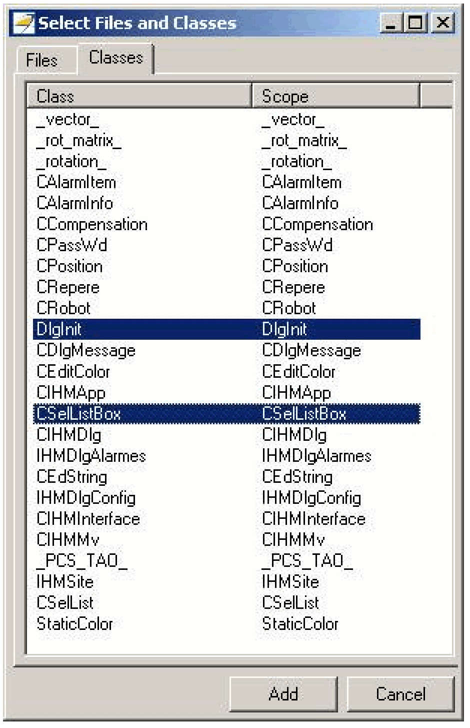
1 In the Visual Studio Solution Explorer, right-click a file and select **Polyspace Verification**.

The Easy Settings dialog box opens.



2 In the Scope window, click .

The Select Files and Classes dialog box opens.



3 Select the classes that you want to verify, then click **Add**.

4 In the Easy Settings dialog box, click **Start** to start the verification.

Verify an Entire Project

You can verify an entire project only through the Project Manager perspective of the Polyspace verification environment (select **Polyspace** > **Configure Project**).

For information on using the Project Manager perspective , see "Project Manager Verification".

Import Visual Studio Project Information into Polyspace Project

You can extract information from a Visual Studio project file (`vcproj`) to configure your Polyspace project.

This Visual Studio import feature can retrieve the following information from a Visual Studio project:

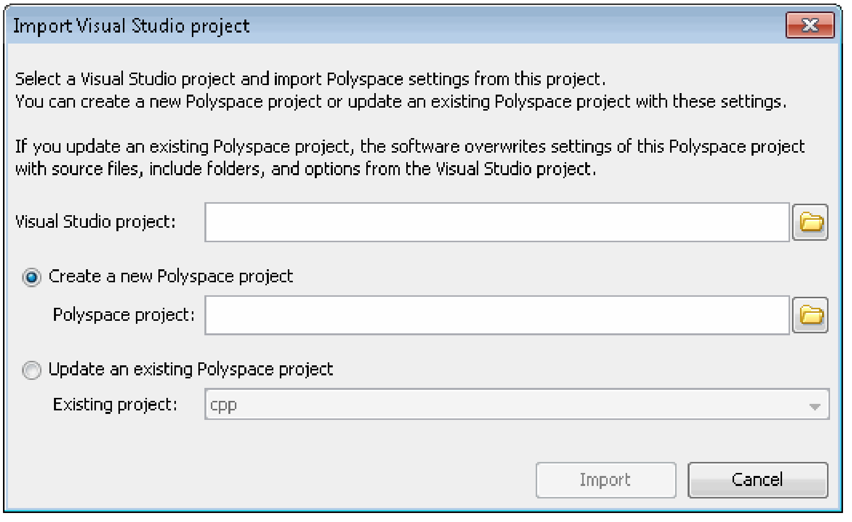
- Source files
- Include folders
- Preprocessing directives (`-D`, `-U`)
- Polyspace specific options about dialect used

Note: This feature supports Visual Studio versions 2008, 2010.

To import Visual Studio information into your Polyspace project:

1. In the Polyspace Project Manager, select **File > Import Visual Studio Project**.

   The Import Visual Studio project dialog box opens.



2. Select the Visual Studio project you want to use.
3. Select the Polyspace project you want to use.
4. Click **Import**.

   The Polyspace project is updated with the Visual Studio settings.

When you import a Visual Studio project, if all the source files are C files (with file extension `.c`), then the project will be a C project. Otherwise, the project will be a C++ project.

Set Standard Polyspace Options

In the Project Manager perspective of the Polyspace verification environment, you specify Polyspace verification options that you cannot set in the Easy Settings dialog box.

To open the Project Manager perspective, select **Polyspace** > **Configure Project**. The software opens the Project Manager perspective using the **last** configuration (`.psprj`) file updated in Visual Studio. The software does not check the consistency of this configuration file with the current project, so it always displays a warning message. This message indicates that the `.psprj` file used by the Project Manager does not correspond to the `.psprj` file of the current project.

For information on *how* to choose your options, see “Analysis Options for C++ Code”.

Configuration File and Default Options

Some options are set by default while others are extracted from the Visual Studio project and stored in the associated Polyspace configuration file.

- The following table shows Visual Studio options that are extracted automatically, and their corresponding Polyspace options:

Visual Studio Option	Polyspace Option
`/D <name>`	`-D` <*name*>
`/U <name>`	`-U` <*name*>
`/MT`	`-D_MT`
`/MTd`	`-D_MT -D_DEBUG`
`/MD`	`-D_MT -D_DLL`
`/MDd`	`-D_MT -D_DLL -D_DEBUG`
`/MLd`	`-D_DEBUG`
`/Zc:wchar_t`	`-wchar-t-is keyword`
`/Zc:forScope`	`-for-loop-index-scope in`
`/FX`	`-support-FX-option-results`

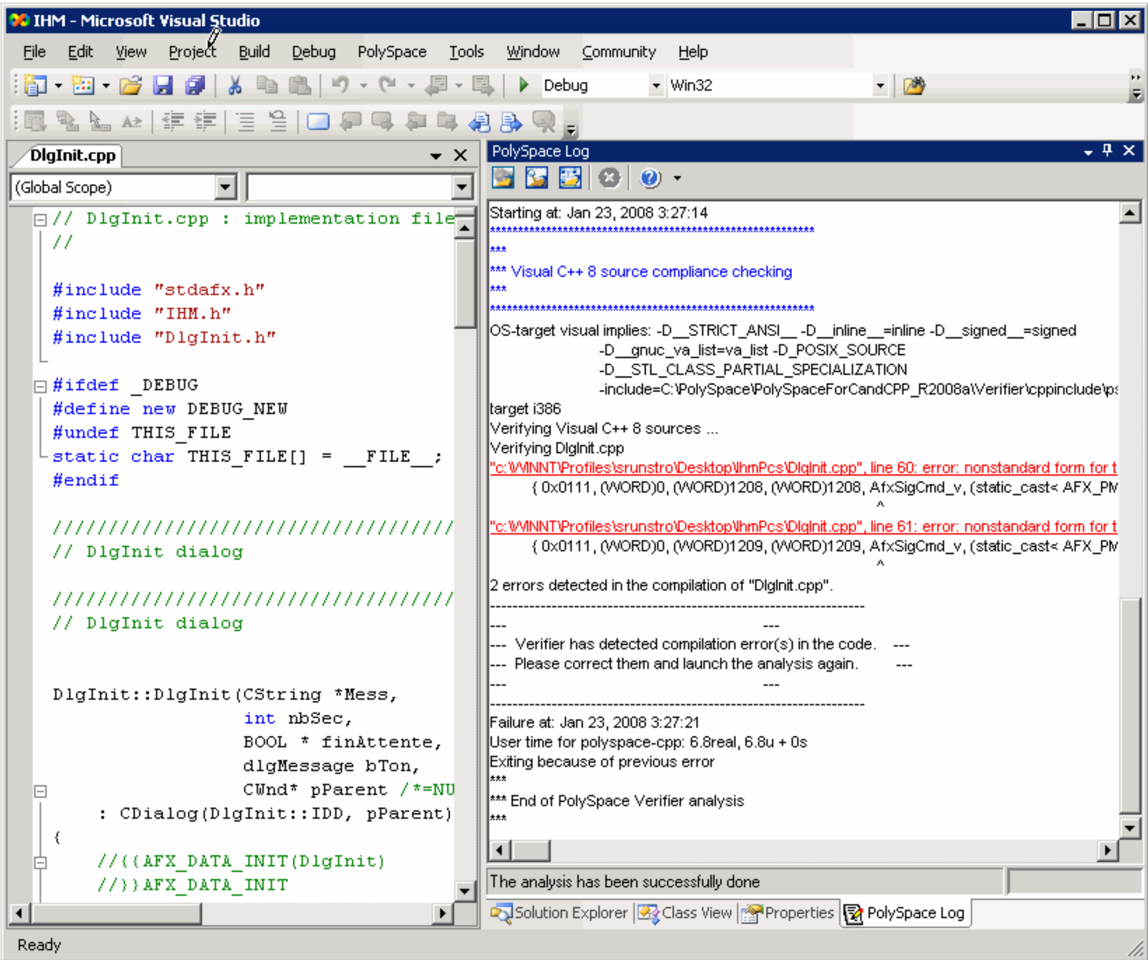
Visual Studio Option	Polyspace Option
/Zp[1,2,4,8,16]	-pack-alignment-value [1,2,4,8,16]

- Source and `include` folders (`-I`) are also extracted automatically from the Visual Studio project.
- Default options passed to the kernel depend on the Visual Studio release: `-dialect Visual7.1` (or `-dialect visual8`) `-OS-target Visual -target i386 -desktop`

Monitor Verification in Visual Studio

Once you start a verification, you can follow its progress in the **Polyspace Log** view.

Compilation errors are highlighted as links. Click a link to display the file and line that produced the error.



If the verification is being carried out on a server, use the Polyspace Job Monitor to follow the verification progress. Select **Polyspace** > **Job Monitor**, which opens the Polyspace Job Monitor interface dialog box.

To stop a verification, on the **Polyspace Log** toolbar, click **X**. For a server verification, this option works only during the compilation phase, before the verification is sent to the server. After the compilation phase, you can select **Polyspace** > **Job Monitor** and in the Polyspace Job Monitor interface dialog box, stop the verification.

For more information on the Polyspace Job Monitor, see “Manage Previous Verifications With Polyspace Metrics”.

Review Verification Results in Visual Studio

Select **Polyspace** > **Open Verification Results** to open the Results Manager perspective of the Polyspace verification environment with the last available results. If verification has been carried out on a server, download the results before opening the Results Manager perspective.

For information on reviewing and understanding Polyspace verification results, see “Run-Time Error Review”.

Glossary

Atomic	In computer programming, atomic describes a unitary action or object that is essentially indivisible, unchangeable, whole, and irreducible.
Atomicity	In a transaction involving two or more discrete pieces of information, either all of the pieces are committed or no pieces are committed.
Batch mode	Execution of verification from the command line, rather than via the launcher Graphical User Interface.
Category	One of four types of orange check: *potential bug, inconclusive check, data set issue* and *basic imprecision*.
Certain error	See "red check."
Check	A test performed during a verification and subsequently colored red, orange, green or gray in the viewer.
Code verification	The Polyspace process through which code is tested to reveal definite and potential runtime errors and a set of results is generated for review.
Dead Code	Code which is inaccessible at execution time under all circumstances due to the logic of the software executed prior to it.
Development Process	The process used within a company to progress through the software development lifecycle.
Green check	Code has been proven to be free of runtime errors.
Gray check	Unreachable code; dead code.
Imprecision	Approximations are made during a verification, so data values possible at execution time are represented by supersets including those values.
mcpu	Micro Controller/Processor Unit
Orange check	A warning that represents a possible error which may be revealed upon further investigation.

Polyspace Approach	The manner of using verification to achieve a particular goal, with reference to a collection of techniques and guiding principles.
Precision	An verification which includes few inconclusive orange checks is said to be precise
Progress text	Output during verification to indicate what proportion of the verification has been completed. Could be considered as a “textual progress bar”.
Red check	Code has been proven to contain definite runtime errors (every execution will result in an error).
Review	Inspection of the results produced by Polyspace verification.
Scaling option	Option applied when an application submitted for verification proves to be bigger or more complex than is practical.
Selectivitiy	The ratio (green checks + gray checks + red checks) / (total amount of checks)
Unreachable code	Dead code.
Verification	The Polyspace process through which code is tested to reveal definite and potential runtime errors and a set of results is generated for review.