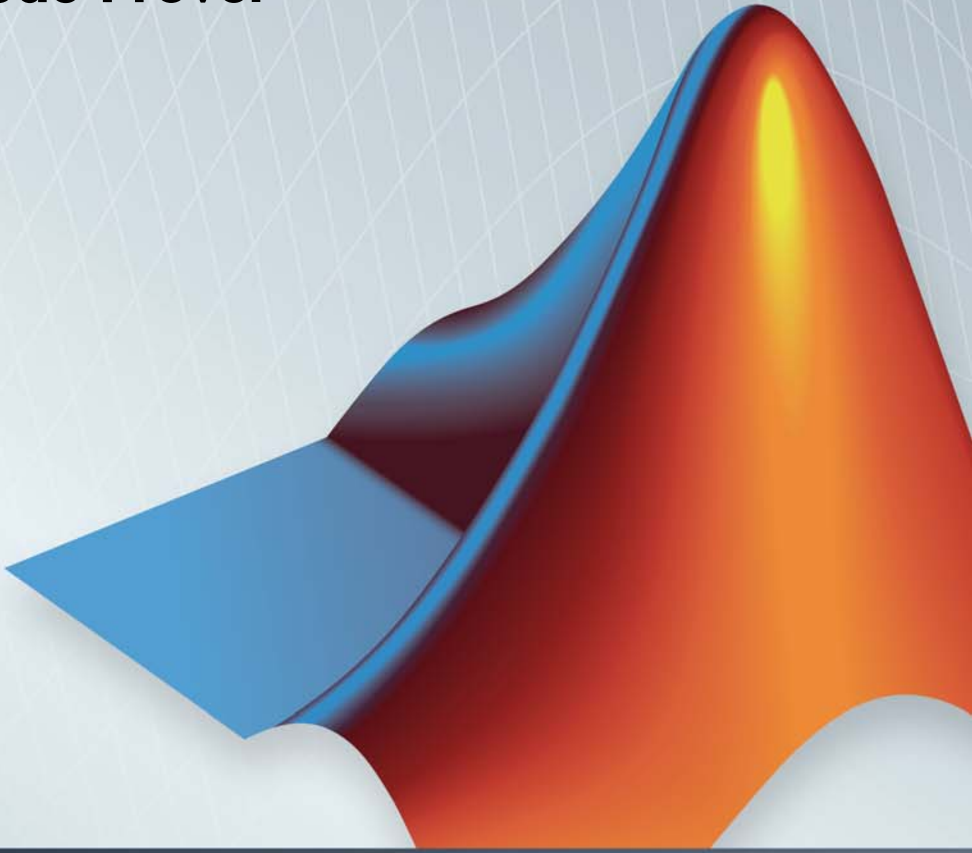
Polyspace® Code Prover™

User's Guide

R2013**b**



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Polyspace® Code Prover™ User's Guide

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Glossary

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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 conditions under 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 conditions under which variables 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" on page 1-3

"Value of Polyspace Verification" on page 1-3

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. Results are color-coded:

- **Green** – Indicates code that never has an error.
- **Red** – Indicates code that always has an error.
- **Gray** – Indicates unreachable code.
- **Orange** – Indicates unproven code (code that might have an error).

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" on page 1-3
- "Decrease Development Time" on page 1-4
- "Improve the Development Process" on page 1-5

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 possible 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++ 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.

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

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.

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 runtime errors. Static verification derives the dynamic properties of a program without actually executing it. This differs significantly from other techniques, such as runtime 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).

Any approximation leads by definition 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 any program variable is always a superset of its actual variation domain. The direct consequence is that no runtime error (RTE) item to be checked can be missed by Polyspace verification.

Related Products

In this section...

"Polyspace Products for Verifying Ada Code" on page 1-8

"Polyspace® Bug Finder™" on page 1-8

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/polyspacebugfinder/`.

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).

Access Qualification Documents for Polyspace Client for C/C++ and Polyspace Server for C/C++

The DO Qualification Kit product supports qualifying the following version and feature of Polyspace code verification tools:

> Version 8.5 (R2013b): Polyspace Client™ for C/C++; Polyspace Server™ for C/C++

Open the Artifacts Explorer to access the document templates, test cases, and test procedures. Alternatively, on the MATLAB® command line, type `qualkitdo`. The documents are located in **Polyspace Client/Server for C/C++ > r2013b**.

The following table lists qualification documents, and the primary files associated with the qualification documents.

Qualification Documents	Files
Theoretical Foundation (TF)	`qualkitdo_polyspace_tf.pdf` `qualkitdo_polyspace_tf.docx`
Tool Qualification Plan (TQP)	`qualkitdo_polyspace_tqp.pdf` `qualkitdo_polyspace_tqp.docx`

Tool Operational Requirements (TOR) and supporting documentation	`qualkitdo_polyspace_tor.pdf`
	`qualkitdo_polyspace_tor.docx`
	`polyspace_install.pdf`
	`polyspace_limitations.pdf`

Tool Development and Verification Process Considerations (PROC)	`qualkitdo_polyspace_proc.pdf` `qualkitdo_polyspace_proc.docx`

Tests Cases, Procedures, and Results (TCPR), and supporting documentation	`qualkitdo_polyspace_tcpr.pdf`
	`qualkitdo_polyspace_tcpr.docx`
	`Matrix_*.txt`
	`tests/qualkitdo_polyspace_tcpr.*`
	`tests/tor-checks/tor-checks.txt`
	`tests/*/*_rules.txt`
	`tests/*/*.c`
	`tests/*/*.cpp`
	`outputs/`

Qualification Documents	Files
	qualkitdo_polyspace_qualificationreport_*.txt qualkitdo_polyspace_qualificationreport_summary.pdf

Access Certification Artifacts for Polyspace Client for C/C++ and Polyspace Server for C/C++

TÜV SÜD certified specific versions of the Polyspace Client for C/C++ and the Polyspace Server for C/C++ products for use in development processes that are required to comply with ISO 26262, IEC 61508, or EN 50128. These product versions are also prequalified according to ISO 26262-8 for Automotive Safety Integrity Levels ASIL A through ASIL D.

The IEC Certification Kit product contains certification artifacts for the following versions of the Polyspace Client for C/C++ and the Polyspace Server for C/C++ products:

Version 8.5 (R2013a)

Previous releases of the Polyspace products are certified or prequalified. For supporting certification artifacts, see previous releases of the IEC Certification Kit product.

Note The Polyspace Client for C/C++ and the Polyspace Server for C/C++ products were not developed using an IEC 61508 certified process.

Open the Artifacts Explorer to access the certification artifacts. Alternatively, on the MATLAB command line, type `certkitiec`. The certification artifacts are located in **Polyspace Client/Server for C/C++ > r2013b**.

Component	File
Certificate	`certkitiec_polyspace_certificate.pdf`
Certificate Report	`certkitiec_polyspace_certreport.pdf`
	`certkitiec_polyspace_workflow.pdf` `certkitiec_polyspace_sqo.pdf`
Conformance Demonstration Template	`certkitiec_polyspace_cdt.docx/.pdf`

Component	File
ISO 26262 Tool Qualification Package	`certkitiec_polyspace_tqp.docx/.pdf`
Test Procedure / Test Cases	`/tests/*` (including `/tests/certkitiec_polyspace_tests.bat/.sh`) `/outputs/*`

How to Use Polyspace Software

- "Polyspace Verification and the Software Development Cycle" on page 2-2
- "Analysis and Review Criteria" on page 2-4
- "Implement Process for Verification" on page 2-9
- "Sample Workflows for Polyspace Verification" on page 2-13

Polyspace Verification and the Software Development Cycle

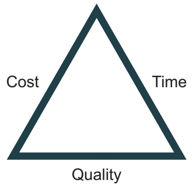
In this section...

"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 always three related variables: cost, quality, and time.



Changing the requirements for one of these variables always impacts 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 meets the required quality level. Unfortunately, this process often ends before quality requirements are met, because the available time or budget has been exhausted.

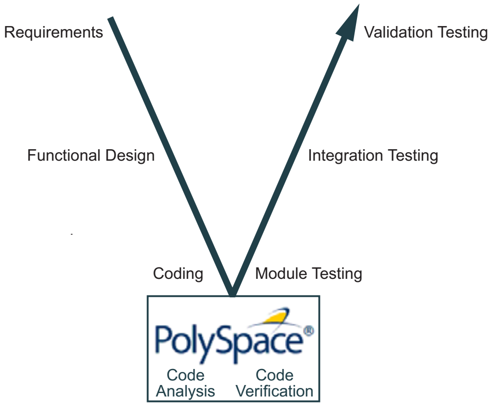
Polyspace verification allows a different process. Polyspace verification can support both productivity improvement and quality improvement at the same time, although there is always a balance between the aims of these activities.

To achieve maximum quality and productivity, however, you cannot simply perform code verification at the end of the development process. You must integrate verification into your development process, in a way that respects time and cost restrictions.

This chapter 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 any 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.

Analysis and Review Criteria

In this section...

"Choose Robustness or Contextual Verification" on page 2-4

"Choose Coding Rules" on page 2-5

"Choose Strict or Permissive Verification" on page 2-6

"Define Software Quality Levels" on page 2-7

Choose Robustness or Contextual Verification

Before using Polyspace products to verify your code, you must decide what type of software verification you want to perform. There are two approaches to code verification that result in slightly different workflows:

- **Robustness Verification –** Prove software works under all conditions.
- **Contextual Verification** – Prove software works under normal working conditions.

Note Some verification processes may incorporate both robustness and contextual verification. For example, developers may perform robustness verification on individual files early in the development cycle, while writing the code. Later, the team may perform contextual verification on larger software components.

Robustness Verification

Robustness verification proves that the software works under all conditions, including "abnormal" conditions for which it was not designed. This can be thought of as "worst case" verification.

By default, Polyspace software assumes you want to perform robustness verification. In a robustness verification, Polyspace software:

- Assumes function inputs are full range
- Initializes global variables to full range

- Automatically stubs missing functions

Although this approach checks the software for all conditions, it can lead to *orange checks* (unproven code) in your results. You must then manually inspect these orange checks in accordance with your software quality goals.

Contextual Verification

Contextual verification proves that the software works under predefined working conditions. This limits the scope of the verification to specific variable ranges, and verifies the code within these ranges.

When performing contextual verification, you use Polyspace options to reduce the number of orange checks. For example, you can:

- Use Data Range Specifications (DRS) to specify the ranges for your variables, thereby limiting the verification to these cases. For more information, see "Specify Data Ranges for Variables and Functions (Contextual Verification)" on page 5-54.
- Create a detailed main program to model the call sequence, instead of using the default main generator. For more information, see "Verify C Application Without a "Main"" on page 5-32.
- Provide manual stubs that emulate the behavior of missing functions, instead of using the default automatic stubs. For more information, see "Stubbing" on page 6-2.

Choose Coding Rules

Coding rules are one of the most efficient means to improve both the quality of your code, and the quality of your verification results.

If your development team observes certain coding rules, the number of orange checks (unproven code) in your verification results will be reduced substantially. This means that there is less to review, and that the remaining checks are more likely to represent actual bugs. This can make the cost of bug detection much lower.

Polyspace software can check that your code complies with specified coding rules. Before starting code verification, you should consider implementing coding rules, and choose which rules to enforce.

For more information, see “Activate Coding Rules Checker” on page 11-5.

Choose Strict or Permissive Verification

While defining the quality goals for your application, you should determine which of these options you want to use.

Options that make verification more strict include:

- **Detect overflows on** `signed and unsigned` (**`-scalar-overflow-checks`**) — Verification is more strict with overflowing computations on unsigned integers.
- **Do not consider all global variables to be initialized (`-no-def-init-glob`)** — Verification treats all global variables as non-initialized, therefore causing a red error if they are read before they are written to.
- **`-Wall`** — Specifies that all C compliance warnings are written to the log file during compilation.
- **`-strict`** — Specifies strict verification mode, which is equivalent to using the `-Wall` and `-no-automatic-stubbing` options simultaneously.

Options that make verification more permissive include:

- **Dialect (`-dialect`)** — Verification allows syntax associated with the IAR and Keil dialects.
- **Ignore overflowing computations on constants (`-ignore-constant-overflows`)** — Verification is permissive with overflowing computations on constants.
- **Allow negative operand for left shifts (`-allow-negative-operand-in-shift`)** — Verification allows a shift operation on a negative number.
- **Enable pointer arithmetic across fields (`-allow-ptr-arith-on-struct`)** — Enables navigation within a structure or union from one field to another.

For more information on these options, see “Analysis Options for C Code”.

Define Software Quality Levels

The software quality level you define determines which Polyspace options you use, and which results you must review.

You define the quality levels for your application, from level QL-1 (lowest) to level QL-4 (highest). Each quality level consists of a set of software quality criteria that represent a certain quality threshold. For example:

Software Quality Levels

Criteria	Software Quality Levels			
	QL1	QL2	QL3	QL4
Document static information	X	X	X	X
Enforce coding rules with direct impact on selectivity	X	X	X	X
Review all red checks	X	X	X	X
Review all gray checks	X	X	X	X
Review first criteria level for orange checks		X	X	X
Review second criteria level for orange checks			X	X
Enforce coding rules with indirect impact on selectivity			X	X
Perform dataflow analysis			X	X
Review third criteria level for orange checks				X

In the example above, the quality criteria include:

- **Static Information** – Includes information about the application architecture, the structure of each module, and all files. Full verification of your application requires the documentation of static information.
- **Coding rules** – Polyspace software can check that your code complies with specified coding rules. The section “Apply Coding Rules to Reduce

Orange Checks” on page 10-15 defines two sets of coding rules – a first set with direct impact on the selectivity of the verification, and a second set with indirect impact on selectivity.

- **Red checks** – Represent errors that occur every time the code is executed.
- **Gray checks** – Represent unreachable code.
- **Orange checks** – Indicate unproven code, meaning a run-time error may occur.
- **Dataflow analysis** – Identifies errors such as non-initialized variables and variables that are written but never read. This can include inspection of:
  - Application call tree
  - Read/write accesses to global variables
  - Shared variables and their associated concurrent access protection

Implement Process for Verification

In this section...

"Overview of the Polyspace Process" on page 2-9

"Define Process to Meet Your Goals" on page 2-11

"Apply Process to Assess Code Quality" on page 2-12

"Improve Your Verification Process" on page 2-12

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" on page 3-16.
- Setting review criteria in the Results Manager perspective for consistent review of results. For more information, see "Review Checks Using Custom Methodologies" on page 9-29.

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 "Review and Comment Checks" on page 9-17.
3. Saving review comments for each component, so they are available for future review. See "Import and Export Review Comments" on page 9-118.
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" on page 2-13

"Software Developers and Testers – Standard Development Process" on page 2-14

"Software Developers and Testers – Rigorous Development Process" on page 2-17

"Quality Engineers – Code Acceptance Criteria" on page 2-21

"Quality Engineers – Certification/Qualification" on page 2-24

"Model-Based Design Users — Verifying Generated Code" on page 2-25

"Project Managers — Integrating Polyspace Verification with Configuration Management Tools" on page 2-29

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. Before implementing Polyspace verification, these users fit the following criteria:

- In Ada, no unit test tools or coverage tools are used – functional tests are performed just after coding.
- In C, either no coding rules are used, or rules are not followed consistently.

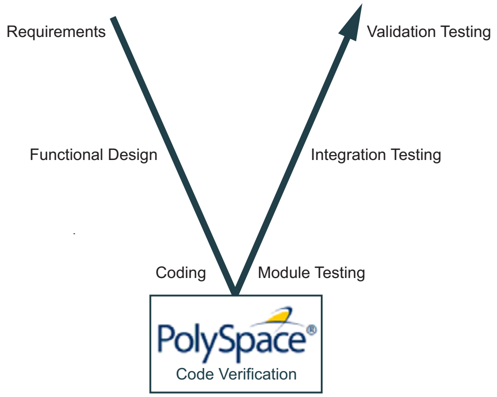
Quality

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 all 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 all **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 any **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.

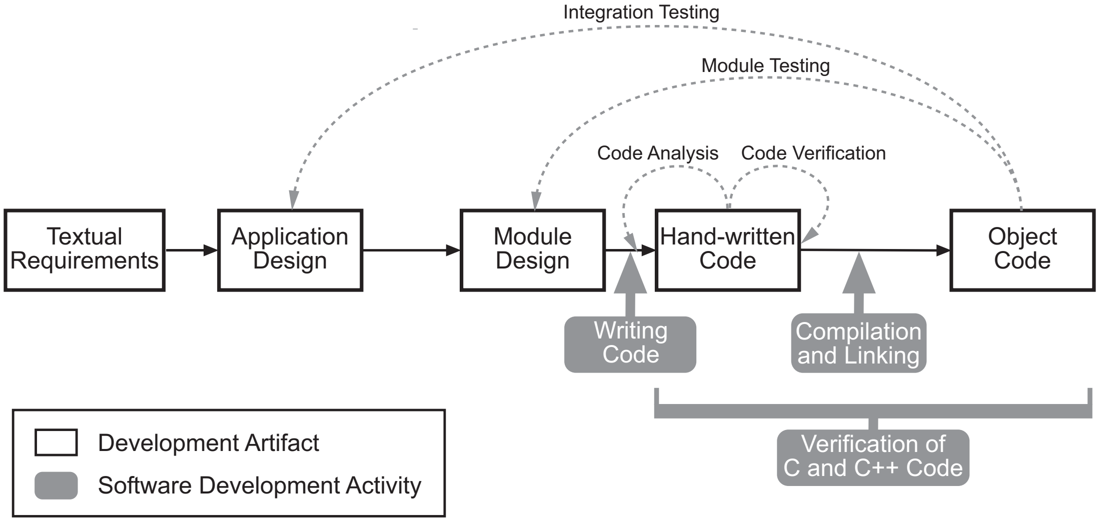
Quality

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 find and fix any bugs more quickly than other processes.

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 any coding rule violations, fixes all **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 all orange checks that were not reviewed as part of previous reviews. This is possible when using coding rules because 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

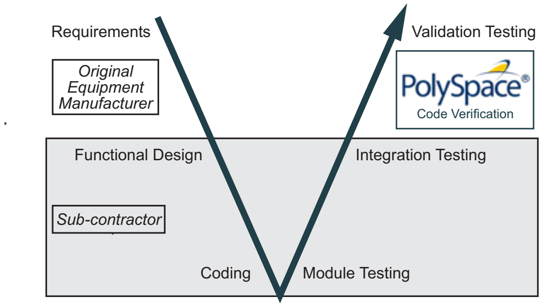
The main goal of Polyspace verification is to control and evaluate the safety of an application.

The criteria used to evaluate code can vary widely depending on the criticality of the application, from no red errors to exhaustive oranges 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 “Define Software Quality Levels” on page 2-7.

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 "Analysis and Review Criteria" on page 2-4.

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 2-11.

5. Quality engineers perform verification on the code.

6. Quality engineers review all **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 Software Quality Levels" on page 2-7).

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 all unresolved function calls.
- Using DRS to provide accurate data ranges for all input variables.

Taking these steps will minimize the number of orange checks reported by the verification, and make it likely that any remaining orange checks represent true 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-178C qualification.

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

For information on using Polyspace products within an IEC 61508 certification environment, see the *IEC Certification Kit: Verification of C and C++ Code Using Polyspace Products*.

For information on using Polyspace products within an DO-178C qualification environment, see the *DO Qualification Kit: Polyspace Client/Server for C/C++ Tool Qualification Plan*.

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 hand-written code with those created using generated code.

Quality

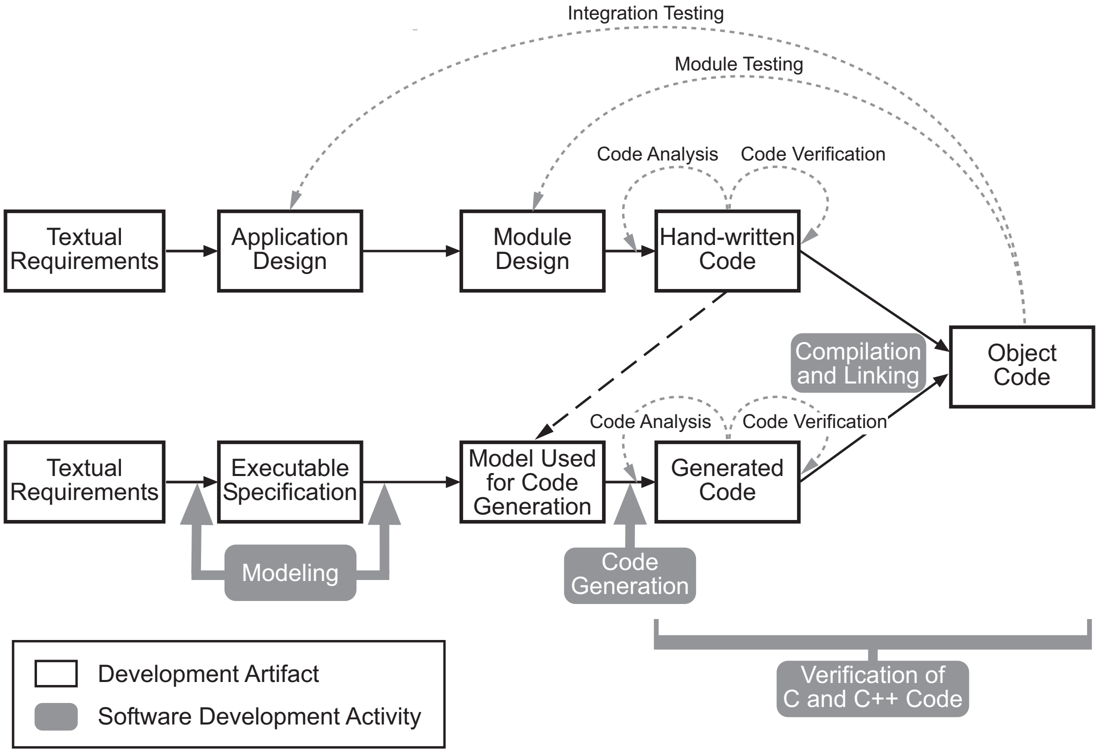
The goal of Polyspace verification is to improve the quality of the software by identifying implementation issues in the code, and proving that the code is both semantically and logically correct.

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 hand-written and generated code

Verification Workflow

The workflow is different for hand-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 hand-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 write hand-coded sections of the application.

3 Developers or testers perform **Polyspace verification** on any hand-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 hand-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 any 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 all multitasking aspects accounted for as required.
   - Pre-peer review check-in — On the whole project, with all 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 bug found within 20 minutes of selective orange review"

Setting Up a Verification Project

- “What Is a Project?” on page 3-2
- “Open Polyspace® Code Prover™” on page 3-3
- “Create Project Automatically from Your Build System” on page 3-4
- “Create Multiple Modules” on page 3-11
- “Create Multiple Analysis Option Configurations” on page 3-12
- “Customize Results Folder Location and Name” on page 3-13
- “Specify Functions Not Called by Generated Main” on page 3-14
- “Specify Analysis Options” on page 3-16
- “Configure Text Editor” on page 3-17
- “Specify Options to Match Your Quality Goals” on page 3-18
- “Set Up Project to Check Coding Rules” on page 3-23
- “Set Up Project to Automatically Test Orange” on page 3-26

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.

Open Polyspace Code Prover

In Windows®, do one of the following:

- From the folder *MATLAB_Install*\polyspace\bin, double-click the Polyspace Code Prover icon.
- Double-click a desktop Polyspace Code Prover shortcut.

  To create this shortcut, in the folder *MATLAB_Install*\polyspace\bin, right-click polyspace-code-prover. Then, from the context menu, select **Create shortcut**.
- In a DOS command window, enter:

  ```
  MATLAB_Install\polyspace\bin\polyspace-code-prover
  ```

  MATLAB_Install is your MATLAB installation folder, for example:

  ```
  C:\Program Files\MATLAB\R2013b
  ```
- From the MATLAB apps gallery, click the Polyspace Code Prover app.

In Linux®, do one of the following:

- Run the following command:

  ```
  MATLAB_Install/polyspace/bin/polyspace-code-prover
  ```
- From the MATLAB apps gallery, click the Polyspace Code Prover app.

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.

If MATLAB is not open, you can open MATLAB from Polyspace Code Prover. On the toolbar, click the icon .

Create Project Automatically from Your Build System

In this section...

"Syntax for Creating a Project Automatically" on page 3-4

"Common Workflows for Using polyspace-configure" on page 3-8

"Considerations for Visual Studio Projects" on page 3-10

Syntax for Creating a Project Automatically

The `polyspace-configure` tool traces your build system and creates a Polyspace project with all the necessary information to run Polyspace.

This tool performs all the initial set up for you, including specifying configuration options and source files.

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.

At the DOS or UNIX command-line shell, enter:

```
matlabroot\polyspace\bin\polyspace-configure lang [options] build command
```

Where,

- *`matlabroot`* is your MATLAB installation folder (i.e., `C:\Program Files\MATLAB\R2013b`).
- *`lang`* is either `-c` if your project is in C or `-cpp` if your project is in C++.
- *`[options]`* are any additional options that you choose to use. The following table shows more information about the additional options.
- *`build command`* is the command that you give to build your code. For example, `make all`.

For better results, use the rebuild option. For example, `make -B` or `msbuild/t:Rebuild` (Visual Studio®).

If the `polyspace-configure` tool fails to create a Polyspace project, the build trace and the cache remain in the working folder to help you debug the problem.

Once the configuration tool has successfully completed creating your configuration, open the Polyspace project in the Polyspace environment or use the options file to run an analysis at the command line.

Additional Options for `polyspace-configure`

Option	Description
`-lang`	A required option. Use this option to specify the code language, either `c` or `cpp.` You can specify the language with or without the `lang` tag. These examples below are equivalent to each other. **Example:** `polyspace-configure -c` *`build_command`* **Example:** `polyspace-configure -lang c` *`build_command`*
`-compiler-configuration`	Use this option to specify the configuration file for your compiler. The compiler configuration file must be in a specific format. As a guide, use *`matlabroot`*`\polyspace\configure\compiler_configuration\dummy_.xml.` You do not need to use this option for `gcc`, `clang`, or `cl.exe` (Visual Studio) compilers. Compiler configuration files have already been provided in the `polyspace\configure\compiler_configuration` folder. **Example:** `polyspace-configure -c -compiler-configuration file1` *`build_command`*
`-prog`	Use this option to specify the name of your Polyspace project. If you do not specify a value, the default project name is `polyspace.psprj`. **Example:** `polyspace-configure -c -prog my_project` *`build_command`*

Additional Options for `polyspace-configure` (Continued)

Option	Description
`-author`	Use this option to specify the author for the Polyspace project properties. **Example:** `polyspace-configure -c -author jsmith` *`build_command`*
`-no-project`	Use this option to build your code normally without creating a Polyspace project. This option automatically uses the `-incremental` option to save the build tracing information. Every time you build your code, `polyspace-configure` traces the build process and saves the information. Later, when you want to run an analysis, you can use the `-no-build` option to quickly create a Polyspace project without performing an actual build. **Example:** `polyspace-configure -c -no-project` *`build_command`*
`-no-build`	Use this option to quickly create a Polyspace project using previously saved build information. This option automatically uses the `-incremental` option to save the build tracing information. You must have previously built your code using `polyspace-configure -no-project`. The `-no-build` option uses the saved build tracing information to create the Polyspace project. If you use this option, you do not need to specify a build command. This option uses the `-incremental` option during your build. **Example:** `polyspace-configure -c -no-build`
`-output-project`	Use this option to specify where to save the Polyspace project file. If you do not specify an option, the current folder is used. **Example:** `polyspace-configure -c -output-project polyspace/project1` *`build_command`*

Additional Options for `polyspace-configure` (Continued)

Option	Description
`-output-options-file`	Use this option to create a Polyspace analysis options file. You can use this options file for command-line analyses. For more information, see "Command-Line Only Workflow" on page 3-9. **Example:** `polyspace-configure -c -output-options-file myOpts` *`build_command`*
`-help` or `-h`	Use this option to get command-line help for this tool. **Example:** `polyspace-configure -help`
`-incremental`	Use this advanced option to save build tracing information from your project creation. This option is useful if you want to reuse the same `polyspace-configure` command and information. **Example:** `polyspace-configure -c -incremental` *`build_command`*
`-build-trace`	Use this advanced option to specify where to store the build trace information. By default the build trace is stored as `polyspace_configure_build_trace.log`. **Example:** `polyspace-configure -f -build-trace ../build_info/trace` *`build_command`*
`-cache-path`	Use this advanced option to specify where to store the cache information. **Example:** `polyspace-configure -c -cache-path` *`cache_folder build_command`*
`-no-cache`	Use this advanced option if you do not want to create a cache of your files. **Example:** `polyspace-configure -c -no-cache` *`build_command`*
`-cache-all-files`	Use this advanced option to cache all files read by `polyspace-configure`, including binaries. **Example:** `polyspace-configure -c -cache-all-files` *`build_command`*

Additional Options for `polyspace-configure` (Continued)

Option	Description
`-output-dump-file`	Use this advanced option to save all trace information found by `polyspace-configure` in a text file. **Example:** `polyspace-configure -output-dump-file` *`build_command`*
`-debug`	An advanced option used by MathWorks technical support. **Example:** `polyspace-configure -debug` *`build_command`*

Note To use this tool in MATLAB, use the command `polyspaceConfigure`. For additional help, use the command `help polyspaceConfigure`

Common Workflows for Using polyspace-configure

Project Creation for the Polyspace Interface

To create a project from your build command:

1. Create a Polyspace project, specifying a unique project name and author:

   ```
   polyspace-configure -c -proj myProject -author jsmith \
              make -B example
   ```

2. Open the Polyspace interface.

3. Select **File > Open Project**.

4. In the Open Project window, locate `myProject.psprj` already created with the configuration tool.

   The project is added to the Project Browser with all the information traced during your build. Run Polyspace and review your results.

Command-Line Only Workflow

If you do not want to use the Polyspace interface to run analyses or verifications, use the `-output-options-file` option with the `nodektop` version of Polyspace.

1 Create a Polyspace configuration, specifying the `-output-options-file` command.

```
polyspace-configure -c -no-project -output-options-file myOptions \
           make -B example
```

The analysis options file option allows you to use the command-line.

2 Use the options file that you created to run the software at the command line:

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

Incremental Build Workflow

If you have added or removed files or options from your coding project, use same `polyspace-configure` command to include these in your Polyspace configuration.

For example:

1 Create a project automatically using your build command. Specify the `-incremental` option:

```
polyspace-configure -c -prog myProject -incremental make -B example
```

2 In your coding project, add or remove a file.

3 Rerun thePolyspace configuration command with the same options:

```
polyspace-configure -c -prog myProject -incremental make example
```

Polyspace uses the previous build tracing information to incrementally add or remove the new files from your Polyspace configuration.

Considerations for Visual Studio Projects

If you are trying to import a Visual Studio 2010 or Visual Studio 2012 project and `polyspace-configure` does not work correctly, 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 -cpp <MSVS path>/msbuild sample.sln
   ```

Create Multiple Modules

A Polyspace Code Prover project can contain multiple modules. 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.

To create a new module in your project:

1. In the Project Browser, select any 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 Source File 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 Source File 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.

Create Multiple Analysis Option Configurations

Each Polyspace project can contain multiple *configurations*. 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.

To create a new configuration in your project:

1. In the Project Browser, select any module.

2. Right-click the Configuration folder in the module. From the context menu, select **Create New Configuration**. In the Project Browser, the software displays a new configuration `*project_name*_1`.

3. In the **Configuration** pane, specify the analysis options for the new configuration.

4. To save your project with the new settings, select **File > Save**.

For information about analysis options, see“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 **Options > 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`*.

Specify Functions Not Called by Generated Main

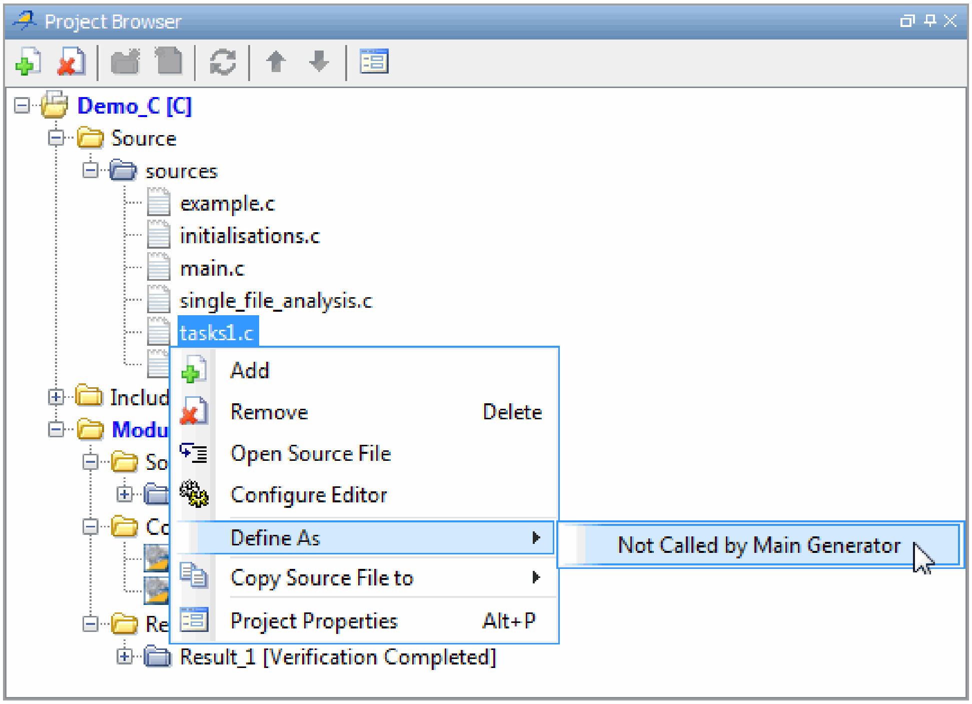
You can specify source files in your project that the main generator will ignore. Functions defined in these source files are not called by the automatically generated main.

Use this option for files containing function bodies, so that the verification looks for the function body only when the function is called by a primary source file and no body is found.

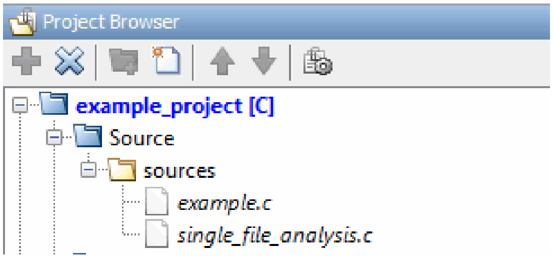
Note This option applies only to automatically generated mains. Therefore, you must also select the option **Generate a main** (`-main-generator`) for this option to take effect.

To specify a source file as not called by the main generator:

1. In the Project Browser Source tree, select the source files you want the main generator to ignore.
2. Right click any selected file, and select **Define As > Not Called by Main Generator**.



The files ignored by the main generator appear is *italics* in the Source tree of the project.



Note To specify that a file previously marked **Not Called by Main Generator** should be called, right-click the file in the project Source tree, then select **Regular Source File**.

Specify Analysis Options

In the Project Manager perspective, use the **Configuration** pane to specify analysis options for your Polyspace verification. For example, to specify options that control the precision of your verification:

1. Select the **Configuration > Code Prover Verification > Precision** pane.

2. On this pane, specify the required options for your project. For example, from the **Precision level** drop-down list, select `1`.

3. To save your project with the new settings, select **File > Save**.

For detailed information about analysis options, see:

- "Analysis Options for C Code"
- "Analysis Options for C++ Code"

.

Configure Text Editor

Before you run a verification, you should configure your text editor through the Polyspace Preferences dialog box. With this editor, you can open source files directly from the Results Manager perspective.

To configure your text editor:

1. Select **Options > Preferences**.

2. From the Polyspace Preferences dialog box, select the **Editors** tab.

3. In the **Text editor** field, specify your text editor. For example:

   ```
   C:\Program Files\Windows NT\Accessories\wordpad.exe
   ```

4. To automatically specify the command line arguments for your editor, from the **Arguments** drop-down list, select your text editor:

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

   If you are using another text editor, select `Custom` from the drop-down menu, and specify the command line arguments for the text editor.

5. Click **OK**.

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`.

Specify Options to Match Your Quality Goals

In this section...

"Choose Contextual Verification Options for C Code" on page 3-18

"Choose Contextual Verification Options for C++ Code" on page 3-19

"Choose Strict or Permissive Verification Options" on page 3-21

Choose Contextual Verification Options for C Code

Polyspace software performs robustness verification by default. If you want to perform contextual verification, there are several options you can use to provide context for data ranges, function call sequence, and stubbing.

For more information on robustness and contextual verification, see "Choose Robustness or Contextual Verification" on page 2-4.

Note If you are aware of run-time errors in your code but still want to run a verification, you can annotate your code so that these known errors are highlighted in the Results Manager perspective. For more information, see "Annotate Known Run-Time Errors" on page 6-47.

To specify contextual verification for your project:

1 In the Project Manager perspective, on the **Configuration > Code Prover Verification** pane, select **Verify module**.

2 To set ranges on variables, use the following options:

- **Code Prover Verification > Variables to initialize** — Specifies how the generated main initializes global variables.

  With cyclic systems, for example, code generated from Simulink models, you configure **Calibration variables** and **Input variables**.

- **Code Prover Verification > Inputs & Stubbing > Variable/function range setup** — Activates the DRS option, allowing you to set specific data ranges for a list of global variables.

3. To specify function call sequence, use the following options:

   - **Code Prover Verification > Initialization functions** (`-functions-called-before-main`) — Specifies an initialization function called after initialization of global variables but before the main loop.

   - **Code Prover Verification > Functions to call** — Specifies how the generated main calls functions.

   With cyclic systems, you configure the options **Initialization functions** (`-functions-called-before-loop`), **Cyclic functions**, and **Termination functions**.

4. To control stubbing behavior, use the following options:

   - **Code Prover Verification > Inputs & Stubbing > No automatic stubbing** — If you select this option, the software does not automatically stub functions. The software list the functions to be stubbed and stops the verification.

   - **Code Prover Verification > Inputs & Stubbing > Functions to stub** — Specify the functions that you want Polyspace to stub.

For more information about these options, see “Analysis Options for C Code”.

Choose Contextual Verification Options for C++ Code

Polyspace software performs robustness verification by default. If you want to perform contextual verification, there are several options you can use to provide context for data ranges, function call sequence, and stubbing.

For more information on robustness and contextual verification, see “Choose Robustness or Contextual Verification” on page 2-4.

Note If you are aware of run-time errors in your code but still want to run a verification, you can annotate your code so that these known errors are highlighted in the Results Manager perspective. For more information, see "Annotate Known Run-Time Errors" on page 6-47.

To specify contextual verification for your project:

1. In the Project Manager perspective, on the **ConfigurationCode Prover Verification** pane, select **Verify module**.

2. To set ranges on variables, use the following options:

   - **Code Prover Verification > Variables to initialize** — Specifies how the generated main initializes global variables.
   - **Code Prover Verification > Inputs & Stubbing > Variable/function range setup** — Activates the DRS option, allowing you to set specific data ranges for a list of global variables.

3. To specify function call sequence, use the following options:

   - **Code Prover Verification > Initialization functions** (`-functions-called-before-main`) — Specifies an initialization function called after initialization of global variables but before the main loop.
   - **Code Prover Verification > Functions to call** — Specifies how the generated main calls functions.

4. To control stubbing behavior, use the following options:

   - **Code Prover Verification > Inputs & Stubbing > No automatic stubbing** — If you select this option, the software does not automatically stub functions. The software list the functions to be stubbed and stops the verification.
   - **Code Prover Verification > Inputs & Stubbing > No STL stubs** — Stub Standard Library functions using standard rules instead of using Polyspace implementation.

- **Code Prover Verification > Inputs & Stubbing > Functions to stub** — Specify the functions that you want Polyspace to stub.

For more information on these options, see “Analysis Options for C++ Code” .

Choose Strict or Permissive Verification Options

Polyspace software provides several options that allow you to customize the strictness of the verification. You should set these options to match the quality goals for your application.

Note If you are aware of run-time errors in your code but still want to run a verification, you can annotate your code so that these known errors are highlighted in the Results Manager perspective. For more information, see “Annotate Known Run-Time Errors” on page 6-47.

Use the following options to make verification more strict:

- **Code Prover Verification > Inputs & Stubbing > Ignore default initialization of global variables** — Verification treats all global variables as non-initialized, causing a red error if the global variables are read before being written to.
- **Code Prover Verification > Check Behavior > Detect overflows** — Stricter checks for overflowing computations on unsigned integers.

Use the following options to make verification more permissive:

- **Target & Compiler > Dialect** — Verification allows syntax associated with the IAR and Keil dialects.
- **Code Prover Verification > Checks Behavior > Ignore overflowing computations on constants** — Verification is permissive with overflowing computations on constants.
- **Code Prover Verification > Checks Behavior > Allow negative operand for left shifts** — Verification allows a shift operation on a negative number.

- **Code Prover Verification > Checks Behavior > Enable pointer arithmetic across fields** — Enables navigation within a structure or union from one field to another.

For more information on these options, see “Analysis Options for C Code”.

Set Up Project to Check Coding Rules

In this section...

"Polyspace Coding Rules Checker Overview" on page 3-23

"Check Compliance with MISRA C Coding Rules" on page 3-23

"Check Compliance with C++ Coding Rules" on page 3-24

Polyspace Coding Rules Checker Overview

Polyspace software can check that your code complies with established C or C++ coding standards. The coding rules checker can check MISRA C, MISRA C++ or JSF++ coding standards.[2]

The Polyspace coding rules checker enables Polyspace software to provide messages when coding rules are not respected. Most messages are reported during the compile phase of a verification.

Note The Polyspace MISRA checker is based on MISRA C:2004, which also incorporates MISRA-C Technical Corrigendum 1 (http://www.misra-c.com).

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.

The Polyspace JSF C++ checker is based on JSF++:2005.
For more information on these coding standards, see
http://www.jsf.mil/downloads/documents/JSF_AV_C++_Coding_Standards_Rev_C.doc.

Check Compliance with MISRA C Coding Rules

To check MISRA C compliance, you set an option in your project before running a verification. Polyspace software finds the violations during the compile phase of a verification. When you have addressed all MISRA C violations, you run the verification again.

[2] MISRA and MISRA C are registered trademarks of MISRA Ltd., held on behalf of the MISRA Consortium.

To set the MISRA C checking option:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.
2. Select the **Check MISRA C rules** check box.
3. Specify coding rule checker options, for example:
   - MISRA C rules to check
   - Custom rules
   - Files, if any, to exclude from the checking
   - Data types that you want Polyspace to consider as Boolean

Note For more information on using the MISRA C checker, see "Activate Coding Rules Checker" on page 11-5.

Check Compliance with C++ Coding Rules

To check coding rules compliance, you set an option in your project before running a verification. Polyspace software finds the violations during the compile phase of a verification. When you have addressed all coding rules violations, you run the verification again.

To set up coding rules checking:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** node.
2. Select the **Check MISRA C++ rules** or **Check JSF C++ rules** check box.
3. Specify other options:
   - MISRA or JSF C++ rules to check
   - Custom rules
   - Files, if any, to exclude from the checking

Note For more information on using the coding rules checker, see "Activate Coding Rules Checker" on page 11-5.

Set Up Project to Automatically Test Orange

In this section...

"Polyspace Automatic Orange Tester" on page 3-26

"Enable Automatic Orange Tester" on page 3-26

Polyspace Automatic Orange Tester

The Polyspace Automatic Orange Tester performs dynamic stress tests on unproven C code (orange checks) to help you identify potential run-time errors. By default, the Automatic Orange Tester is disabled. If you enable the Automatic Orange Tester:

- The software runs the Automatic Orange Tester at the end of static verification
- You can manually run the Automatic Orange Tester after the verification

For more information, see "Test Orange Checks Automatically".

Enable Automatic Orange Tester

To enable the Automatic Orange Tester:

1. In the Project Manager perspective, select the **Configuration > Advanced Settings** pane.
2. Select the **Automatic Orange Tester** check box.
3. Specify values for the following options:
   - **Number of automatic tests** — Total number of tests. Default is 500. Software supports maximum of 100,000.
   - **Maximum loop iterations** — Maximum number of iterations allowed before a loop is considered to be an infinite loop. Default is 1000, which is also the maximum value that software supports.
   - **Maximum test time** — Maximum time allowed for each test. Default is 5 seconds. Software supports maximum of 60.

For more information about the Automatic Orange Tester, see “Test Orange Checks Automatically”.

Set Up Project

- “What Is a Project Template?” on page 4-2
- “Project Folders” on page 4-3
- “Create New Projects” on page 4-4
- “Open An Existing Project” on page 4-6
- “Create Project Using Visual Studio Information” on page 4-7
- “Add Source Files and Include Folders” on page 4-8
- “Specify Target Environment” on page 4-10
- “Create Custom Project Templates” on page 4-11
- “Save and Close Projects” on page 4-14
- “Storage of Polyspace Preferences” on page 4-15

What Is a Project Template?

A Project Template (Compilation Environment Template), is a predefined set of analysis options configured for a specific compilation environment.

When you create a new project, you can select a project template to automatically set analysis options for your compiler, and help locate required include folders.

Polyspace software provides predefined templates for common compilers such as IAR, Kiel, and VxWorks. For additional templates, see Polyspace Compiler Templates .

You can also create custom templates from existing project configurations. For more information, see "Create Custom Project Templates" on page 4-11.

Project Folders

Before you begin using Polyspace software, you must know the location of your source files and include files. You must also know where you want to store the results.

To simplify the location of your files, you may want to create a project folder, and then in that folder, create separate folders for the source files, include files, and results. For example:

```
polyspace_project/
```

- `sources`
- `includes`
- `results`

Create New Projects

Through the Polyspace user interface, you can manage multiple projects. When you create a new project or open an existing project, the software adds the project to the Project Browser tree.

1 Select **File > New Project**.

   The Project – Properties dialog box opens.

2 In the **Project name** field, enter a name for your project.

3 If you want to specify a location for your project, clear the **Use default location** check box, and enter a **Location** for your project.

Note You can update the default project location. Select **Options > Preferences**, which opens the Polyspace Preferences dialog box. On the **Project and Results Folder** tab, in the **Default project location** field, specify the new default location.

4 In the Project language section, click **C** or **C++**.

5 If you want to use a template, select the **Use template** check box. Then, click **Next**.

6 Select the template for your compiler. If your compiler does not appear in the list of predefined templates, select **Baseline C** or **Baseline C++**, which allows you to start with a generic template. See “What Is a Project Template?” on page 4-2)

7 Click **Next**.

8 From the Project - Add Source Files and Include Folders dialog box, in the **Look in** field, you should see the project folder location that you specified in step 3. Otherwise, navigate to the project folder.

9 From the project folder, select the source files for the your project. Then click **Add Source Files**.

The software displays these files in the Source tree for your project.

10 From the project folder, select the Include folders for your project. Then click **Add Include Folders**.

The software displays these files in the Include tree for your project.

11 Click **Finish**.

The new project opens in the Project Browser, with default options from the project template that you selected.

Open An Existing Project

1 Select **File > Open Project**.

2 Through the **Open Project** dialog box, navigate to the project folder.

3 Select the project configuration file, for example, `Demo_C.psprj` or `Bug_Finder.bf.psprj`. Then click **Open**.

Note If you open a Polyspace Bug Finder project in Polyspace Code Prover, the software asks you to resave the project as a Code Prover project to preserve your Bug Finder specific options.

If you open a Polyspace Code Prover project in Polyspace Bug Finder, the software asks you to resave the project and as a Bug Finder project to preserve your Code Prover specific options. Additionally, if you have multiple configurations, the software prompts you to specify which one should be imported into the Bug Finder project.

Create Project Using Visual Studio Information

You can extract information from a Visual Studio project file (vcproj) to help configure your Polyspace project.

Note You cannot directly import projects from Visual Studio 2010 or Visual Studio 2012. To create a Polyspace project with your Visual Studio information use the `polyspace-configure` tool. For more information, see "Create Project Automatically from Your Build System" on page 3-4.

The Visual Studio import can retrieve the following information from a Visual Studio project:

- Source files
- Include folders
- Preprocessing directives (`-D`, `-U`)
- Polyspace specific options about dialect

To import Visual Studio information into your Polyspace project:

1. In the Polyspace user interface, from 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. Specify the **Polyspace project** that you want to use.
4. Click **Import**.

   The Polyspace project is updated with the Visual Studio settings.

For more information on using the Visual Studio integration, see "Visual Studio Verification""Visual Studio Environment".

Add Source Files and Include Folders

In this section...

"Specify Source Code and Include Files" on page 4-8

"Manage Include File Sequence" on page 4-8

Specify Source Code and Include Files

1 In the Project Browser, select your project folder.

2 Click the **Add source** icon ➕.

   The Project – Add Source Files and Include Folders dialog box opens.

3 In the **Look in** field, specify the folder that contains your source files.

4 From the folder view, select the source files for your project. Then click **Add Source Files**.

5 The software automatically adds the standard include folders to your project. If your project uses additional include files, you can specify these files for your analysis:

   a In the **Look in** field, specify the folder that contains your include files.

   b From the folder view, select the required include folders or files. Then click **Add Include Folders**.

6 Click **Finish**.

Manage Include File Sequence

You can change the order of the include folders in your project to manage the sequence in which include files are compiled during the compilation phase.

1 In the Project Browser, expand the **Include** folder.

2 Select the include folder that you want to move.

3 On the Project Browser toolbar, to the move the folder up, click ⇧. To move the folder down, click ⇩.

Specify Target Environment

Many applications are designed to run on specific target CPUs and operating systems. Since some run-time errors are dependent on the target, you must specify the type of CPU and operating system used in the target environment before running Polyspace.

The **Configuration > Target & Compiler** pane in the Project Manager perspective allows you to specify the target operating system and processor type for your application.

To specify the target environment for your application:

1. From the **Target operating system** drop-down list, select the operating system on which your application is designed to run.

2. From the **Target processor type** drop-down list, select the processor on which your application is designed to run.

You can also specify language variants through the **Dialect** field.

For more information about emulating your target environment, see “Set Up a Target” on page 5-2.

Create Custom Project Templates

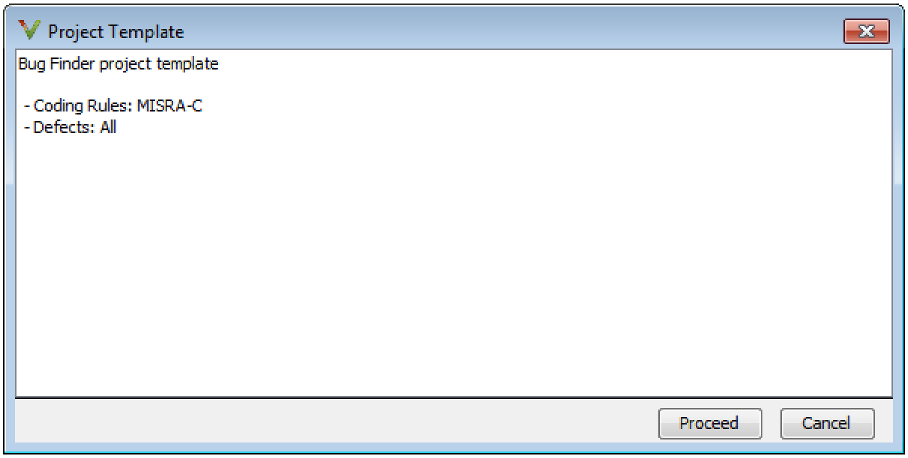
Once you have configured a project, you can save the Configuration as a custom Project Template, and use it to configure future projects. Using custom templates allows you to automatically set up the compilation environment, include folders, and other analysis options for your projects.

You can include any Analysis option in the template, but the following options should typically be included:

- Target processor type (`-target`)
- Target operating system (`-OS-target`)
- Dialect support (`-dialect`)
- Defined Preporcessor Macros (`-D`)
- Include (`-include`)

To create a custom project template:

1. Open the project you want to use as a template.
2. Right-click the configuration you want to use, and select **Export As Template**.
3. Enter a description for the template, then click **Proceed**.



Bug Finder project template

- Coding Rules: MISRA-C
- Defects: All

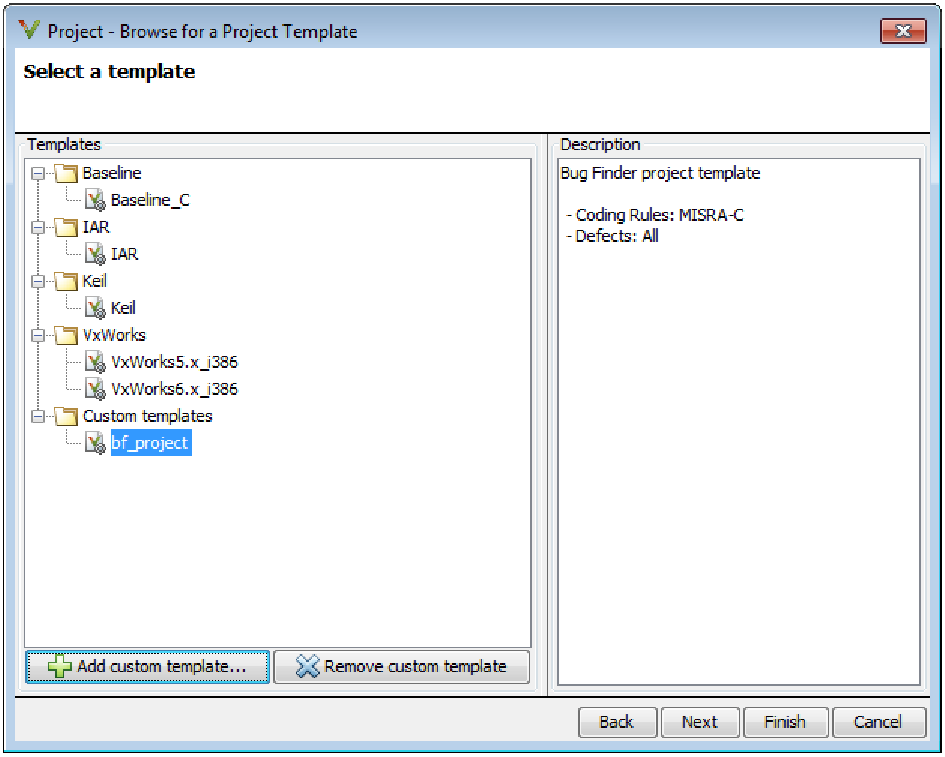
4 Save your Compilation Environment Template file with the name you want to appear in the Templates browser.

5 Create a new project.

6 In the Project – Browse for a Project Template dialog box, select **Add custom template**.

7 Select the template that you exported, then click **Open**.

8 The new template appears in the **Custom templates** folder of the Templates browser, and can be used for future projects.



Bug Finder project template

- Coding Rules: MISRA-C
- Defects: All

Save and Close Projects

Through the Polyspace user interface, you can manage multiple projects simultaneously. The software displays projects in the Project Browser tree.

To save Project Manager changes, select **File > Save** or enter **Ctrl+S**.

To close and remove a project from the Project Browser tree:

1 In the Project Browser, select the project that you want to close.

2 Right-click the project. From the context menu, select **Close Active Project**.

Storage of Polyspace Preferences

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

- On a Windows system, `%APPDATA%\Polyspace\polyspace.prf`
- On a Linux system, `$HOME/.polyspace/polyspace.prf`

Emulating Your Runtime Environment

- “Set Up a Target” on page 5-2
- “Verify C Application Without a “Main”” on page 5-32
- “Polyspace C++ Class Analyzer” on page 5-38
- “Specify Data Ranges for Variables and Functions (Contextual Verification)” on page 5-54

Set Up a Target

In this section...

"Target & Compiler Overview" on page 5-2

"Specify Target and Compiler" on page 5-3

"Predefined Target Processor Specifications" on page 5-3

"Modify Predefined Target Processor Attributes" on page 5-6

"Define Generic Target Processors" on page 5-8

"Common Generic Targets" on page 5-9

"View or Modify Existing Generic Targets" on page 5-10

"Delete Generic Target" on page 5-11

"Compile Operating System Dependent Code" on page 5-12

"Address Alignment" on page 5-18

"Ignore or Replace Keywords Before Compilation" on page 5-19

"Language Extensions" on page 5-22

"Verify Keil or IAR Dialects" on page 5-23

"Gather Compilation Options Efficiently" on page 5-30

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 affect whether errors (such as overflows) will occur.

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.

For detailed information on each **Target & Compiler** option, see "Target & Compiler".

Specify Target and Compiler

In the Project Manager perspective, the **Configuration > Target & Compiler** pane allows you to specify the target environment and compiler behavior for your application.

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

1. From the **Target operating system** drop-down list, select the operating system on which your application is designed to run.
2. From the **Target processor type** drop-down list, select the processor on which your application is designed to run.

   For detailed specifications of each predefined target processor, see "Predefined Target Processor Specifications" on page 5-3.

For information about target and compiler options, see "Target & Compiler".

Predefined Target Processor Specifications

Polyspace software supports many commonly used processors, as listed in the table below. To specify one of the predefined processors, select it from the **Target processor type** drop-down list.

Predefined Target Processor Specifications

Target	char	short	int	long	long long	float	double	long double	ptr	sign of char	endian	align
`i386`	8	16	32	32	64	32	64	96	32	signed	Little	32
`sparc`	8	16	32	32	64	32	64	128	32	signed	Big	64
`m68k / ColdFire`[3]	8	16	32	32	64	32	64	96	32	signed	Big	64
`powerpc`	8	16	32	32	64	32	64	128	32	unsigned	Big	64
`c-167`	8	16	16	32	32	32	64	64	16	signed	Little	64
`tms320c3x`	32	32	32	32	64	32	32	40[4]	32	signed	Little	32
`sharc21x61`	32	32	32	32	64	32	32 [64]	32 [64]	32	signed	Little	32
`NEC-V850`	8	16	32	32	32	32	32	64	32	signed	Little	32 [16, 8]
`hc08`[5]	8	16	16 [32]	32	32	32	32 [64]	32 [64]	16[6]	unsigned	Big	32 [16]
`hc12`[5]	8	16	16 [32]	32	32	32	32 [64]	32 [64]	32[6]	signed	Big	32 [16]
`mpc5xx`[5]	8	16	32	32	64	32	32 [64]	32 [64]	32	signed	Big	32 [16]
`c18`	8	16	16	32 [24][7]	32	32	32	32	16 [24]	signed	Little	8

[3] The M68k family (68000, 68020, etc.) includes the “ColdFire” processor

[4] All operations on long double values will be imprecise (that is, shown as orange).

[5] Non ANSI C specified keywords and compiler implementation-dependent pragmas and interrupt facilities are not taken into account by this support

[6] All kinds of pointers (near or far pointer) have 2 bytes (hc08) or 4 bytes (hc12) of width physically.

[7] The `c18` target supports the type `short long` as 24-bits.

Predefined Target Processor Specifications (Continued)

Target	char	short	int	long	long long	float	double	long double	ptr	sign of char	endian	align
x86_64	8	16	32	64 [32][8]	64	32	64	96	64	signed	Little	64 [32]
mcpu (Advanced)	8 [16]	8 [16]	16 [32]	32	32 [64]	32	32 [64]	32 [64]	16 [32]	signed	Little	32 [16, 8]

Note The following target processors are supported only for C code verifications: `tms320c3x`, `sharc21x61`, `NEC-V850`, `hc08`, `hc12`, `mpc5xx`, and `c18`.

After selecting a predefined target, you can modify some default attributes by selecting the browse button to the right of the **Target processor type** drop-down menu. The optional settings for each target are shown in [brackets] in the table.

If your processor is not listed, you can specify a similar processor that shares the same characteristics, or create a generic target processor.

Note If your target processor does not match the characteristics of any processor described above, contact MathWorks technical support for advice.

[8] Use option `-long-is-32bits` to support Microsoft C/C++ Win64 target

Modify Predefined Target Processor Attributes

You can modify certain attributes of the predefined target processors. If your specific processor is not listed, you may be able to specify a similar processor and modify its characteristics to match your processor.

Note The settings that you can modify for each target are shown in [brackets] in the Predefined Target Processor Specifications on page 5-4 table.

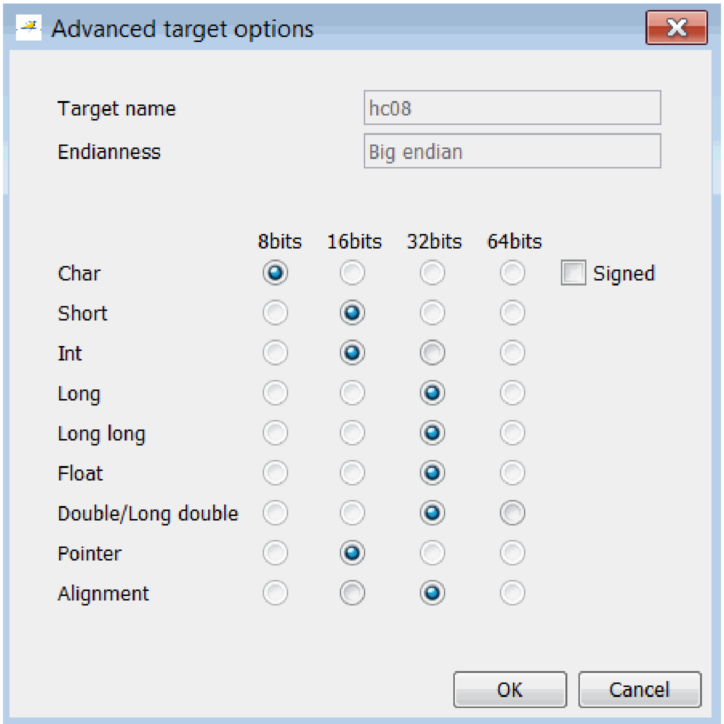
To modify target processor attributes:

1. In the Project Manager perspective, select the **Configuration > Target & Compiler** pane.

2. From the **Target processor type** drop-down list, select the target processor that you want to use.

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

   The Advanced target options dialog box opens.



Advanced target options

Target name	hc08
Endianness	Big endian

	8bits	16bits	32bits	64bits	
Char	●	○	○	○	□ Signed
Short	○	●	○	○	
Int	○	●	○	○	
Long	○	○	●	○	
Long long	○	○	●	○	
Float	○	○	●	○	
Double/Long double	○	○	●	○	
Pointer	○	●	○	○	
Alignment	○	○	●	○	

4 Modify the attributes as required.

For information on each target option, see “Generic target options”.

5 Click **OK** to save your changes.

Define Generic Target Processors

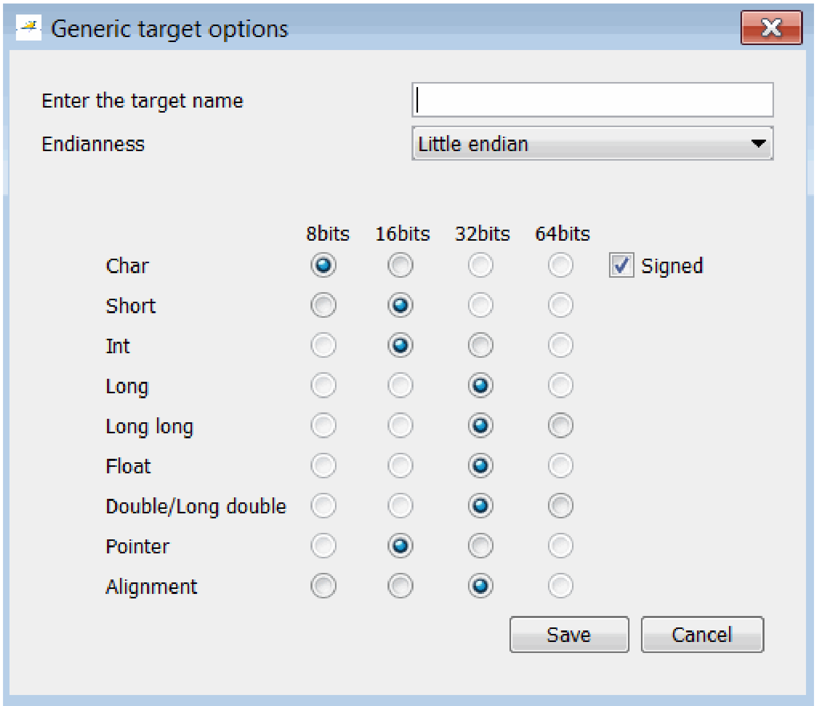
If your application is designed for a custom target processor, you can configure many basic characteristics of the target by selecting the selecting the `mcpu... (Advanced)` target, and specifying the characteristics of your processor.

To configure a generic target:

1. In the Project Manager perspective, select the **Configuration > Target & Compiler** pane.

2. From the **Target processor type** drop-down list, select `mcpu... (Advanced)`.

   The Generic target options dialog box opens.



Enter the target name

Endianness: Little endian

	8bits	16bits	32bits	64bits	
Char	●	○	○	○	☑ Signed
Short	○	●	○	○	
Int	○	●	○	○	
Long	○	○	●	○	
Long long	○	○	●	○	
Float	○	○	●	○	
Double/Long double	○	○	●	○	
Pointer	○	●	○	○	
Alignment	○	○	●	○	

3. In the **Enter the target name** field, enter a name, for example, `MyTarget`.

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 always 8, it implies that the storage assigned to arrays and structures is strictly determined by the size of the individual data objects (without fields and end padding).

Note For information on each target option, see "Generic target options".

5 Click **Save** to save the generic target options and close the dialog box.

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
alignment	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
alignment	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
alignment	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
alignment	8	16	32/ 16	32/16	32/16	32/16	32/16	32/16	32/16	N/A	N/A

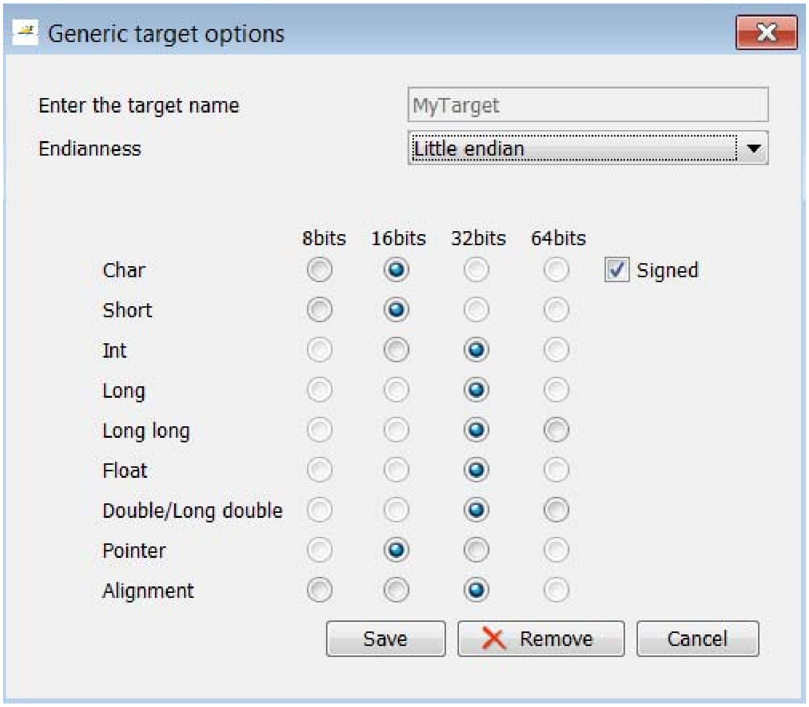
View or Modify Existing Generic Targets

To view or modify generic targets that you previously created:

1 In the Project Manager perspective, select the **Configuration > Target & Compiler** pane.

2 From the **Target processor type** drop-down list, select your target, for example, `MyTarget`.

3 Click **Edit**. The Generic target options dialog box opens, displaying your target attributes.



Generic target options

Enter the target name: MyTarget

Endianness: Little endian

	8bits	16bits	32bits	64bits	
Char	○	●	○	○	☑ Signed
Short	○	●	○	○	
Int	○	○	●	○	
Long	○	○	●	○	
Long long	○	○	●	○	
Float	○	○	●	○	
Double/Long double	○	○	●	○	
Pointer	○	●	○	○	
Alignment	○	○	●	○	

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

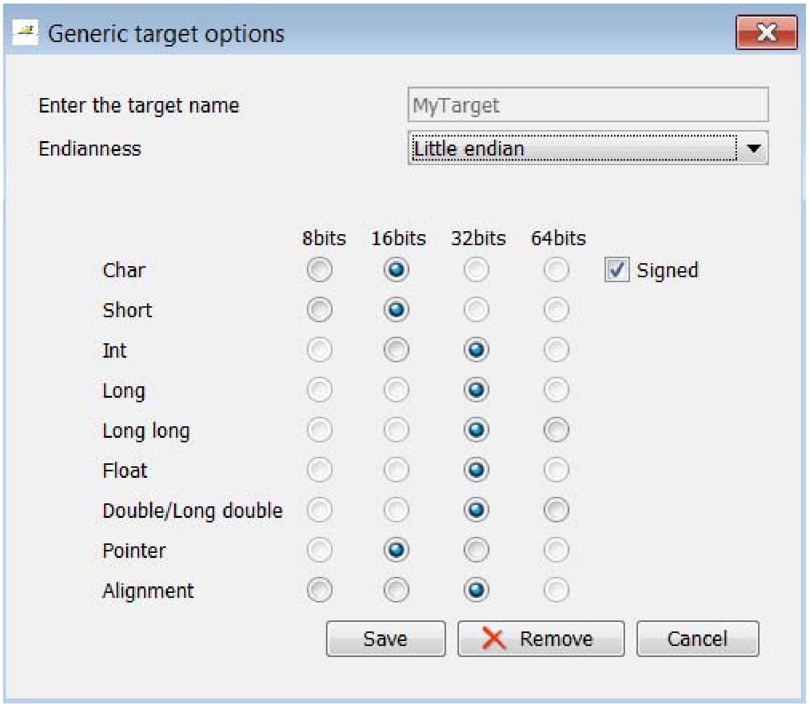
5 Otherwise, click **Cancel**.

Delete Generic Target

To delete a generic target:

1 In the Project Manager perspective, select the **Configuration > Target & Compiler** pane.

2 From the **Target processor type** drop-down list, select the target that you want to remove, for example, `MyTarget`.



Enter the target name: MyTarget

Endianness: Little endian

	8bits	16bits	32bits	64bits	
Char	○	●	○	○	☑ Signed
Short	○	●	○	○	
Int	○	○	●	○	
Long	○	○	●	○	
Long long	○	○	●	○	
Float	○	○	●	○	
Double/Long double	○	○	●	○	
Pointer	○	●	○	○	
Alignment	○	○	●	○	

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

Compile Operating System Dependent Code

This section describes the options required to compile and verify code designed to run on specific operating systems. It contains the following:

- "Predefined Compilation Flags for C Code" on page 5-13
- "Predefined Compilation Flags for C++ Code" on page 5-15
- "My Target Application Runs on Linux" on page 5-17
- "My Target Application Runs on Solaris" on page 5-18
- "My Target Application Runs on Vxworks" on page 5-18
- "My Target Application Does Not Run on Linux, VxWorks, or Solaris" on page 5-18

Predefined Compilation Flags for C Code

These flags concern the predefined **Target operating system** (`-OS-target`) option values: `no-predefined-OS`, `Linux`, `VxWorks`, `Solaris` and `Visual`.

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__`
	`-D__SVR4`
		`-include`
		`<`*`product_dir`*`>/cinclude/pst-vxworks.h`

`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`
		`<`*`product_dir`*`>/cinclude/pst-linux.h`

Target operating system	Compilation flags	—include file and content
	-D__i386 -D__i386__ -Di686 -D__i686 -D__i686__ -Dpentiumpro -D__pentiumpro -D__pentiumpro__	
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 -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__	<product_dir>/cinclude/pst-linux.h	polyspace-[desktop-]cpp -OS-target Linux \ -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>
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	<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
	-D__unux__ -Dsparc -D__sparc -D__sparc__ -Dsun -D__sun -D__sun__ -D__svr4 -D__SVR4		
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		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-cpp \ -OS-target Solaris \ -I /usr/include

Target operating system	Compilation flags	-include file	Minimum set of options
	-D__sun -D__sun__ -D__svr4 -D__SVR4		
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:

- that global `sizeof` and `offsetof` fields are optimum (i.e. as short as possible);
- the alignment of all 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[9]
- 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.
- 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` (listed below) allows you to ignore these keywords:

1. Save the listed template as `C:\Polyspace\myTpl.pl`.
2. Select the **Configuration > Target & Compiler > Environment Settings** pane.
3. To the right of the **Command/script to apply to preprocessed files** field, 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`.

[9] except in the cases of “double” and “long” on some targets.

Content of myTpl.pl file

```
#!/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 $_;
}
```

Perl Regular Expression Summary

```
##########################################################
# 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 occurence 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/;
#
##########################################################
```

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.
	• 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`
		`sfr16 y = 0x4EEF;`
		For this example, options need to be:
		`-dialect keil`
		`-sfr-types sfr=8,  \`
		`    sfr16=16`
			sfr and sbit types are only allowed in declarations of external global variables.

Example: `-dialect keil -sfr-types sfr=8` (Continued)

Type/Language	Description	Example	Restrictions

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).

Example: `-dialect keil -sfr-types sfr=8` (Continued)

Type/Language	Description	Example	Restrictions

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 ignored	alien, bdata, far, idata, ebdata, huge, sdata, small, compact, large, reentrant. Defining -D __C51__, keywords large code, data, xdata, pdata and xhuge are ignored.		

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).
		`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

Example: `-dialect iar -sfr-types sfr=8` (Continued)

Type/Language	Description	Example	Restrictions
	• A variable of type bit is a register bit 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).

Example: `-dialect iar -sfr-types sfr=8` (Continued)

Type/Language	Description	Example	Restrictions

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

Keywords ignored	`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:
	- with a variable name, field name is hidden
	- with a field of another
		`union { int x; };`
		`union { int y; struct { int z; }; } @ 0xF0;`	

Example: `-dialect iar -sfr-types sfr=8` (Continued)

Type/Language	Description	Example	Restrictions
	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 (as discussed to "Verify Keil or IAR Dialects" on page 5-23). Rather than applying minor changes to the code, create a single polyspace.h file which will contain 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 all 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);
```

Verify C Application Without a "Main"

In this section…

"Main Generator Overview" on page 5-32

"Automatically Generate a Main" on page 5-32

"Manually Generate a Main" on page 5-34

"Specify Call Sequence" on page 5-35

"Specify Functions Not Called by Generated Main" on page 5-36

"Main Generator Assumptions" on page 5-37

Main Generator Overview

When your application is a function library (API) or a single module, you must provide a main that calls each function because of the execution model used by Polyspace verification. You can either manually provide a main, or use Polyspace software to automatically generate a main.

If you specify **Verify whole application**, the verification stops if the software does not detect a main.

If you specify **Verify module**, the software checks your code for a main:

- If a main exists in your source files, the verification uses that main.
- If a main does not exist, the software generates a main using the options 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 every function in any order. This means that in some particular situations, a function "f" might be called before a function "g". In the default usage, Polyspace verification assumes that "f" and "g" can be called in any order. If some actions set by "f" must be executed before "g" is called, writing a main which will call "f" and "g" in the exact order will bring a higher selectivity.

Colored Source Code Example

With the default launching mode of Polyspace verification, no problem will be highlighted on the following example. With a bit of setup, more bugs can be found.

```
static char x;
static int y;

void f(void)
{
y = 300;
}

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

With knowledge of the relative call sequence between g and f: if g is called first, the assignment is green, otherwise its red. Thanks to the exact call order, an attempt to place 300 in a char fails, displaying a red.

Example of Call Sequence

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

Simply create a main that calls in the desired order the list of functions from the module.

Specify Functions Not Called by Generated Main

You can specify source files in your project that the main generator will ignore. Functions defined in these source files are not called by the automatically generated main.

Use this option for files containing function bodies, so that the verification looks for the function body only when the function is called by a primary source file and no body is found.

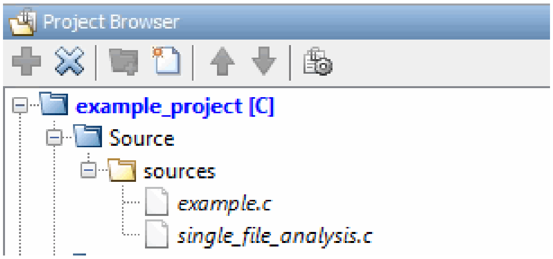
Note This option applies only to an automatically generated main. Therefore, you must also select the option **Verify module** (`-main-generator`) for this option to take effect.

To specify source files that the generated main does not call:

1. From the Project Browser, in your **Source** folder, select the source files that you want the main generator to ignore.

2. Right click any selected file. From the context menu, select **Define As > Not Called by Main Generator**.

   The names of ignored files are *italicised*.



Note To specify that a file previously marked **Not Called by Main Generator** should be called, right-click the file in the **Source** folder. From the context menu, select **Regular Source File**.

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" on page 5-38

"How the Class Analyzer Works" on page 5-39

"Sources Verified" on page 5-39

"Architecture of Generated Main" on page 5-39

"Class Verification Log File" on page 5-40

"Characteristics of Class and Log File Messages" on page 5-41

"Behavior of Global variables and members" on page 5-41

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"Abstract Classes" on page 5-50

"Virtual Inheritance" on page 5-51

"Other Types of Classes" on page 5-52

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 bugs for all possible uses of the class. The class can be considered free of bugs 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 all the possible uses of a class by:

1. Creating objects using all constructors (default if none exist).

2. Calling all methods (public, static, and protected) on previous objects in every order.

3. Calling all methods of the class between time zero and infinity.

4. Calling every destructor on 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 any 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. All missing code will be 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:
 void calculate_new(void);
 int x;

public:
 // constructor 1
 Location(int intx = 0) { x = intx; };
 // constructor 2
 Location(float fx) { x = fround(fx); };

 void setx(int intx) { x = intx; calculate_new(); };
 void fsetx(float fx) {
  int tx = fround(fx);
  if (tx / globvar1 != 0) // ZDV check is orange
  {
   tx = tx / globvar2; // ZDV check is green
   setx(tx);
  }
 };
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 Specificities

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 ()
```

```
{
 toparray = -1;
 for (int i = 0 ; i < MAXARRAY; i++)
 array[i] = 0;
}

int stack::top (void)
{
 int i = toparray;
 return (array[i]);
}

bool stack::isempty (void)
{
 if (toparray >= 0)
  return false;
 else
  return true;
}

bool stack::push (int newvalue)
{
 if (toparray < MAXARRAY)
 {
  array[++toparray] = newvalue;
  return true;
 }

 return false;
}

void stack::pop (void)
{
 if (toparray >= 0)
  toparray--;
}
```

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

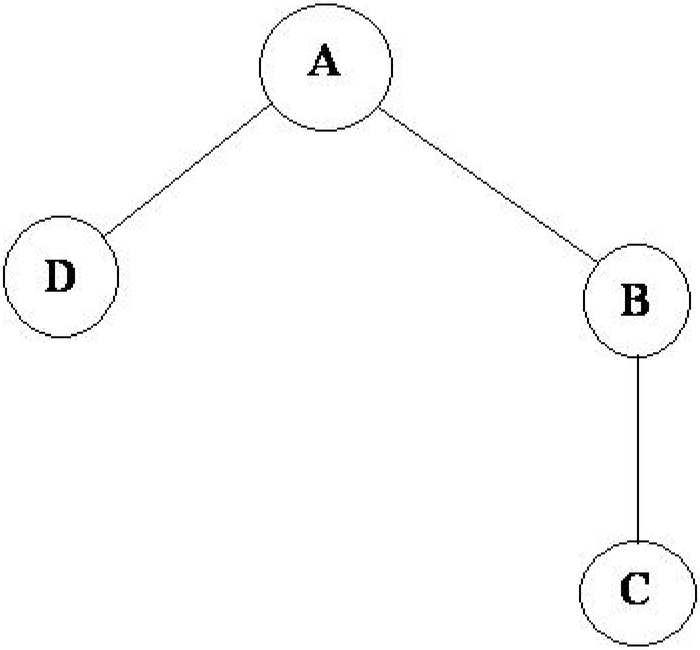
The verification of this class highlights two problems:

- 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.

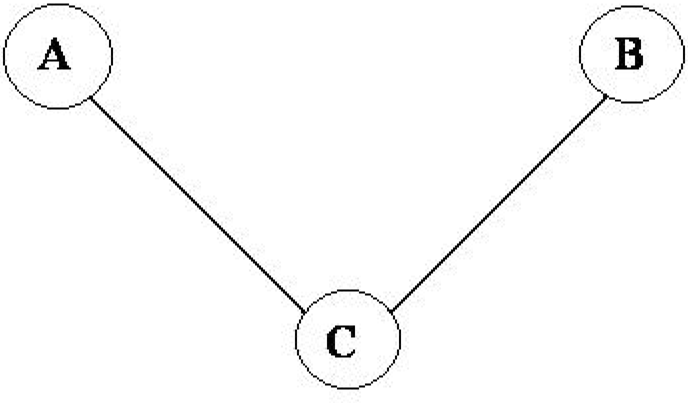
4. You can analyze class C by providing the C code, the B class declaration and the A class declaration. In this case, A and B codes will be stubbed automatically.

5. You can analyze class C by providing the A, B and C codes 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 bugs only 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:

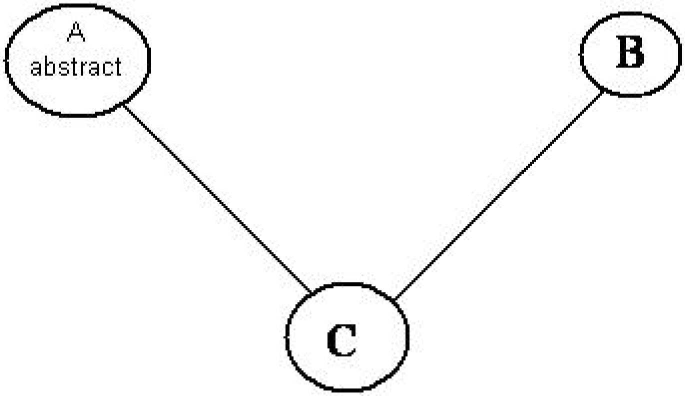
1 You can analyze classes A and B separately just by providing their codes to the software. This corresponds to the previous “Simple Class” section in this chapter.

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.

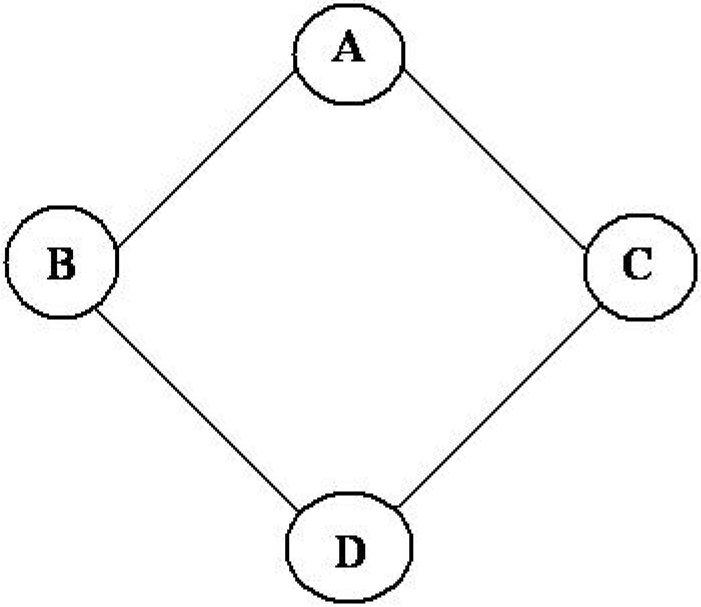
A and B are base classes of C.

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.

Specify Data Ranges for Variables and Functions (Contextual Verification)

In this section...

"Overview of Data Range Specifications (DRS)" on page 5-54

"Specify Data Ranges Using DRS Template" on page 5-55

"Remove Non Applicable Entries from DRS File" on page 5-57

"DRS Configuration Settings" on page 5-58

"Specify Data Ranges Using Existing DRS Configuration" on page 5-63

"Edit Existing DRS Configuration" on page 5-64

"XML Format of DRS File" on page 5-65

"Specify Data Ranges Using Text Files" on page 5-72

"Variable Scope" on page 5-75

"Perform Efficient Module Testing with DRS" on page 5-79

"Reduce Oranges with DRS" on page 5-80

Overview of Data Range Specifications (DRS)

By default, Polyspace software performs *robustness verification*, proving that the software works under all conditions. Robustness verification assumes that all data inputs are set to their full range. Therefore, nearly any operation on these inputs could produce an overflow.

The Polyspace Data Range Specifications (DRS) feature allows you to perform *contextual verification*, proving that the software works under normal working conditions. Using DRS, you set constraints on data ranges, and verify the code within these ranges. This can substantially reduce the number of orange checks in the verification results.

You can use DRS to set constraints on:

- Global variables
- Input parameters for user-defined functions called by the main generator

- Return values for stub functions

Note Data ranges are applied during level 2 verification (`pass2`).

Specify Data Ranges Using DRS Template

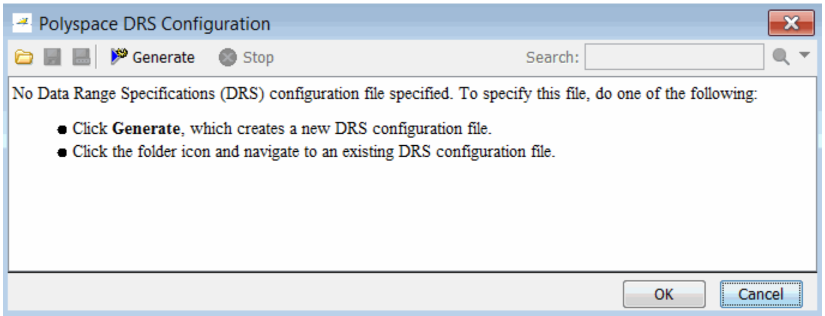
To use the DRS feature, you must provide a list of variables (or functions) and their associated data ranges.

Polyspace software can analyze the files in your project, and generate a DRS template containing all the global variables, user-defined functions, and stub functions for which you can specify data ranges. You can then modify this template to set data ranges.

To use a DRS template to set data ranges:

1. Open the project for which you want to set data ranges.
2. Check that the project contains all the source files and include folders that you want to verify, and specifies the verification options that you want to use. The software generates a DRS template only after the completion of the compilation phase of verification.
3. In the Project Manager perspective, expand the **Configuration > Code Prover Verification** node.
4. Select **Inputs & Stubbing**.
5. Under **Inputs**, to the right of the **Variable/function range setup** field, click the **Edit** button.

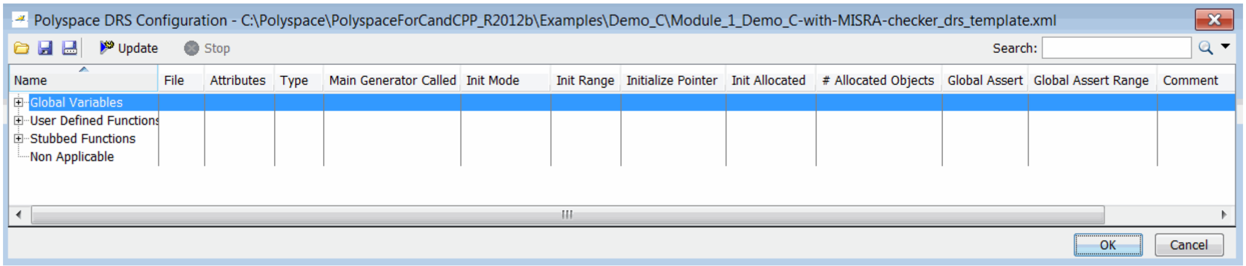
   The Polyspace DRS Configuration dialog box opens.



No Data Range Specifications (DRS) configuration file specified. To specify this file, do one of the following:

- Click **Generate**, which creates a new DRS configuration file.
- Click the folder icon and navigate to an existing DRS configuration file.

6 On the toolbar, click **Generate**. The software compiles the project and generates a DRS template, for example, `Module_1_Demo_C-with-MISRA-checker_drs_template.xml`. You can view the DRS values through the Polyspace DRS Configuration dialog box.


Polyspace DRS Configuration - C:\Polyspace\PolyspaceForCandCPP_R2012b\Examples\Demo_C\Module_1_Demo_C-with-MISRA-checker_drs_template.xml
Update
Stop
Search:
OK
Cancel

Name	File	Attributes	Type	Main Generator Called	Init Mode	Init Range	Initialize Pointer	Init Allocated	# Allocated Objects	Global Assert	Global Assert Range	Comment
Global Variables												
User Defined Functions												
Stubbed Functions												
Non Applicable												

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++.

7 Specify the data ranges for global variables, user-defined function inputs, and stub-function return values. For more information, see “DRS Configuration Settings” on page 5-58.

8 To save your DRS configuration file, click 💾 (`Save DRS`).

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

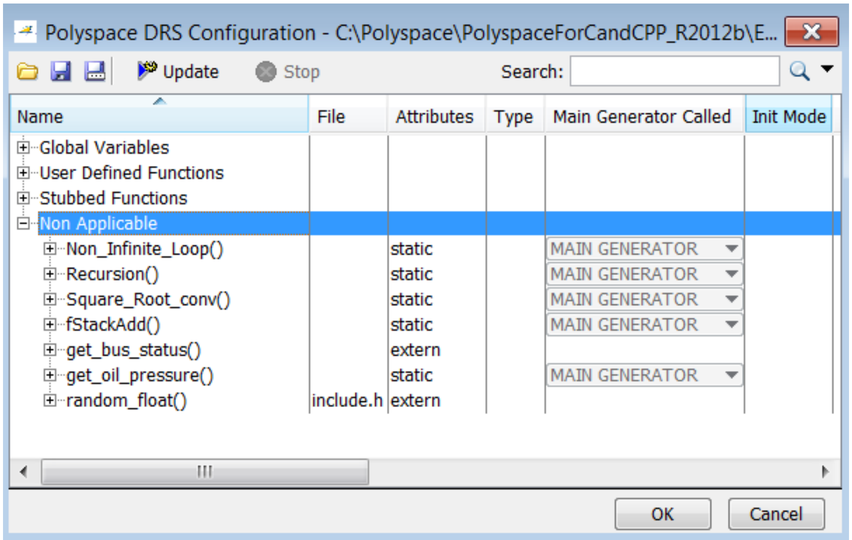
9 If you change your source code, click Update to generate an updated DRS configuration file. As a result of the source code changes, the updated file might contain entries that no longer apply to your code. You can remove these entries from the file. See "Remove Non Applicable Entries from DRS File" on page 5-57.

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

11 Select **File > Save Project** to save your project settings.

Remove Non Applicable Entries from DRS File

If you change your source code, you must update your DRS configuration file. From the Polyspace DRS Configuration dialog box, click Update. The software updates the file, placing all DRS entries that no longer apply to your code under the **Non Applicable** node.



Polyspace DRS Configuration - C:\Polyspace\PolyspaceForCandCPP_R2012b\E...

Name	File	Attributes	Type	Main Generator Called	Init Mode
⊞ Global Variables					
⊞ User Defined Functions					
⊞ Stubbed Functions					
⊟ Non Applicable					
⊞ Non_Infinite_Loop()		static		MAIN GENERATOR	
⊞ Recursion()		static		MAIN GENERATOR	
⊞ Square_Root_conv()		static		MAIN GENERATOR	
⊞ fStackAdd()		static		MAIN GENERATOR	
⊞ get_bus_status()		extern			
⊞ get_oil_pressure()		static		MAIN GENERATOR	
⊞ random_float()	include.h	extern			

You can remove:

- All entries that do not apply:
  1. Right-click **Non Applicable**.
  2. From the context menu, select **Remove This Node**.
- Entries corresponding to a subnode:
  1. Right-click the subnode, for example, **Non_Infinite_loop()**.
  2. From the context menu, select **Remove This Node**.

DRS Configuration Settings

The Polyspace DRS Configuration dialog box allows you to specify data ranges for all the 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 all global variables in the Project. • **User defined functions** – Displays a list of all user-defined functions in the Project. Expand any function name to see a list of the input arguments for which you can specify a data range. • **Stubbed functions** – Displays a list of all stub functions in the Project. Expand any 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`.
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.

Column	Settings
Init Mode	Specifies how the software assigns a range to the variable: • **`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`
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.
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 on page 5-62.

Column	Settings
	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 on page 5-62. **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
}
```

Specify Data Ranges Using Existing DRS Configuration

Once you have created a DRS configuration file for a project, you can reuse the data ranges for subsequent verifications.

To specify an existing DRS configuration file for your project:

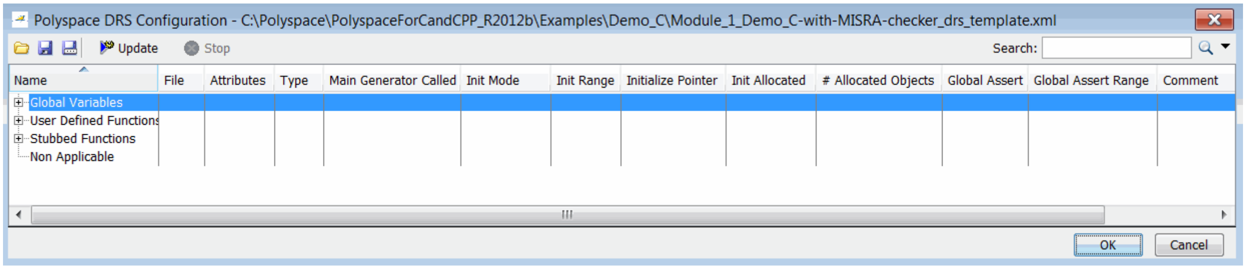
1. Open the project.

2. In the Project Manager perspective, expand the **Configuration > Code Prover Verification** node.

3. Select **Inputs & Stubbing**.

4. Under **Inputs**, to the right of the **Variable/function range setup** field, click the **Edit** button.

   The Polyspace DRS Configuration dialog box opens.



Polyspace DRS Configuration - C:\Polyspace\PolyspaceForCandCPP_R2012b\Examples\Demo_C\Module_1_Demo_C-with-MISRA-checker_drs_template.xml

Name	File	Attributes	Type	Main Generator Called	Init Mode	Init Range	Initialize Pointer	Init Allocated	# Allocated Objects	Global Assert	Global Assert Range	Comment
Global Variables												
User Defined Functions												
Stubbed Functions												
Non Applicable												

5. On the toolbar, click the button 📂 to open the Load a DRS file dialog box.

6 Navigate to the folder that contains the required DRS configuration file, and select the file. Then click **Open**. The Load a DRS file dialog box closes.

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

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

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

Edit Existing DRS Configuration

Once you have created a DRS configuration file for your project, you can edit the configuration using the Polyspace DRS Configuration dialog box.

To edit an existing DRS configuration:

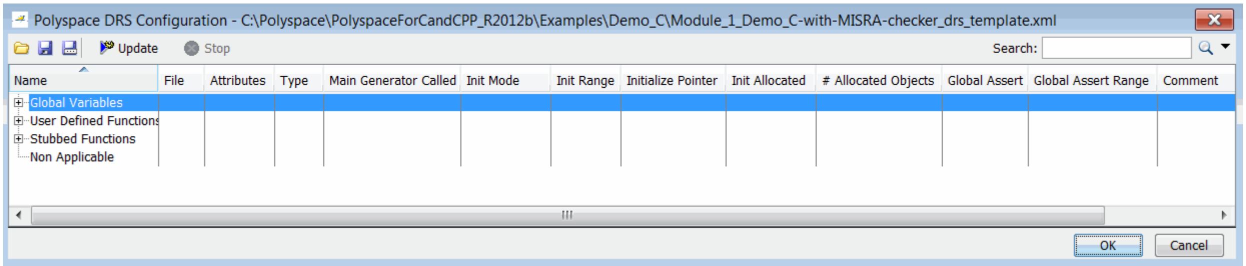
1 Open the project.

2 In the Project Manager perspective, expand the **Configuration > Code Prover Verification** node.

3 Select **Inputs & Stubbing**.

4 Under **Inputs**, to the right of the **Variable/function range setup** field, click the **Edit** button.

The Polyspace DRS Configuration dialog box opens.



Polyspace DRS Configuration - C:\Polyspace\PolyspaceForCandCPP_R2012b\Examples\Demo_C\Module_1_Demo_C-with-MISRA-checker_drs_template.xml

Name	File	Attributes	Type	Main Generator Called	Init Mode	Init Range	Initialize Pointer	Init Allocated	# Allocated Objects	Global Assert	Global Assert Range	Comment
⊞ Global Variables												
⊞ User Defined Functions												
⊞ Stubbed Functions												
Non Applicable												

5 Specify the data ranges for global variables, user-defined function inputs, and stub-function return values.

6. To save your DRS configuration file, click 💾 (Save DRS),

7. Click **OK**, which closes the Polyspace DRS Configuration dialog box.

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 5-70.
- **(*****)** — 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`

`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 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`*

`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 NULL	NONE SINGLE MULTI	INIT May be NULL max MULTI
		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

Scope	Type		Init modes	Gassert mode	Initialize pointer	Init allocated	Default
		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
		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

Specify Data Ranges Using Text Files

To use the DRS feature, you must provide a list of variables (or functions) and their associated data ranges.

You can specify data ranges using the Polyspace DRS Configuration dialog box (see “Specify Data Ranges Using DRS Template” on page 5-55), or you can provide a text file that contains a list of variables and data ranges.

Note If you used the DRS feature prior to R2010a, you created a text file to specify data ranges. The format of this file has not changed. You can use your existing DRS text file to specify data ranges.

To specify data ranges using a DRS text file:

1. Create a DRS text file containing the list of global variables (or functions) and their associated data ranges, as described in “DRS Text File Format” on page 5-73.

2. Open the project.

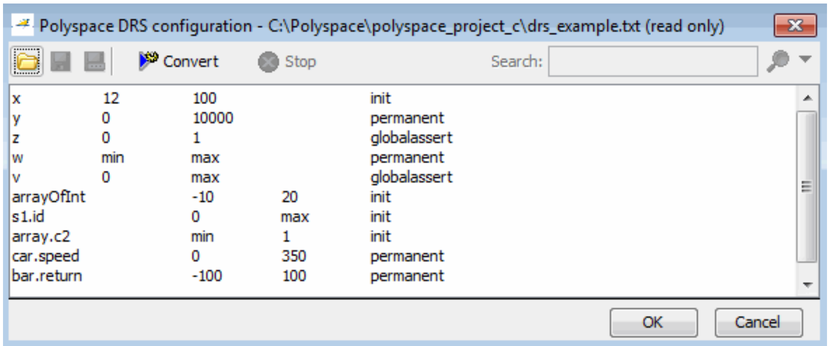
3. In the Project Manager perspective, expand the **Configuration > Code Prover Verification** node.

4. Select **Inputs & Stubbing**.

5. Under **Inputs**, to the right of the **Variable/function range setup** field, click the **Edit** button. The Polyspace DRS Configuration dialog box opens.

6. On the toolbar, click the button 📂 to open the Load a DRS file dialog box.

7. Navigate to the folder that contains the required DRS text file, and select the file. Then click **Open**. The Load a DRS file dialog box closes.



Polyspace DRS configuration - C:\Polyspace\polyspace_project_c\drs_example.txt (read only)

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

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

9 Select **File > Save Project** 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.

Note You can convert your text file to an XML file. On the toolbar of the Polyspace DRS Configuration dialog box, click the button Convert. The software generates an XML version of your text file, which you can edit without affecting your original text file.

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
```

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)
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>`

	init	permanent	globalassert	comments
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 5-78.
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
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.

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.	↑	→
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

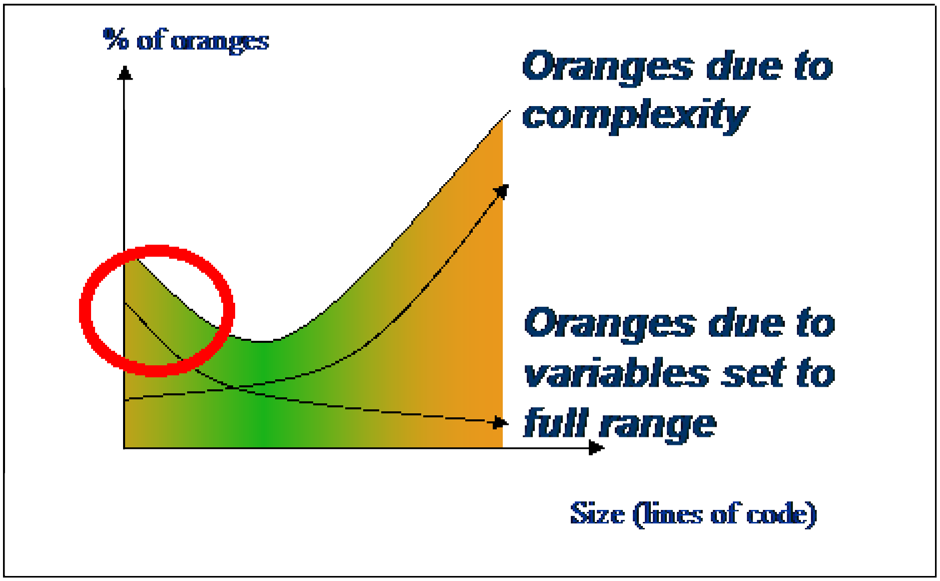
When performing robustness (worst case) verification, data inputs are always set to their full range. Therefore, every operation on these inputs, even a simple "`one_input + 10`" can produce an overflow, as the range of `one_input` varies between the min and the max of the type.

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 on the variable. For example, if you specify that "`one-input`" can vary between `0` and `10`, Polyspace software will definitely know that:

- `one_input + 100` will never overflow
- the results of this operation will always be between `100` and `110`

This not only eliminates the local overflow orange, 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" on page 8-54.

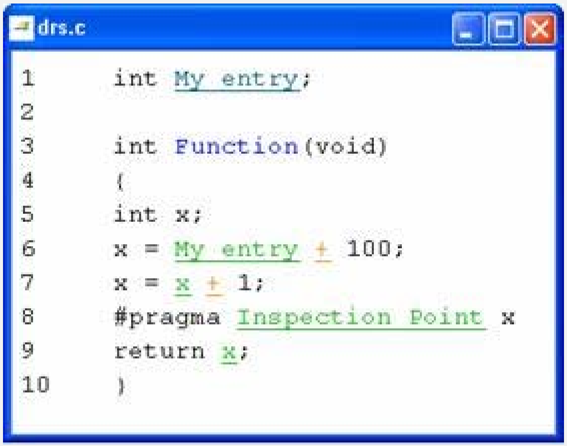
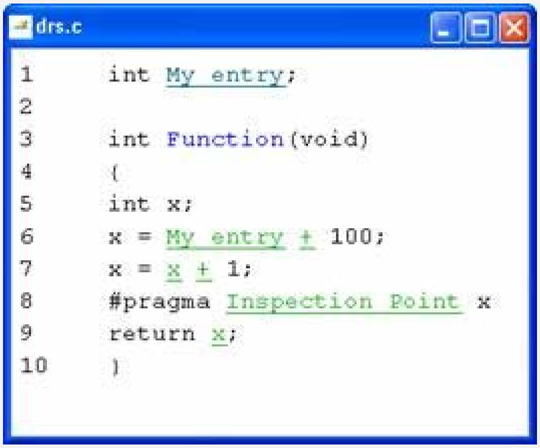
This section describes how DRS reduces oranges on files or modules only.

Example

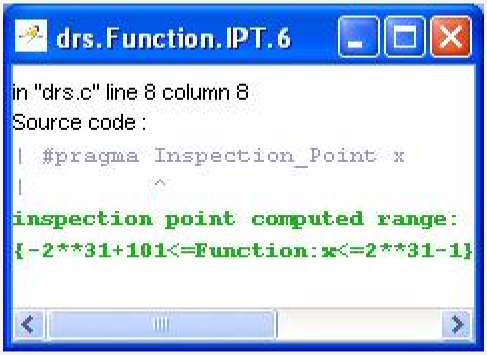
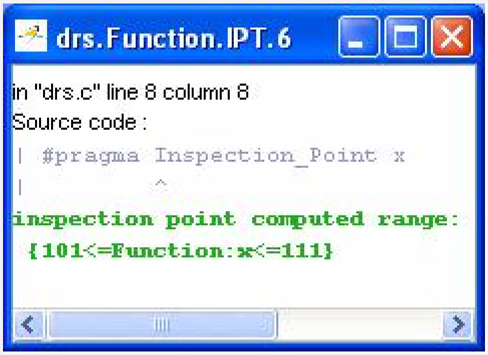
The following example illustrates how DRS can reduce oranges. Suppose that in the real world, the input "`My_entry`" can vary between `0` and `10`.

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

Without DRS	**With DRS — 2 Oranges Removed + Return Statement More Accurate**


drs.c
`int My_entry;`
 	
`int Function(void)`
`{`
`int x;`
`x = My_entry + 100;`
`x = x + 1;`
`#pragma Inspection_Point x`
`return x;`
`}`
	
	drs.c
	`int My_entry;`
	
	`int Function(void)`
	`{`
	`int x;`
	`x = My_entry + 100;`
	`x = x + 1;`
	`#pragma Inspection_Point x`
	`return x;`
	`}`

• 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.	• 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.

<table>
<tr><th>Without DRS</th><th>With DRS — 2 Oranges Removed + Return Statement More Accurate</th></tr>
<tr><td>And the returned result is between [min+101 max]</td><td>And the returned result is between [101,111]</td></tr>
<tr><td>
in "drs.c" line 8 column 8
Source code :
| #pragma Inspection_Point x
| ^
inspection point computed range:
{-2**31+101<=Function:x<=2**31-1}</td><td>
in "drs.c" line 8 column 8
Source code :
| #pragma Inspection_Point x
| ^
inspection point computed range:
 {101<=Function:x<=111}</td></tr>
</table>

Preparing Source Code for Verification

- “Stubbing” on page 6-2
- “Prepare Code for Variables” on page 6-22
- “Prepare Code for Built-In Functions” on page 6-27
- “Prepare Multitasking Code” on page 6-30
- “Annotate Known Run-Time Errors” on page 6-47
- “Annotate Known Coding-Rule Violations” on page 6-50
- “Types Promotion” on page 6-54
- “Ignoring Assembly Code” on page 6-57
- “Verify “Unsupported” Code” on page 6-65
- “Loss of Precision Using `memset` and `memcpy`” on page 6-68
- “Initialize Structures with Precision Using `memset` and `memcpy`” on page 6-69

Stubbing

In this section...

"Stubbing Overview" on page 6-2

"Manual vs. Automatic Stubbing" on page 6-2

"Stubbing Examples" on page 6-6

"Automatic Stubbing Behavior for C++ Pointer/Reference" on page 6-9

"Specify Functions to Stub Automatically" on page 6-10

"Constrain Data with Stubbing" on page 6-12

"Default and Alternative Behavior for Stubbing" on page 6-18

"Function Pointer Cases" on page 6-20

"Stub Functions with a Variable Argument Number" on page 6-20

"Stub Standard Library Functions" on page 6-21

Stubbing Overview

A function stub is a small piece of code that emulates the behavior of a missing function.

Stubs do not need to model the details of functions or procedures. They represent only the effect that the code might have on the remainder of the system.

Stubbing allows you to verify code before all functions are developed.

Manual vs. Automatic Stubbing

The approach you take to stubbing can have a significant impact on the speed and precision of your verification.

In Polyspace verification, there are two types of stubs:

- **Automatic stubs** – When you attempt to verify code that calls an unknown function, the software automatically creates a stub function based on the function prototype (the function declaration). Automatic stubs do not provide insight into the behavior of the function.

- **Manual stubs** – You create these stub functions to emulate the behavior of the missing functions, and manually include the stub functions in the verification with the rest of the source code.

By default, Polyspace software automatically stubs functions. However, in some cases you may want to manually stub functions. For example, when:

- Automatic stubbing does not provide an adequate representation of the code that it represents— both in regard to missing functions and assembly instructions.
- You verify the entire code. When the verification stops, it means the code is not complete.
- You want to improve the selectivity and speed of the verification.
- You want to gain precision by restricting return values generated by automatic stubs.
- You need to work with a function that writes to global variables.

For Example:

```
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.

Note Automatically generated stubs do not deinitialize variables that are given as parameters.

Deciding Which Stub Functions to Provide

In the following section, *procedure_to_stub* can represent either procedure or a sequence of assembly instructions which would be automatically stubbed in the absence of a manual stub.

Stubs do not need to model the details of functions or procedures. They represent only the effect that the code might have on the remainder of the system.

Consider `procedure_to_stub`. If it 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), then you can stub `procedure_to_stub` with an empty action (`void procedure(void)`). Polyspace does not need a concept of timing because the software takes into account all possible scheduling and interleaving of concurrent execution. Therefore, there is no need to 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 procedure(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 `procedure_to_stub` and why. Do not stub the concerned `procedure_to_stub` if:
  - The variable is volatile.
  - The variable is a task list. Such lists are accounted for by default because all tasks declared with the `-task` option are automatically modelled as though they have been started. Write a procedure_to_stub 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.

Follow the Data Flow:

- Polyspace software uses only the C code which is provided.
- Polyspace does not need to be informed of timing constraints because all possible sequencing is taken into account.

Example

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.

Default Stubbing	Manual Stubbing	Function Ignored

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

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.

Summary

Stub manually to gain precision by restricting return values generated by automatic stubs, for example, when you work with a function that writes to global variables.

Stub automatically to minimize preparation time. No run-time error is introduced by automatic stubbing.

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. The default stub would therefore have no 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. cnx_id, port and data remain unchanged
param in/out	None	

File: connection_lib		**Function: Lib_connection_open**
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, automatically stubbed C++ functions behave differently than 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. In the Project Manager perspective, select the **Configuration > Code Prover Verification > Inputs & Stubbing** pane.
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.
4. For each additional function, repeat steps 2 and 3.
5. Save your project.

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

Note All overloaded versions of the function will be discarded.

Constrain Data with Stubbing

- "Add Precision Constraints Using Stubs" on page 6-12
- "Default Behavior of Global Data" on page 6-13
- "Constraining the Data" on page 6-14
- "Apply the Technique" on page 6-14
- "Integer Example" on page 6-15
- "Recode Specific Functions" on page 6-15

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;`
` int tmp;`
` tmp = random;`
` assert(tmp>=1 && tmp<=10 );`
` return`
	`#include <assert.h>`
	`extern int other_func(void);`
	`int stub(void)`
	`{`
	` int tmp;`
	` tmp= other_func();`
	` assert(tmp>=1 && tmp<=10);`
	` return`
	`}`
		`extern int other_func(void);`
		`int stub(void)`
		`{`
		` 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. However, it is not always fruitful and it is therefore recommended only where its application is not too labor intensive - that is, where its implementation can be automated.

The technique therefore 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

To 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 all relevant variables into a single procedure

3 Call this procedure at the beginning of the main. This should replace any 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] **and** assumes the ability to write into (int *) u	Returns [-2^31, 2^31-1]
`int f3 (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)`		Unless you use the option `permissive-stubber`, 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

Function Prototype	Comments

`void _reg(int);`
`int _seq(void *);`
 	
`unsigned char bar(void){`
` return 0;`
`}`
 	
`void main(void){`
` unsigned char x=0;`
` _reg(_seq(bar));`
`}`
	Both functions, “_reg” and “_seq”, are automatically stubbed, but the Polyspace software does not exercise the call to the `bar` 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.

Stub Functions with a 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-c -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 "STD_LIB – Standard Library Function Call".

For more information about how you can use __polyspace__stdstubs.c, see "Standard Library Function Stubbing Errors" on page 8-36.

Prepare Code for Variables

In this section...

"Check Variable Ranges with `Assert`" on page 6-22

"Check Properties on Global Variables: Global Assert" on page 6-23

"Model Variable Values External to Application" on page 6-23

"Initialize Variables" on page 6-24

"Data and Coding Rules" on page 6-25

"Undefined or Undeclared Variables and Functions" on page 6-26

Check Variable Ranges with `Assert`

Assert is a UNIX, Linux, and Windows macro that aborts the program if the test performed inside the assertion proves to be false.

Assert failures are real RTEs because they lead to a processor halt. Because of this, the verification produces checks for the assert failures. The behavior matches the behavior exhibited during execution, because **all execution paths for unsatisfied conditions are truncated** (red and then gray). You can assume that any verification performed downstream of the assert uses value ranges which satisfy the assert conditions.

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 Properties on Global Variables: Global Assert

The global assert mechanism works by inserting a check on each write access to a global variable to verify that it is the range specified.

You enable this feature using DRS `globalassert` mode.

For more information, see “Specify Data Ranges for Variables and Functions (Contextual Verification)” on page 5-54.

Model Variable Values External to Application

There are three main considerations:

- Use of volatile variable.
- Express that the variable content can change at every new read access.
- Express that some variables are external to the application.

A volatile variable is a variable which does not respect the following axiom:

"If I write a value V in the variable X, and if I read X’s value before any other writing to X occurs, I will get V."

The value of a volatile variable is "unknown". It can be any value that can be represented by a variable of its type, and that value can change at any time; even between two successive memory accesses.

A volatile variable is viewed as a "permanent random" by Polyspace verification because the value may have changed between one read access and the next.

Note Although the volatile characteristic of a variable is also commonly used by programmers to avoid compiler optimization, this characteristic has no consequence for Polyspace verification.

```
int return_random(void)
{
 volatile int random; // random ~ [-2^31, 2^31-1], although
        // random is not initialized
 int y;
 y = 1 / random;   // division and init orange because
        // random ~ [-2^31, 2^31-1]
 random = 100;
 y = 1 / random;   // division and init orange because
        // random ~ [-2^31, 2^31-1]
 return random;  // random ~ [-2^31, 2^31-1]
}
```

Initialize Variables

Consider external, volatile, and absolute address variables in the following examples.

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 “Understanding Sequence of Checks” on page 9-102.

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 Addressing

The content of an absolute address is always 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 ZDV for division operator as X is potentially unitialized
}

void f2(void) {
 int *p = (int *)0x20000;  // Orange ABS_ADDR for absolute address
 *p  = 100;
 y  = 1/ *p;
 }
```

Data and Coding 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 resulting problems in a design, such as

- File APIs (or function accessible from outside the file) with no 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.

Undefined or Undeclared Variables and Functions

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 (see "Initialize Variables" on page 6-24).

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" on page 6-27

"Stubs of `stl` Functions" on page 6-27

"Stubs of `libc` Functions" on page 6-27

Overview

Polyspace software stubs all functions that are not defined within the verification. Polyspace software provides an accurate stub for all the functions defined in the `stl` and in the standard `libc`, taking into account functional aspects of the function.

Stubs of `stl` Functions

All functions of the `stl` are stubs by Polyspace software. Using the `no-stl-stubs` option allows deactivating standard stl stubs (not recommended for further possible scaling trouble).

Note All 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

All the 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 all 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.

Prepare Multitasking Code

In this section...

"Polyspace Software Assumptions" on page 6-30

"Model Synchronous Tasks" on page 6-31

"Model Interruptions and Asynchronous Events and Tasks" on page 6-33

"Are Interruptions Maskable or Preemptive?" on page 6-35

"Shared Variables" on page 6-37

"Mailboxes" on page 6-41

"Atomicity (Can Instruction be Interrupted by Another?)" on page 6-44

"Priorities" on page 6-45

Polyspace Software Assumptions

This section describes the default behavior of the Polyspace software. If your code does not conform to these assumptions, before starting verification, you must make minor modifications to the code.

The assumptions are:

- The main procedure must terminate for entry-points (or tasks) to start.
- All tasks or entry-points start after the end of the main procedure without any predefined basis regarding the sequence, priority, or preemption. If an entry-point is seen as dead code, it is because the main procedure contains a red error and therefore does not terminate.
- Verification assumes that there is no atomicity, nor timing constraints.
- Only entry points with `void any_name (void)` as prototype are considered.

Read this entire section before applying the rules described. Some rules are mandatory while other rules allow you to gain selectivity.

Model Synchronous Tasks

In some circumstances, you must adapt your source code to allow synchronous tasks to be taken into account.

Suppose that an application has the following behavior:

- Once every 10 ms: `void tsk_10ms(void);`
- Once every 30 ms: `...`
- Once every 50 ms

These tasks never interrupt each other. They include no infinite loops, and always return control to the calling context. For example:

```
void tsk_10ms(void)
{ do_things_and_exit();
 /* it's important it returns control*/
}
```

However, if you specify each entry-point at launch using the option:

```
polyspace-c -entry-points tsk_10ms,tsk_30ms,tsk_50ms
```

then the results are not valid, because each task is called only once.

To address this problem, you must specify that the tasks are purely sequential. You can do this by writing a function to call each of the tasks in the right sequence, and then declaring this new function as a single task entry point.

Solution 1

Write a function that calls the cyclic tasks in the right order; an **exact sequencer**. This sequencer is then specified at launch time as a single task entry point.

This solution requires knowledge of the exact sequence of events.

For example, the sequencer might be:

```
void one_sequential_C_function(void)
{
 while (1) {
  tsk_10ms();
  tsk_10ms();
  tsk_10ms();
  tsk_30ms ();
  tsk_10ms();
  tsk_10ms();
  tsk_50ms ();
 }
}
```

and the associated launching command:

```
polyspace-c -entry-points one_sequential_C_function
```

Solution 2

Make an **upper approximation sequencer**, taking into account every possible scheduling.

This solution is less precise but quick to code, especially for complicated scheduling:

For example, the sequencer might be:

```
void upper_approx_C_sequencer(void)
{
 volatile int random;
 while (1) {
  if (random) tsk_10ms();
  if (random) tsk_30ms();
  if (random) tsk_50ms();
  if (random) tsk_100ms();
  .....
 }
}
```

and the associated launching command:

```
polyspace-c -entry-points upper_approx_C_sequencer
```

Note If this is the only entry-point, then it can be added at the end of the main procedure rather than specified as a task entry point.

Model Interruptions and Asynchronous Events and Tasks

You can adapt your source code to allow Polyspace software to consider both *asynchronous* tasks and *interruptions*. For example:

```
void interrupt isr_1(void)
{ ... }
```

Without such an adaptation, interrupt service routines appear as gray (dead code) in the Results Manager perspective. The gray code indicates that this code is not executed and is not taken into account, so all interruptions and tasks are ignored by the verification..

The standard execution model is such that the main procedure is executed initially. Only if the main procedure terminates and returns control (i.e. if it is not an infinite loop and has no red errors) do the entry points start, with all potential starting sequences being modelled automatically. You can adopt several different approaches to implement the required adaptations.

Solution 1: Where Interrupts (ISRs) Cannot Preempt Each Other

If the following conditions are fulfilled:

- The interrupt functions it_1 and it_2 (say) can never interrupt each other.
- Each interrupt can be raised several times, at any time.
- The functions are returning functions, and not infinite loops.

Then these non preemptive interruptions may be grouped into a single function, and that function declared as an entry point.

```
void it_1(void);
void it_2(void);
void all_interruptions_and_events(void)
{ while (1) {
 if (random()) it_1();
 if (random()) it_2();
 ... }
}
```

The associated launching command would be:

```
polyspace-c -entry-points all_interruptions_and_events
```

Solution 2: Where Interrupts Can Preempt Each Other

If two ISRs can each be interrupted by the other, then:

- Encapsulate each of them in a loop.
- Declare each loop as an entry point.

One approach is to replace the original file with a Polyspace version.

original_file.c

```
void it_1(void)
{
 ... return;
}

void it_2(void)
{
 ... return;
}

void one_task(void)
{
 ... return;
}
```

polyspace.c

```
void polys_it_1(void)
{
 while (1)
if (random())
 it_1();
}

 void polys_it_2(void)
{
 while (1)
  if (random())
   it_2();
}

void polys_one_task(void)
{
 while (1)
  if (random())
   one_task();
}
```

The associated launching command would be:

```
polyspace-c -entry-points polys_it_1,polys_it_2,polys_one_task
```

Are Interruptions Maskable or Preemptive?

For user interruptions, no *implicit* critical section is defined: you must write all of them manually.

Sometimes, an application which includes interrupts has a critical section written into its main entry point, but shared data is still flagged as unprotected.

This occurs because Polyspace verification does not distinguish between interrupt service routines and tasks. If you specify an interrupt to be a "`-entry-points`" entry point, it has the same priority level as the other procedures declared as tasks ("-entry-points" option). Because Polyspace verification makes an **upper approximation of all scheduling and all interleaving,** in this case, that **includes the possibility that the ISR might be interrupted by any other task**. More paths modelled than could happen during execution, but this has no adverse effect on of the results obtained except that more scenarios are considered than could happen during “real life” execution - and the shared data is not seen as being protected.

To address this, the interrupt must be embedded in a specific procedure that uses the same critical section as the interrupt used in the main task. Then, each time this function is called, the task will enter a critical section which will model the behavior of a nonmaskable interruption.

Original files:

```
int shared_x ;

void my_main_task(void)
{
 // ...
 MASK_IT;
 shared_x = 12;
 UMASK_IT;
 // ...
}
int shared_x ;

void interrupt my_real_it(void)
{ /* which is by specification unmaskable */
 shared_x = 100;
}
```

Additional C files required by the verification:

```
extern void my_real_it(void);  // declaration required

#define MASK_IT pst_mask_it()
#define UMASK_IT pst_unmask_it()

void pst_mask_it(void);    // functions to model critical sections
void pst_unmask_it(void);  //


void other_task (void)
{
  MASK_IT;
  my_real_it();
  UMASK_IT;
}
```

The associated launch command:

```
polyspace-c \
 -D interrupt= \
 -entry-points my_main_task,other_task \
 -critical-section-begin "pst_mask_it:table" \
 -critical-section-end "pst_unmask_it:table"
```

Shared Variables

When you launch Polyspace without any options, all tasks are examined as though concurrent and with no assumptions about priorities, sequence order, or timing. Shared variables in this context are considered unprotected, and so are shown as orange in the variable dictionary.

The software uses the following explicit protection mechanisms to protect the variables:

- Critical section
- Mutual exclusion

- "Critical Sections" on page 6-37
- "Mutual Exclusion" on page 6-39
- "Semaphores" on page 6-39
- "Effects of Imprecision on Shared Variable List" on page 6-40

Critical Sections

This is the most common protection mechanism found in applications, and is simple to represent in Polyspace software:

- If one entry-point makes a call to a particular critical section, all other entry-points are blocked on the "critical-section-begin" function call until the originating entry-point calls the "critical-section-end" function.

- The code between two critical sections is not atomic.
- The code is a binary semaphore, so there is only one token per label (CS1 in the following example). Unlike many implementations of semaphores, it is not a decrementing counter that can keep track of a number of attempted accesses.

Consider the following example:

Original Code

```
void proc1(void)
{
 MASK_IT;
 x = 12; // X is protected
 y = 100;
 UMASK_IT;
}
void proc2(void)
{
 MASK_IT;
 x = 11; // X is protected
 UMASK_IT;
 y = 101; // Y is not protected
}
```

File Replacing the Original Include File

```
void begin_cs(void);
void end_cs(void);
#define MASK_IT begin_cs()
#define UMASK_IT end_cs()
```

Command Line to Launch Polyspace Verification

```
polyspace-c \
 -entry-point proc1,proc2 \
 -critical-section-begin"begin_cs:label_1" \
 -critical-section-end"end_cs:label_1"
```

Mutual Exclusion

You can implement mutual exclusion between tasks or interrupts while preparing to launch verification.

Suppose there are entry-points which never overlap each other, and that variables are shared by nature.

If entry-points are mutually exclusive, i.e. if they do not overlap in time, you may want the verification to take that into account. Consider the following example:

These entry points cannot overlap:

- t1 and t3
- t2, t3 and t4

These entry-points can overlap:

- t1 and t2
- t1 and t4

Before launching verification, the names of mutually exclusive entry-points are placed on a single line:

```
polyspace-c -temporal-exclusion-file myExclusions.txt
-entry-points t1,t2,t3,t4
```

The file myExclusions.txt is also required in the current folder. This file contains:

```
t1 t3
t2 t3 t4
```

Semaphores

Although you can implement the code in C, verification cannot take into account a semaphore system call. However, you can use critical sections to model the behavior of semaphores.

Effects of Imprecision on Shared Variable List

The list of shared variables that Polyspace identifies might contain more than the exact number of shared variables.

Note At a minimum, the list of shared variables contains all global variables or the exact number of shared variables.

Consider the following example.

```
// -entry-points IT_1, IT_2
int C[1];
int D[1];
extern int random(void);
void alias(int* par)
{
  int var;
  var=*par;
}

void IT_1(void)
{
while (1)
  {
     if (random())
     {
        D[0]=C[0];
        alias(D);
     }
  }
}

void IT_2(void)
{
while (1)
  {
     if (random())
     {
        C[0]=C[0]+1;
        alias(C);
     }
  }
}

void main(void)
{
   C[0]=0;
   D[0]=0;
}
```

The variable D is not a shared variable. However, because of array imprecision, Polyspace considers D a shared variable.

Mailboxes

Suppose that an application has several tasks, some of which post messages in a mailbox while other tasks read the messages asynchronously.

This communication mechanism is possible because the OS libraries provide send and receive procedures. The source files will be unavailable because the procedures are part of the OS libraries, but the mechanism needs to be modelled for meaningful verification.

By default, the verification automatically stubs the missing OS send and receive procedures. The stub exhibits the following behavior:

- For send(char *buffer, int length), the content of the buffer is written only when the procedure is called.
- For receive(char *buffer, int *length), each element of the buffer will contain the full range of values for the corresponding data type.

You can use this mechanism and other mechanisms, with different levels of precision.

Let Polyspace software stub automatically	• Quick and easy to code. • **imprecise** because there is no direct connection between a mailbox sender and receiver. It means that even if the sender is only submitting data within a small range, the full data range for the type(s) will be used for the receiver data
Provide a **real mailbox** mechanism	• Costly (time consuming) to implement. • Can introduce errors in the stubs. • Provides little additional benefit when compared to the upper approximation solution.
Provide an **upper approximation of the mailbox**	Models the mechanism so that new read from the mailbox reads **one** of the recently posted messages, but not necessarily the last message. • Quick and easy to code. • **gives precise results**

Consider the following detailed implementation of the upper approximation solution:

polyspace_mailboxes.h

```
typedef struct _r {
 int length;
 char content[100];
} MESSAGE;
extern MESSAGE mailbox;
void send(MESSAGE * msg);
void receive(MESSAGE *msg);
```

polyspace_mailboxes.c

```
#include "polyspace_mailboxes.h"

MESSAGE mailbox;

void send(MESSAGE * msg)
{
 volatile int test;
 if (test) mailbox = *msg;
 // a potential write to the mailbox
}

void receive(MESSAGE *msg)
{
 *msg = mailbox;
}
```

Original code

```
#include "polyspace_mailboxes.h"

void t1(void)
{
 MESSAGE msg_to_send;
 int i;
 for (i=0; i<100; i++)
  msg_to_send.content[i] = i;
 msg_to_send.length = 100;
 send(&msg_to_send);
}
void t2(void)
{
 MESSAGE msg_to_read;
  receive (&msg_to_read);
}
```

The verification then proceeds on the assumption that each new read from the mailbox reads a message, but not necessarily the last message.

The associated launching command is:

```
polyspace-c -entry-points t1,t2
```

Atomicity (Can Instruction be Interrupted by Another?)

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 none are.

Instructional decomposition

Polyspace verification does not take into account either CPU instruction decomposition or timing considerations.

Polyspace verification assumes that instructions are never atomic except in the case of read and write instructions. Polyspace verification makes an **upper approximation of all scheduling and all interleaving**. There are more paths modelled than could be implemented during execution, but given that **all possible paths are always analyzed,** this has no adverse effect on of the results.

Consider a 16–bit target that can manipulate a 32–bit type (an int, for example). In this case, the CPU needs at least two cycles to write to an integer.

Suppose that x is an integer in a multitasking system, with an initial value of 0x0000. Now suppose 0xFF55 is written it. If the operation is not atomic it could be interrupted by another instruction in the middle of the write operation.

- Task 1: Writes 0xFF55 to x.
- Task 2: Interrupts task 1. Depending on the timing, the value of x could be either 0xFF00, 0x0055 or 0xFF55.

Polyspace verification considers write/read instructions atomic, so **task 2 can only read 0xFF55**, even if X is not protected (see “Shared Variables” on page 6-37).

Critical sections

In terms of critical sections, Polyspace does not model the concept of atomicity. A critical section guarantees only that once the function associated with -critical-section-begin is called, any other function making use of the same label is blocked. All other functions can still continue to run, even if somewhere else in another task a critical section has been started.

Polyspace verification of run-time errors supposes that there is no conflict when writing the shared variables. Therefore, even if a shared variable is not protected, the run-time error verification is complete and correct.

More information is available in "Critical Sections" on page 6-37.

Priorities

Priorities are not taken into account by Polyspace verification. However, the timing implications of software execution are not relevant to the verification, which is the primary reason for implementing software task prioritization. In addition, priority inversion issues can mean that the software cannot assume that priorities can protect shared variables. For that reason, Polyspace software makes no such assumption.

While there is no capability to specify differing task priorities, all priorities **are** taken into account because the default behavior of the software assumes that:

- All task entry points (as defined with the option -entry-points) start potentially at the same time;
- The task entry points can interrupt each other in any order, no matter the sequence of instructions. Therefore, all possible interruptions are accounted for, in addition to some interruptions which do not actually occur.

If you have two tasks, t1 and t2, in which t1 has higher priority than t2, use polyspace-c -entry-points t1,t2.

- t1 interrupts t2 at any stage of t2, which models the behavior at execution time.

- t2 interrupts t1 at any stage of t1, which models a behavior which (ignoring priority inversion) would never take place during execution. Polyspace verification has made an **upper approximation of all scheduling and all interleaving**. There are more paths modelled than could happen during execution, but this has no adverse effect on the results.

Annotate Known Run-Time Errors

You can place comments in your code that inform Polyspace software of known run-time errors. Through the use of these comments, you can:

- Highlight run-time errors:
  - Identified in previous verifications.
  - That are not significant.
- Categorize previously reviewed run-time errors.

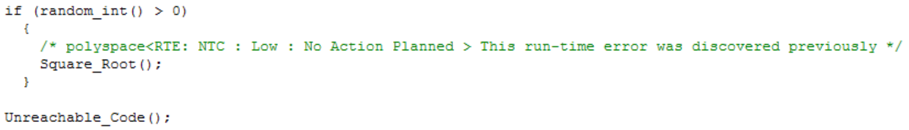
Therefore, during your analysis of verification results, you can disregard these known errors and focus on new errors.

Annotate your code before running a verification:

1. Open your source file using a text editor.

2. Locate the code that produces a run-time error.

3. Insert the required comment.

   ```
   if (random_int() > 0)
     {
       /* polyspace<RTE: NTC : Low : No Action Planned > This run-time error was discovered previously */
       Square_Root();
     }

   Unreachable_Code();
   ```

   See also “Syntax for Run-Time Errors” on page 6-48.

   Note Instead of typing the full syntax of the annotation, you can copy an annotation template from the Results Manager perspective, paste it into your source code, and modify the template to comment the check. To copy the annotation template, right-click any check in the Source pane and select **Add Pre-Justification to Clipboard**.

   ---

4. Save your file.

5 Start the verification. The software produces a warning if your comments do not conform to the prescribed syntax, and they do not appear in the Results Manager perspective.

When the verification is complete, open the Results Manager perspective. You see run-time errors in the **Results Summary** view.

In the **Classification**, **Status**, and **Comment** columns, the information that you provide within your code comments is now visible. If the `Status` field in your annotation was set to `Justify with annotations` or `No action planned`, the checkbox in the **Justified** column is selected.

Syntax for Run-Time Errors

To apply comments to a single line of code, use the following syntax:

```
/* polyspace<RTE:RTE1[,RTE2] : [Classification] : [Status] >
[Additional text] */
```

where,

- Square brackets *[]* indicate optional information.
- *RTE1,RTE2,…* are formal Polyspace checks, for example, `OBAI`, `IDP`, and `ZDV`. You can also specify `ALL`, which covers every check.
- *Classification*, for example, `High` and `Low`, allows you to categorize the seriousness of the issue with a predefined classification. To see the complete list of predefined classifications, in the Preferences dialog box, click the **Review Statuses** tab.
- *Status* allows you to categorize the run-time error with either a predefined status, or a status that you define in the Preferences dialog box, through the **Review Statuses** tab.
- *Additional text* appears in the **Comment** column of the **Results Summary** view of the Results Manager perspective. Use this text to provide information about the run-time errors.

The software applies the comments, which are case-insensitive, to the first non-commented line of C code that follows the annotation.

Note The software does not process code annotations that occupy several lines through the use of the C++ line continuation character \. For example,

```
// polyspace<RTE: OBAI > This comment starts on \
   one line but finishes on another.
```

Syntax Example:

```
/* polyspace<RTE: NTC : Low : No Action Planned > Known issue */
```

Note Instead of typing the full syntax of the annotation, you can copy an annotation template from the Results Manager perspective, paste it into your source code, and modify the template to comment the check. To copy the annotation template, right-click any check in the Source pane and select **Add Pre-Justification to Clipboard**.

Syntax for Sections of Code

To apply comments to a section of code, use the following syntax:

```
/* polyspace:begin<RTE:RTE1[,RTE2] : [Classification] : [Status] >
[Additional text] */

... Code section ...

/* polyspace:end<RTE:RTE1[,RTE2] : [Classification] : [Status] >
 */
```

Annotate Known Coding-Rule Violations

You can place comments in your code that inform Polyspace software of known or acceptable coding rule violations. The software uses the comments to highlight, in the Results Manager perspective, errors or warnings related to the coding rule violations. Use this functionality to inform other users of known coding rule violations.

Note Source code annotations do not apply to code comments. Therefore, the following coding rules cannot be annotated:

- MISRA-C Rules 2.2 and 2.3
- MISRA-C++ Rule 2-7-1
- JSF++ Rules 127 and 133

To annotate your code before running a verification:

1. Open your source file using a text editor.

2. Locate the code that violates a coding rule.

3. Insert the required comment.

```
static void Pointer_Arithmetic (void)
{
  int array[100];
  int i, *p = array;

  for(i = 0; i < 100; i++)
    {
      *p = 0;
      /* polyspace<MISRA-C:17.4: Low : Justify with annotations > Known issue */
      p++;
    }
```

See also “Syntax for Coding Rule Violations” on page 6-52 .

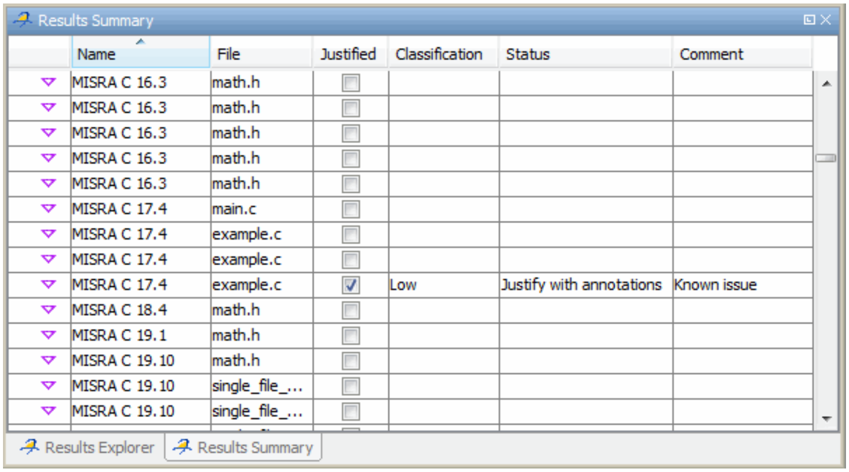
Note Instead of typing the full syntax of the annotation, you can copy an annotation template from the Results Manager perspective, paste it into your source code, and modify the template to comment the violation. To copy the annotation template, in the **Source** pane, right-click any coding rule violation and select **Add Pre-Justification to Clipboard**.

---

4 Save your file.

5 Start the verification. The software produces a warning if your comments do not conform to the prescribed syntax, and they do not appear in the Results Manager perspective.

When the verification is complete, or stops because of a compilation error, you can view all coding rule violations through the **Results Summary** tab in the Results Manager perspective.



Results Summary

	Name	File	Justified	Classification	Status	Comment
▽	MISRA C 16.3	math.h	□			
▽	MISRA C 16.3	math.h	□			
▽	MISRA C 16.3	math.h	□			
▽	MISRA C 16.3	math.h	□			
▽	MISRA C 16.3	math.h	□			
▽	MISRA C 17.4	main.c	□			
▽	MISRA C 17.4	example.c	□			
▽	MISRA C 17.4	example.c	□			
▽	MISRA C 17.4	example.c	☑	Low	Justify with annotations	Known issue
▽	MISRA C 18.4	math.h	□			
▽	MISRA C 19.1	math.h	□			
▽	MISRA C 19.10	math.h	□			
▽	MISRA C 19.10	single_file_...	□			
▽	MISRA C 19.10	single_file_...	□			

In the **Classification**, **Status** and **Comment** columns, the information that you provide within your code comments is now visible.If the `Status` field in your annotation was set to `Justify with annotations` or `No action planned`, the checkbox in the **Justified** column is selected.

Syntax for Coding Rule Violations

To apply comments to a single line of code, use the following syntax:

```
/* polyspace<Rule_Set:Rule1[,Rule2] : [Classification] : [Status] >
[Additional text] */
```

where

- Square brackets `[]` indicate optional information.
- *`Rule_Set`* is, depending on your rule checker, either `MISRA-C`, `MISRA-CPP` or `JSF`.
- *`Rule1,Rule2,`* are rules (for example, `10.3`, `11.5`), that are defined in your rules file (for example, `misra-rules.msr`). You can also specify `ALL`, which covers every coding rule.
- *`Classification`*, for example, `High` and `Low`, allows you to categorize the seriousness of the coding rule violation with a predefined classification. To see the complete list of predefined classifications, in the Polyspace Preferences dialog box, click the **Review Statuses** tab.
- *`Status`* allows you to categorize the coding rule violation with either a predefined status, or a status that you define in the Preferences dialog box, through the **Review Statuses** tab.
- *`Additional text`* appears in the **Comment** fields of the **Results Summary** and **Check Review** tabs in the Results Manager perspective. Use this text to provide information about the coding rule violations.

The software applies the comments, which are case-insensitive, to the first non-commented line of C code that follows the annotation.

Note The software does not process code annotations that occupy several lines through the use of the C++ line continuation character `\`. For example,

```
// polyspace<JSF: 11 > This comment starts on \
   one line but finishes on another.
```

Syntax Examples:

MISRA C rule violation:

```
/* polyspace<MISRA-C:6.3 : Low : Justify with annotations> Known issue */
```

JSF++ rule violation:

```
/* polyspace<JSF:9 : Low : Justify with annotations> Known issue */
```

Note Instead of typing the full syntax of the annotation, you can copy an annotation template from the Results Manager perspective, paste it into your source code, and modify the template to comment the check. To copy the annotation template, right-click any check in the Source pane and select **Add Pre-Justification to Clipboard**.

Syntax for Sections of Code

To apply comments to a section of code, use the following syntax:

```
/* polyspace:begin<MISRA-C:Rule1[,Rule2] :
[Classification] : [Status] >
[Additional text] */

... Code section ...

/* polyspace:end<MISRA-C:Rule1[,Rule2] : [Classification] : [Status] >  */
```

Types Promotion

In this section…

"Unsigned Integers Promoted to Signed Integers" on page 6-54

"Promotions Rules in Operators" on page 6-55

"Example" on page 6-55

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 any 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.

```
extern char random_char(void);
extern int random_int(void);

void main(void)
{
 char c1 = random_char();
 char c2 = random_char();
 int i1 = random_int();
 int i2 = random_int();

 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.

```
2 extern char random_char(void);
3
4 void main(void)
5 {
6  char c1 = random_char();
7  char c2 = random_char();
8
9  c1 = (char)((int)c1 + (int)c2);  // Warning OVFL: due to
10            // integer promotion
11 }
```

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 there is no possibility of any overflow (OVFL) on the +operator.

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 the 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.

Ignoring Assembly Code

In this section...

"Ignoring Assembly Code — Overview" on page 6-57

"Ignore Assembly Code When Rest of Function Is Unaffected" on page 6-57

"Automatic Stubbing of Single Function" on page 6-60

"Automatic Stubbing of List of Functions" on page 6-60

"Directives `#asm` and `#endasm`" on page 6-62

"If Verification Fails to Parse `asm` Code" on page 6-62

"Local Variables in Functions with Assembly Code" on page 6-63

Ignoring Assembly Code — Overview

Polyspace verification is designed for C code. By default, Polyspace ignores assembly code during verification.

In cases, where Polyspace does not ignore assembly code by default, use the command line options `-asm-begin` and `-asm-end` to specify the beginning and end of assembly code sections.

Ignore Assembly Code When Rest of Function Is Unaffected

Ignoring assembly instructions can change the behavior of the code. For example, a write access to a shared variable can be written in assembly code. If this write access is ignored, the verification may produce inaccurate results. In such cases, use "Stubbing" on page 6-2, which applies to functions as well as to stubbed instructions.

Ignoring assembly code is an acceptable approach when the ignored assembly instructions have no impact on the remainder of the function. See"Manual vs. Automatic Stubbing" on page 6-2.

The following code illustrates this approach.

```
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_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 pragma_ignored(void)
{
 #pragma asm
  SRST
 #pragma endasm
  assert (1); // is green
}

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_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;
}

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
}
```

Automatic Stubbing of Single Function

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
}
```

Automatic Stubbing of List of Functions

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
}
```

For more information, see "Stubbing" on page 6-2.

Directives #asm and #endasm

By default, the software disregards assembly code that lies between `#asm` and `#endasm`.

```
void test(void)
{
  #asm
    mov _as:pe, reg
    jre _nop
  #endasm
  int r;
  r=0;
  r++;
}
```

If Verification Fails to Parse asm Code

Occasionally the software might not automatically ignore an assembly code section, for example, when the code section is compiler-specific. In this case, use the options `-asm-begin` and `-asm-end`.

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 any 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 any unsupported assembly code section to be ignored without changing the meaning of the original code.

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.

```
int dummy(void) {
  int g,h;
  h = g * 2;      // orange NIVL for g (red NIVL before 12a)
  h = 2;           // h is assigned the value 2
  asm("int $0x3");
  asm("mov 4%0,%%eax"::"m"(g));
  asm("movss 4%0,%%xmm1"::"m");
  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.

Verify “Unsupported” Code

Backward “goto” Statements

Polyspace verification is not designed to support backward “goto” statements. However, macros provide a solution. Verifications that includes backward “goto” statements stop at an early stage, and a message appears saying that backward “goto” statements are not supported.

Macros provided with the Polyspace software can work around this limitation **as long as the “goto” labels and jump instructions are in the same code block (and in the same scope)**.

To insert these macros into the code:

1. Edit the C file containing the “goto” statements.
2. Add #include pstgoto.h" at the beginning of the file (located in *Polyspace_Install*/polyspace/verifier/cxx/cinclude).
3. Go to the beginning of the block containing the “goto” statements.
4. Insert the USE_1_GOTO(*<tag>*) macro call after the variable declarations (local to the block).
5. Insert the EXIT_1_GOTO(*<tag>*) macro call before the end of this same block (take care with the closing bracket "}").
6. Replace "goto *<tag>*" with "GOTO(*<tag>*)".

For example, the following code would cause a verification to terminate:

```
{
/* local variable declarations */
int x; ...
/* Instructions */
...
label1:
...
goto label1
...
}
```

You could address this problem as follows:

```
/* the pstgoto.h file is provided by Polyspace and its path */
{
/* local variable declarations */
int x; ...
USE_1_GOTO(label1);
/* Instructions */
...
label1:
...
GOTO(label1);
...
EXIT_1_GOTO(label1);
}
```

The code block may contain many instances of backward “goto” statements. Using matching USE_n_GOTO() and EXIT_n_GOTO() statements addresses this issue,(for example, USE_2_GOTO(), USE_3_GOTO(), etc.)

Note You must copy pstgoto.h from *Polyspace_Install*/polyspace/verifier/cxx/cinclude, and add it to the list of include folders (-I).

The code block may also use several different tags. You can use multiple “tag” parameters to address these situations. For example, use:

```
USE_n_GOTO (<tag 1>, <tag 2>, ..., <tag n>);
EXIT_n_GOTO(<tag 1>, <tag 2>, ..., <tag n>);
```

Consider the following example.

Original Code	Modified Code for Verification

{
  .
Reset:
  .
 	
  {
 	
   {
    if (X)
     goto Reset;
   }
 	
  {
   if (Y)
    goto Reset;
  }
}
	{
	USE_1_GOTO(Reset);
	
	Reset:
	
	{
	
	  {
	   if (X)
	    GOTO(Reset);
	}
	
	  {
	   if (Y)
	    GOTO(Reset);
	  }
	}
	EXIT_1_GOTO(Reset);

Loss of Precision Using `memset` and `memcpy`

Polyspace verifies uses of `memset` and `memcpy` as full-range values for all possibilities except zero. This interpretation of values can cause a loss of precision for data not initialized to zero. `memset` and `memcpy` view structures as a block of contiguous data. Problems can occur because of “padding” between fields, especially if the fields are of different data types. Additionally, reading fields with `memcpy` might result in different values depending on the endianness of the machine. For example, consider two variables `tab` and `glob`:

```
char tab[4] = {0, 0, 0, 1}; //4 bytes of memory
int glob;                   //also 4 bytes of memory
memcpy(&glob, tab, 4);
```

Under different machines, the `memcpy` function gives`glob` different values.

Machine Environment	**Value of `glob`**
Big endian (i.e. Sparc)	1
Little endian (i.e. x86)	16777216 (0x01000000)

These machine dependencies cause Polyspace to see the values as full range and prevent it from proving the validity of the data values. Therefore, objects modified by `memset` or `memcpy` might result in an orange check.

To learn how to improve Polyspace precision when initializing with `memset`, see “Initialize Structures with Precision Using `memset` and `memcpy`” on page 6-69.

Initialize Structures with Precision Using memset and memcpy

The most common use of memset is initialization of an object (array, structure, etc.). When initializing to zero, Polyspace can validate the value of the data as exactly zero. The software assumes full range for all other values (i.e. [-2^31, 2^31–1] for an int). However, a better way to do the initialization is to replace the call to memset by initializing with curly braces: S another_struct = {2,1,0}. With this initialization, Polyspace recognizes precisely what the structure fields are and their values. You can use the syntax { } only in a declaration statement.

The following example summarizes how Polyspace sees objects when modified with memset and mempcy. The comments show the value of x depending on how the data is initialized:

```
#include <string.h>

typedef struct {
    char a;
    int b;
    char c;
} S;

S s;
int glob;

void main() {
    int x;

// initialize
    S struct_2 = {1,1,1};
    char tab[4] = {0,0,0,1};

// test of memcpy
    memcpy(&glob, tab, 4);   // array of char to int
    x = glob;                // x is full range ~ [-2^31, 2^31-1]

// test of memset
    memset(&s, 1, sizeof(S));
    x = s.b;                 // x is full range ~ [-2^31, 2^31-1]
    memset(&s, 0, sizeof(S));
    x = s.b;                 // x = 0

    s = struct_2;
    x = s.b;                 // x = 1
}
```

To learn why `memset` and `memcpy` cause a loss of precision in Polyspace verification, see “Loss of Precision Using `memset` and `memcpy`” on page 6-68.

Running a Verification

- “Types of Verification” on page 7-2
- “Specify Results Folder” on page 7-3
- “Select Analysis Options Configuration” on page 7-4
- “Check for Compilation Problems” on page 7-5
- “Start Local Verification” on page 7-7
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- “Stop Verification” on page 7-9
- “Phases of Verification” on page 7-10
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- “Manage Previous Verifications With Polyspace Metrics” on page 7-13
- “Manage Remote Verifications” on page 7-16
- “Monitor Progress of Verification” on page 7-17
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- “Modularization of Large Applications” on page 7-21
- “Partition Application into Modules” on page 7-22
- “Choose Number of Modules for Application” on page 7-25
- “Partition Application Using Batch Command” on page 7-28

Types of Verification

You can run a local or remote verification.

Verification type	How to specify verification	Use when
Remote	Select **Distributed Computing > Batch** check box.	Source files are large (more than 800 lines of code including comments), and execution time of verification is long.
	Select **Distributed Computing > Add to results repository** check box.	You want to generate Polyspace Metrics. Through Polyspace Metrics, you can manage verifications and monitor quality over a project lifecycle.
Local	Clear **Distributed Computing > Batch** check box.	Source files are small, and execution time of verification is short.

Specify Results Folder

Each module in the Project Browser can contain multiple result folders. This allows you to save results from multiple verifications of the same source files, either to compare results using different analysis options, or to track verification results over time as your source files are revised.

By default, the software creates a new results folder for each verification. However, if you want to reuse an existing results folder, you can select that folder before starting the verification. For example, you may want to reuse a results folder if you stopped a verification before completion and want to run the verification again.

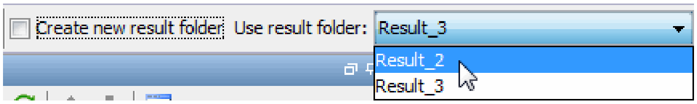
Caution If you specify an existing results folder, all results in that folder are deleted when you start a new verification.

To specify the results folder for a verification:

1 In the Project Browser select the module you want to verify.

2 In the Project Manager toolbar, clear the **Create a new result folder** check box.

3 In the **Use result folder** drop-down menu, select the folder you want to use.



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

For more information, see “Customize Results Folder Location and Name” on page 3-13.

Select Analysis Options Configuration

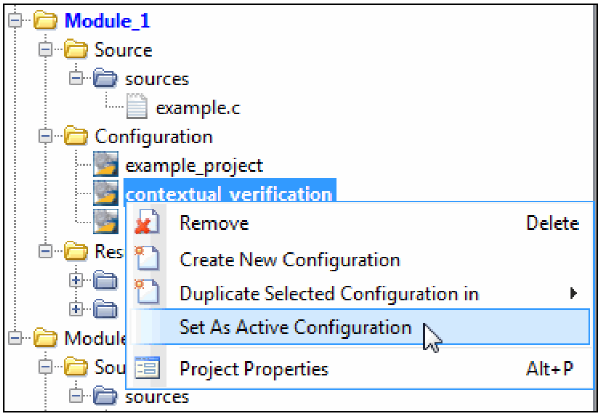
Each module in the Project Browser can contain multiple configurations, with each configuration specifying a set of analysis options. This allows you to verify the same source files multiple times using different analysis options for each verification.

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. From the context menu, select **Set As Active Configuration**.



When you start the verification, the software uses the analysis options from this configuration.

For more information, see “Specify Analysis Options” on page 3-16.

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 **Options > Preferences**.

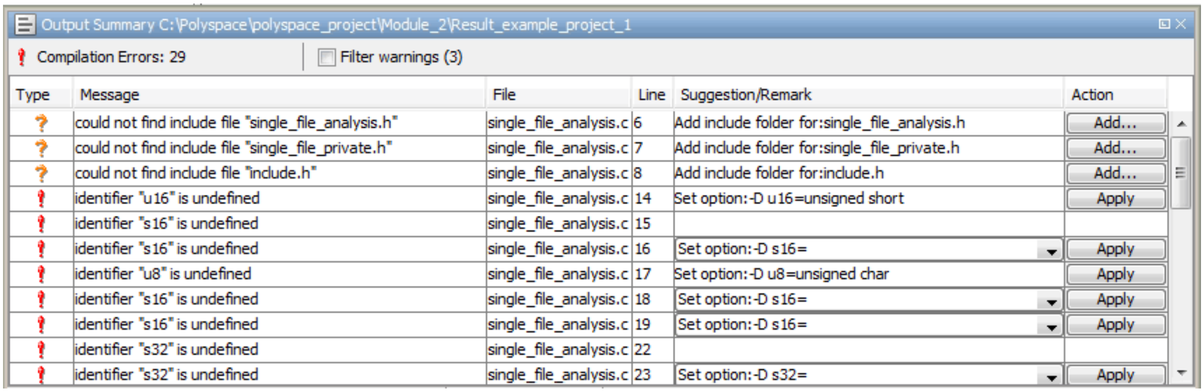
2. In the Polyspace Preferences dialog box, click the **Project and Results Folder** tab.

3. Select the **Use Compilation Assistant** check box. Then click **OK**.

4. On the Project Manager toolbar, click ▷ Run.

   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.



Output Summary C:\Polyspace\polyspace_project\Module_2\Result_example_project_1

! Compilation Errors: 29 | □ Filter warnings (3)

Type	Message	File	Line	Suggestion/Remark	Action
?	could not find include file "single_file_analysis.h"	single_file_analysis.c	6	Add include folder for:single_file_analysis.h	Add...
?	could not find include file "single_file_private.h"	single_file_analysis.c	7	Add include folder for:single_file_private.h	Add...
?	could not find include file "include.h"	single_file_analysis.c	8	Add include folder for:include.h	Add...
!	identifier "u16" is undefined	single_file_analysis.c	14	Set option:-D u16=unsigned short	Apply
!	identifier "s16" is undefined	single_file_analysis.c	15		
!	identifier "s16" is undefined	single_file_analysis.c	16	Set option:-D s16= ▾	Apply
!	identifier "u8" is undefined	single_file_analysis.c	17	Set option:-D u8=unsigned char	Apply
!	identifier "s16" is undefined	single_file_analysis.c	18	Set option:-D s16= ▾	Apply
!	identifier "s16" is undefined	single_file_analysis.c	19	Set option:-D s16= ▾	Apply
!	identifier "s32" is undefined	single_file_analysis.c	22		
!	identifier "s32" is undefined	single_file_analysis.c	23	Set option:-D s32= ▾	Apply

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 all 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. Select the **Configuration > Distributed Computing** pane.

3. By default, the **Batch** check box is not selected. However, if this check box is selected, you must clear the check box.

4. On the Project Manager toolbar, click ▷ Run.

You can monitor the progress of the verification through the **Progress Monitor**, **Full Log**, and **Output Summary** tabs. See "Monitor Progress of Verification" on page 7-17.

If the verification fails, go to "Verification Process Failed Errors" on page 8-2.

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 Polyspace Metrics”.

To start a remote verification:

1 In the Project Manager perspective, from the **Project Browser** pane, select the module you want to verify.

2 Select the **Configuration > Distributed Computing** pane.

3 Select the **Batch** check box. The software runs the verification on your computer cluster with batch commands.

4 On the Project Manager toolbar, click ▷ Run.

   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 7-10.

   Note If you see the message `Verification process failed`, click **OK** and go to “Verification Process Failed Errors” on page 8-2.

By default, the software also selects the **Add results to repository** check box, which enables the generation of Polyspace Metrics. If you clear this check box, the software does not generate Polyspace Metrics but downloads results automatically when the verification is complete.

To monitor progress and manage the verification, see “Manage Remote Verifications” on page 7-16.

Stop Verification

In this section…

“Stop Remote Verification” on page 7-9

“Stop Local Verification” on page 7-9

Stop Remote Verification

1. On the Polyspace Code Prover toolbar, click .
2. In the Polyspace Queue Manager, right-click your verification. From the context menu, select **Remove From Queue**.

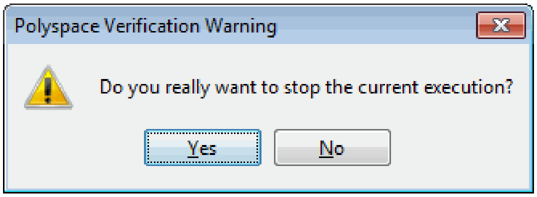
For more information, see “Manage Previous Verifications With Polyspace Metrics” on page 7-13.

Stop Local Verification

To stop a local verification:

1. On the Project Manager toolbar, click the **Stop** button.

   A warning dialog box opens.



Polyspace Verification Warning

Do you really want to stop the current execution?

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 independent of any particular compiler, 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 (`-main-generator`)” — C verification
   - “Verify module (`-main-generator`)” — C++ verification

3. Analyzing the code for run-time errors and generating color-coded results.

Run Verification Unit-by-Unit

When you run a remote verification, you can create a separate verification job for each source file in the project. Each file is compiled, sent to the head node of your computer cluster, and verified individually. You can view verification results for the entire project, or for individual units.

To run a unit-by-unit verification:

1. In the Project Manager perspective, select the **Configuration > Distributed Computing** pane.

2. Select the **Batch** check box.

3. Select the **Configuration > Code Prover Verification** pane.

4. Select the **Run unit by unit verification** check box.

   The **Unit by unit common source** files view is now visible.

5. You can create a list of common files to include with each unit verification:

   a. Click ✚. The software creates a new row.

   b. In the new row, enter the full path to a common file. For example, `C:\Polyspace\polyspace_project\includes\include.h`.

      Repeat steps `a` and `b` until you have created your list of common files. These files are compiled once, and then linked to each unit before verification. Functions that are not included in this list are stubbed.

6. Save your project.

7. On the Project Manager toolbar, click **Run**.

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, from the Project Browser, select the project for which you want to run verifications.
2. Select **Run > Run All**.

   The software verifies each module as an individual job. For information on the verification process, see "Phases of Verification" on page 7-10.

   Note If the verification fails, go to "Verification Process Failed Errors" on page 8-2.

Manage Previous Verifications With Polyspace Metrics

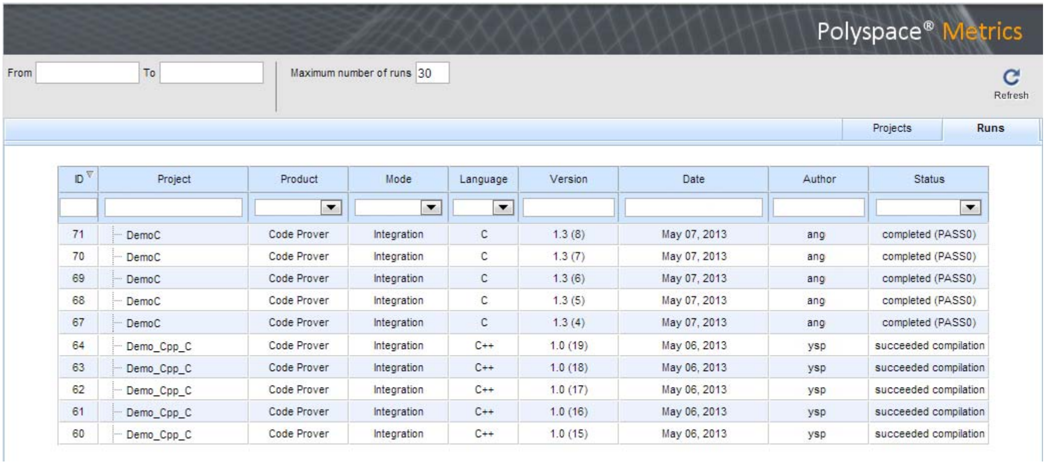
Use the **Runs** view of Polyspace Metrics to administer previous remote verifications. For example, you can:

- 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).



From To Maximum number of runs 30

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” on page 12-14.

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.

Control	Details
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`.
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 Queue Manager:

1. On the Polyspace Code Prover toolbar, click ✓.
2. In the Polyspace Queue Manager, 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. On the Polyspace Code Prover toolbar, click .

2. In the Polyspace Queue Manager, 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:

- **Progress Monitor** — A blue progress bar indicates the current phase of the verification. The tab also displays the time and percentage completed for each phase.
- **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.
- **Output Summary** — Displays 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.

At the end of a local verification, the **Verification Statistics** tab displays statistics, for example, code coverage and check distribution.

Run Verification from the 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 Polyspace Metrics”.

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 Verifications from the Command Line

Use the following line command to manage remote verifications:

```
MATLAB_Install\polyspace\bin\polyspace-jobs-manager
-option[additional_opts] [-scheduler NodeHost | MJSName@NodeHost]
```

MATLAB_Install is your MATLAB installation folder, for example:

```
C:\Program Files\MATLAB\R2013b
```

The following table lists management task options for the command.

Option	Additional options	Task
-listjobs	None	Generate a list of all Polyspace verification jobs on the MATLAB Job Scheduler (MJS). For each job, the software produces the following information: • ID — Verification identifier. • AUTHOR — Name of user that submitted verification. • 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 **Options > Preferences > Server Configuration** tab. • WORKER — Local computer from which verification was submitted. • STATUS — Status of verification, for example, running and completed.

Option	Additional options	Task
		- DATE — Date on which verification was submitted. - LANG — Language of submitted source code.
-download	-job *ID* -results-folder *FolderPath*	Download results of verification with specified ID to folder specified by *FolderPath*. If -results-folder is not specified, the software downloads results to current folder.
-getlog	-job *ID*	Open log for verification with specified ID.
-remove	-job *ID*	Remove verification with specified ID from the MJS.
-scheduler *NodeHost* | *MJSName@NodeHost*	None	Specify 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*). You can use this option with all the other options.

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 7-22 and "Partition Application Using Batch Command" on page 7-28.
- Specify the number of modules in a trade-off between verification speed and precision — see "Choose Number of Modules for Application" on page 7-25.

Polyspace Model Link products do not support modularization of applications.

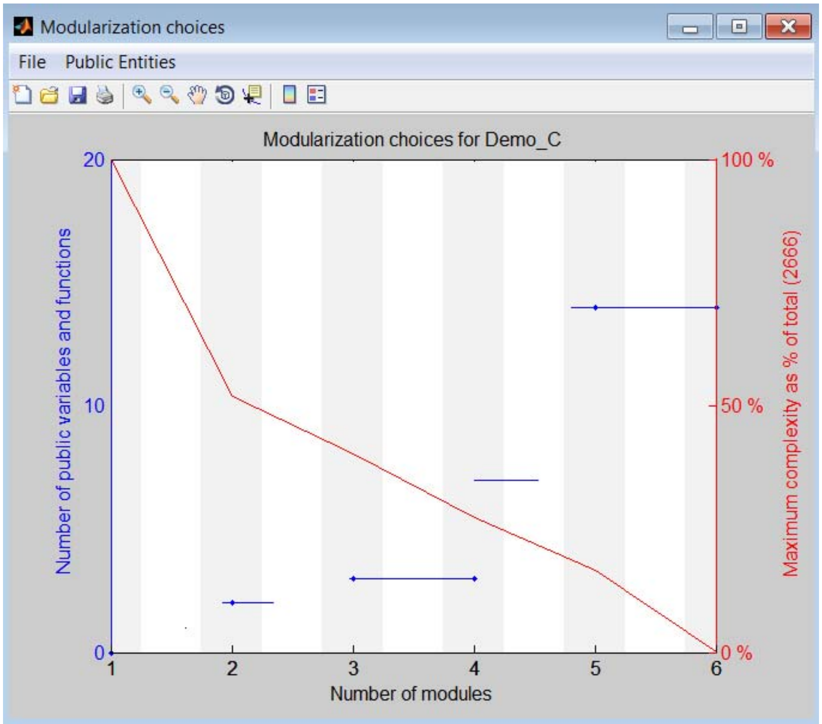
You can carry out faster analysis with a larger number of small modules. However, with more modules, greater cross-module referencing is required during verification, which results in a loss of precision.

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 **Run > Run Modularize**. The software analyzes your application code and displays two plots in a new Modularization choices window.

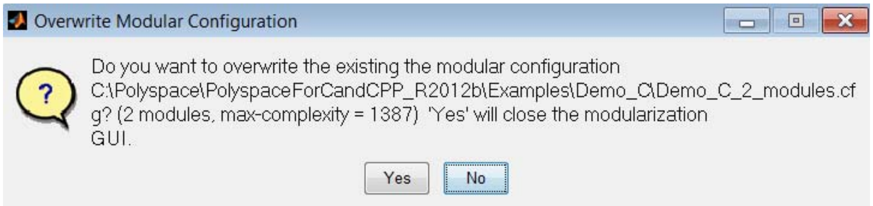

Modularization choices
File
Public Entities
Modularization choices for Demo_C
Number of public variables and functions
0
10
20
Maximum complexity as % of total (2666)
0 %
50 %
100 %
Number of modules
1
2
3
4
5
6

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 7-25. In this example, a suitable number is 2 or 4.

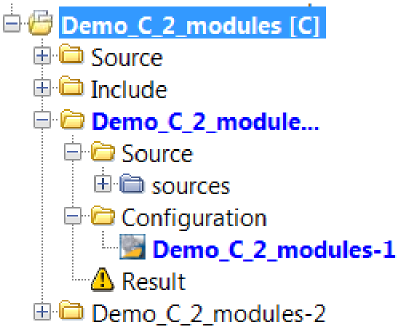
5 Click the vertical gray region associated with the number of modules that you choose, for example, `2`. A dialog box opens.



Overwrite Modular Configuration

Do you want to overwrite the existing the modular configuration C:\Polyspace\PolyspaceForCandCPP_R2012b\Examples\Demo_C\Demo_C_2_modules.cfg? (2 modules, max-complexity = 1387) 'Yes' will close the modularization GUI.

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`

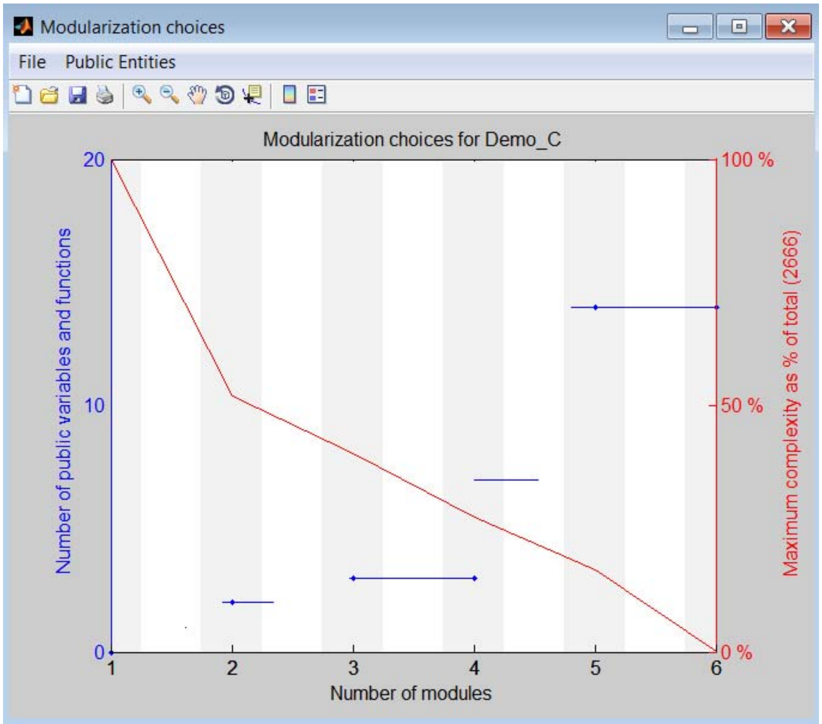
You can change these values through the **Configuration > Precision** pane.

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:

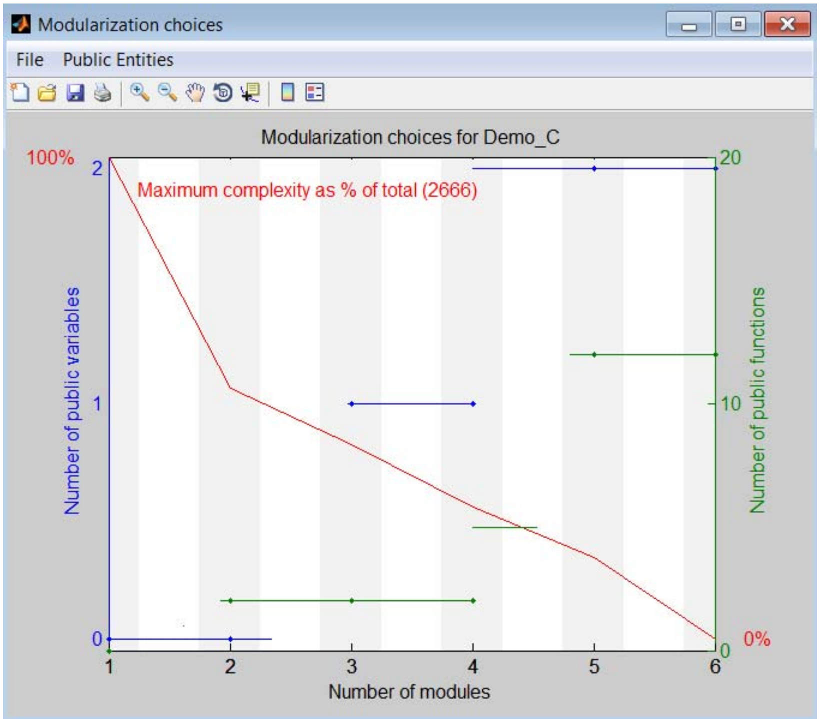
- Time — The smaller the maximum complexity, the shorter the time required for verification. This time saving is even greater if the different modules are verified in parallel.
- Precision — The smaller the number of public variables and functions, the greater the precision of the verification.

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).


Modularization choices
File
Public Entities
Modularization choices for Demo_C
Number of public variables and functions
20
10
0
1
2
3
4
5
6
Number of modules
100 %
50 %
0 %
Maximum complexity as % of total (2666)

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.


Modularization choices
File
Public Entities
Modularization choices for Demo_C
100%
2
1
0
20
10
0
0%
Maximum complexity as % of total (2666)
Number of public variables
Number of public functions
1
2
3
4
5
6
Number of modules

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" on page 7-28

"Constrain Module Complexity During Partitioning" on page 7-29

"Control Naming of Result Folders" on page 7-31

"Forbid Cycles in Module Dependence Graph" on page 7-31

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 all 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*.

Option	Description
`-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.
`-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
```

Troubleshooting Verification Problems

- “Verification Process Failed Errors” on page 8-2
- “Compilation Errors” on page 8-5
- “C++ Dialect Issues” on page 8-17
- “C Link Errors” on page 8-26
- “C++ Link Errors” on page 8-32
- “Standard Library Function Stubbing Errors” on page 8-36
- “Automatic Stubbing Errors” on page 8-43
- “Troubleshooting Using Preprocessed Files” on page 8-45
- “Reduce Verification Time” on page 8-50
- “Obtain Configuration Information” on page 8-68
- “Remove Preliminary Results Files” on page 8-69
- “Storage of Temporary Files” on page 8-70
- “Disk Defragmentation and Antivirus Software” on page 8-71
- “Out of Memory Errors During Report Generation” on page 8-72

Verification Process Failed Errors

In this section...
"Reasons Verification Can Fail" on page 8-2
"View Error Information When Verification Stops" on page 8-2
"Include File Location Not Specified" on page 8-3
"Polyspace Software Cannot Find the Server" on page 8-4

Reasons Verification Can Fail

If you see a message that includes `Verification process failed`, the Polyspace software could not perform the verification. The following sections present some possible reasons for a failed verification.

Message	See
`include.h: No such file or folder` (where `include.h` represents the included file)	"Include File Location Not Specified" on page 8-3

`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 ...`
	"Polyspace Software Cannot Find the Server" on page 8-4

View Error Information When Verification Stops

If the Polyspace software provides no graphical result, it lists the errors and their locations at the end of the log file. To find the errors, scroll through the verification log file, starting at the end and working backwards.

The following example shows the log file information that results if you use the C++ `-class-analyzer` *`argument`*, but the verification cannot find *`argument`* 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
***
```

Include File Location Not Specified

Message

In the verification log (where include.h represents the included file):

```
include.h:  No such file or folder
```

Cause

Either the files are missing or you did not specify the location of included files.

Solution

Do one of the following:

- Include the file in the designated location.
- Specify the location of include files.

You should create a project file to store include files, as described in “Add Source Files and Include Folders” on page 4-8.

Polyspace Software Cannot Find the Server

Message

Search the end of the verification log for:

```
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.
```

Cause

Polyspace software uses information in the preferences to locate the server. In this case, Polyspace software cannot find the server.

Solution

To find the server information in the preferences:

1 Select **Options > Preferences**.

2 Select the **Server Configuration** tab.

To set up the server correctly, see "Set Up Remote Verification and Polyspace Metrics".

Compilation Errors

In this section...

"Compilation Error Overview" on page 8-5

"Check Compilation Before Verification" on page 8-6

"Examine Log for Compilation Errors" on page 8-6

"Compilation Messages Described in This Section" on page 8-7

"Syntax Error" on page 8-7

"Undeclared Identifier" on page 8-8

"Unknown Prototype" on page 8-9

"No Such File or Folder" on page 8-10

"#error directive" on page 8-10

"Class, Array, Struct or Union is Too Large" on page 8-11

"Large Static Initializer" on page 8-12

"Unsupported Non-ANSI Keywords (C)" on page 8-13

"Initialization of Global Variables (C++)" on page 8-14

"Double Declarations of Standard Template Library Functions" on page 8-15

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)

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" on page 7-5.

Examine Log for Compilation Errors

The verification log displays compile phase messages and errors. To search the log, enter search terms in the **Search in the log** box. Click the left arrow to search backward or click the right arrow to search forward.

To examine errors in the verification log:

1. At the bottom of the Project Manager perspective, click the **Output Summary** tab.

   The software displays a list of compile phase messages.

2. Click any of the messages to see message details, as well as the full path of the file containing the error.

3. To open the source file referenced by any message, right click the row for the message. From the context menu, select **Open Source File**.

   Note Before you can open source files, you must configure a text editor . See "Configure Text Editor" on page 3-17.

4. If you do not understand the error information in the **Detail** pane, right-click the row for the message. From the context menu, select **Open Preprocessed File**.

This action opens the `.ci` file that the Polyspace software uses to compile the source file. The contents of this file helps you to understand the compilation error.

Compilation Messages Described in This Section

This section describes compiler messages that include the following phrases:

Phrase Found in Message	See
`syntax error`	"Syntax Error" on page 8-7
`undeclared identifier`	"Undeclared Identifier" on page 8-8
`unknown prototype`	"Unknown Prototype" on page 8-9

`No such file or folder`
or
`Catastrophic error: could not open source file`
	"No Such File or Folder" on page 8-10

`#error: directive`	"#error directive" on page 8-10

This section also describes error messages triggered by unsupported keywords. See "Unsupported Non-ANSI Keywords (C)" on page 8-13.

This section includes sample code that triggers the example message.

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" on page 5-30.

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" on page 5-30.

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, all 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, in the **Target/Compilation** section, under **Analysis options**, for the **Defined Preprocessor Macros** option, specify one of those three compilation flags and restart the verification.

Class, Array, Struct or Union 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 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.

For more information, see “Set Up a Target” on page 5-2.

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 occured 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

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`. All 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:

in file Test.h	in file Test.cpp

`class Test`
`{`
`public:`
`static int m_number;`
`};`
	`int Test::m_number = 0;`

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__
```

C++ Dialect Issues

In this section...

“ISO versus Default Dialects” on page 8-17

“CFront2 and CFront3 Dialects” on page 8-19

“Visual Dialects” on page 8-20

“GNU Dialect” on page 8-22

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>
```

```
17  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 ;
```

All 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. The GNU dialect supports the keyword `__asm__ __volatile__`, which is used to support inline functions. For example, the `<sys/io.h>` header includes many inline functions. The GNU dialect supports these inline functions.

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)) ;

  }
  ```

- All 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;
}
...
```

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

In this section...

"Link Error Overview (C)" on page 8-26

"Function: Wrong Argument Type" on page 8-27

"Function: Wrong Argument Number" on page 8-27

"Variable: Wrong Type" on page 8-28

"Variable: Signed/Unsigned" on page 8-28

"Variable: Different Qualifier" on page 8-29

"Variable: Array Against Variable" on page 8-29

"Variable: Wrong Array Size" on page 8-30

"Missing Required Prototype for varargs" on page 8-30

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`. All 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: 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 f(int *y);
{
  int r;                  void main(void)
  r=12;                   {
}                           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.

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" on page 8-32

"Lib C Stubbing Errors" on page 8-33

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" on page 8-36

"_polyspace_stdstubs.c Compilation Errors" on page 8-36

"Troubleshooting Approaches for Standard Library Function Stubs" on page 8-38

"Restart with the -I option" on page 8-38

"Replace Automatic Stubbing with Include Files" on page 8-39

"Create _polyspace_stdstubs.c File with Required Includes" on page 8-40

"Provide .c file Containing Prototype Function" on page 8-41

"Ignore _polyspace_stdstubs.c" on page 8-42

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 8-43.

_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 any of 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 8-38
- "Replace Automatic Stubbing with Include Files" on page 8-39
- "Create _polyspace_stdstubs.c File with Required Includes" on page 8-40

  (Use when precision is important enough to justify extensive code preparation time)
- "Provide .c file Containing Prototype Function" on page 8-41

  (Use when you do not want to invest much time for code preparation time)
- "Ignore _polyspace_stdstubs.c" on page 8-42

If the problem persists after trying all 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 8-40
- "Provide .c file Containing Prototype Function" on page 8-41
- "Ignore _polyspace_stdstubs.c" on page 8-42

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” on page 5-30.

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 any 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 a proper 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” on page 8-43

“Unknown Prototype Error” on page 8-43

“Parameter -entry-points Error” on page 8-43

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 8-36.

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.

Troubleshooting Using Preprocessed Files

In this section...

"Overview of Preprocessed (.ci) Files" on page 8-45

"Example .ci File" on page 8-45

"Troubleshooting Methodology" on page 8-47

Overview of Preprocessed (.ci) Files

The preceding sections explained common types of compile and linking error messages. However, sometimes the error messages do not provide enough information to find the cause of a problem — the problem does not correspond to any of the common error messages.

Polyspace software, like other compilers, transforms source code into preprocessed code. These preprocessed files are located in the folder: `<results folder>/CPP-ALL/SRC/MACROS` or `<results folder>/ALL/SRC/MACROS`. They have a `.ci` extension, and they can help you understand the cause of an error.

Example .ci File

A `*.ci` file is a copy of original file containing whole header files inside a unique file:

- Compile flags activate some parts of code,
- Macro commands are expanded,
- Arguments which are described as `#define xxx`, are replaced by their owned definition,
- etc.

Extension.cpp

```
#include "Extension.h"

Extension::Extension(int val)
{
 m_val = 0;
 ABS(val);

 if (val > MAX_VALUE )
  m_val = -1;
 }

#ifdef _DEBUG
void Extension::message(char*) {}
#else
 void print(char*) {}
#endif
```

Extension.h

```
#define MAX_VALUE 10
#define ABS(x) ((x)<0?(x):-(x))

class Extension
{
public:
 int m_val;
 Extension(int val);

#ifdef _DEBUG
 void message(char*);
#else
 void print(char*);
#endif
};
```

The associated file `Extension.ci` uses the compile flag `_DEBUG`:

```
# 1 "../sources/extension.cpp"
# 1 "MATLAB_Install/polyspace/verifier/cxx/cinclude/polyspace_std_decls.h" 1

# 1 "../sources/extension.cpp" 2
# 1 "../sources/extension.h" 1
class Extension
{
public:
 int m_val;
 Extension(int val);

 message(char*);     // _DEBUG activates the message member function

};

# 2 "../sources/extension.cpp" 2

Extension::Extension(int val)
```

```
{
 m_val = 0;
 ((val)<0?(val): -(val));  // EXPANDED MACRO ABS

 if (val > 10 )     // MAX_VALUE REPLACED BY 10
  m_val = -1;
 }

void Extension::message(char*) {}
```

Analyzing these files with the compile flag `-D _DEBUG` expands the code fully and may help you find problems quickly.

Troubleshooting Methodology

This section is designed to help you understand error messages, and the differences between your compiler and Polyspace compilation:

1. Check whether the compile error messages come from a dialect problem.
2. Verify that link error messages are related or not to:
   - A C++ stubbing error which could be resolved by an option (like `-no-stl-stubs`)
   - C stubbing error which could be resolved by an option or a compilation flag like `POLYSPACE_NO_STANDARD_STUBS` or `POLYSPACE_STRICT_ANSI_STANDARD_STUBS`.
3. Check the preprocessed `*.ci` files to see the expanded files. Looking at the preprocessed code can help you find errors faster.

Example with these original codes:

Child1.c	Child2.c	Test.h

`#define DEBUG`
 	
`#include "Test.h"`
 	
`class Child1 : public Test`
`{`
`public:`
` Child1();`
` Child1(int val);`
 	
` void search(int val);`
 	
`};`
	`#undef DEBUG`
	
	`#include "Test.h"`
	
	`class Child2 : public Test`
	`{`
	`public:`
	` Child2();`
	` Child2(int val);`
	
	` void qshort(int val);`
	
	`protected:`
	` int m_status;`
	`};`
		`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;`
		`};`

Error message:

```
Pre-linking C++ sources ...
"../sources/test.h", line 4: error: declaration of function
"Test::Test(const Test &)" does not match function
"Test::algorithm" during compilation of "CPP-ALL/SRC/
MACROS/Child2.cpp" (one may have been removed due to #define)
   class  Test
     ^
  detected during compilation of secondary translation unit
"CPP-ALL/SRC/MACROS/Child2.cpp"
```

In this example it is clear that `DEBUG` is defined in `child1.c` but not in `child2.c`, which creates two different definition of the class `test`.

The solution can also come up by comparing the two `*.ci` files:

Test.ci	Child2.ci

....
 	
# 1 "../sources/Test.cpp" 2 	
# 1 "../sources/test.h" 1 	
 	
class Test
{
public:
 Test();
 Test(int val);
 	
 int getVal();
 void setVal(int val);
 	
 void algorithm(int val, int max);
 	
private:
 int m_val;
};
 	
# 2 "../sources/Test.cpp" 2 	
 	
....
	....
	
	# 1 "../sources/Child2.cpp" 2
	# 1 "../sources/Child2.h" 1
	# 1 "../sources/test.h" 1
	
	class Test
	{
	public:
	 Test();
	 Test(int val);
	
	 int getVal();
	 void setVal(int val);
	
	private:
	 int m_val;
	};
	
	# 2 "../sources/Child2.h" 2
	
	....

Looking at the preprocessed code can help to find errors faster.

Reduce Verification Time

In this section...

"Factors Impacting Verification Time" on page 8-50

"Techniques to Improve Verification Performance" on page 8-50

"Tune Polyspace Parameters" on page 8-53

"Subdivide Code" on page 8-54

"Reduce Procedure Complexity" on page 8-64

"Reduce Task Complexity" on page 8-66

"Reduce Variable Complexity" on page 8-66

"Choose Lower Precision" on page 8-67

Factors Impacting 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 impact 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`).

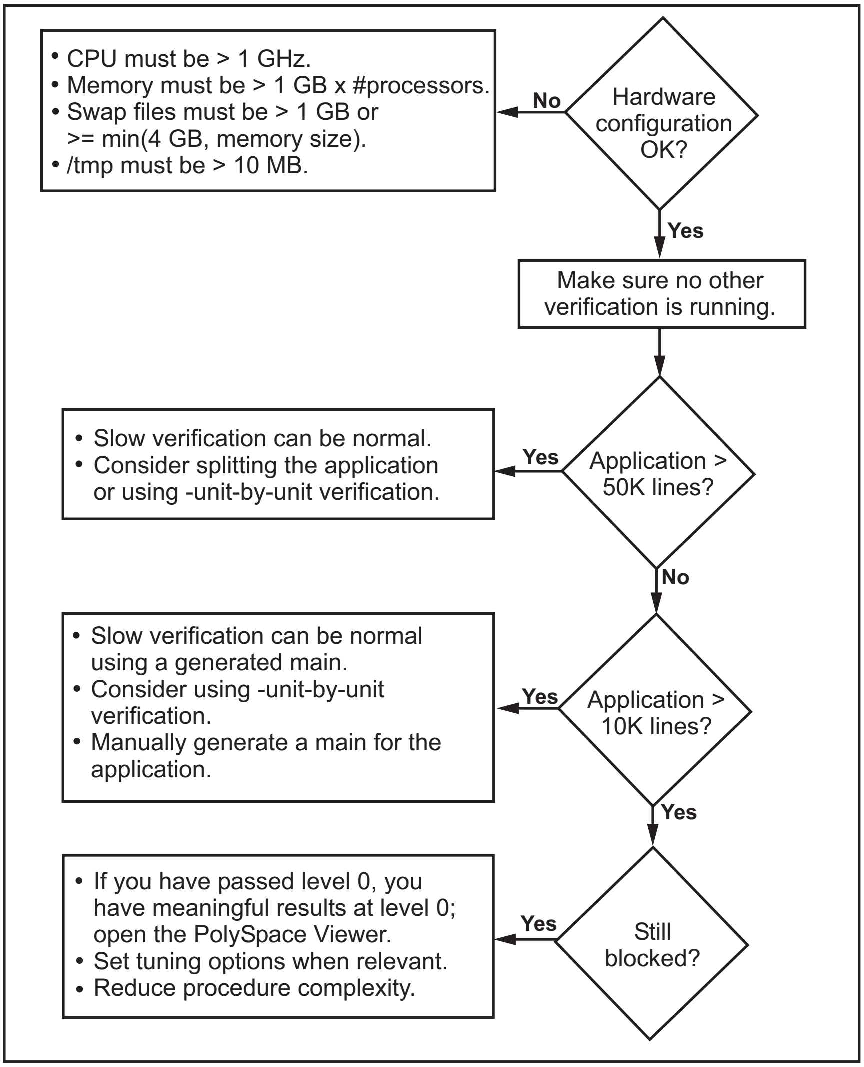
You can use several techniques to reduce the amount of time required for a verification, including

- "Disk Defragmentation and Antivirus Software" on page 8-71
- "Tune Polyspace Parameters" on page 8-53
- "Subdivide Code" on page 8-54
- "Reduce Procedure Complexity" on page 8-64
- "Reduce Task Complexity" on page 8-66
- "Reduce Variable Complexity" on page 8-66
- "Choose Lower Precision" on page 8-67

You can combine these techniques. See the following performance-tuning flow charts:

- "Standard Scaling Options Flow Chart" on page 8-52
- "Reduce Code Complexity" on page 8-53

Standard Scaling Options Flow Chart



Hardware configuration OK?
No
• CPU must be > 1 GHz.
• Memory must be > 1 GB x #processors.
• Swap files must be > 1 GB or >= min(4 GB, memory size).
• /tmp must be > 10 MB.
Yes
Make sure no other verification is running.
Application > 50K lines?
Yes
• Slow verification can be normal.
• Consider splitting the application or using -unit-by-unit verification.
No
Application > 10K lines?
Yes
• Slow verification can be normal using a generated main.
• Consider using -unit-by-unit verification.
• Manually generate a main for the application.
Yes
Still blocked?
Yes
• If you have passed level 0, you have meaningful results at level 0; open the PolySpace Viewer.
• Set tuning options when relevant.
• Reduce procedure complexity.

Reduce Code Complexity

To reduce code complexity, try the following techniques, in the order listed:

- "Reduce Procedure Complexity" on page 8-64
- "Reduce Task Complexity" on page 8-66
- "Reduce Variable Complexity" on page 8-66

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 8-54
- “Benefits of Subdividing Code” on page 8-54
- “Possible Issues with Subdividing Code” on page 8-55
- “Approach” on page 8-56
- “Select a Subset of Code” on page 8-58

An Ideal Application Size

People have used Polyspace software to analyze numerous applications with greater than 100,000 lines of code.

There always is a compromise 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 any thread affecting 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]
```

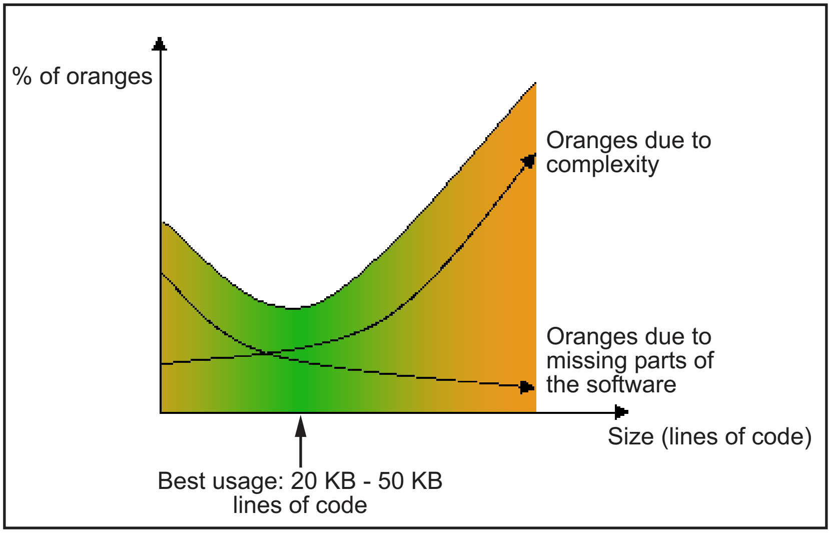
This phenomenon increases the number of orange warnings when the size of the program becomes large.

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 any assumption 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.

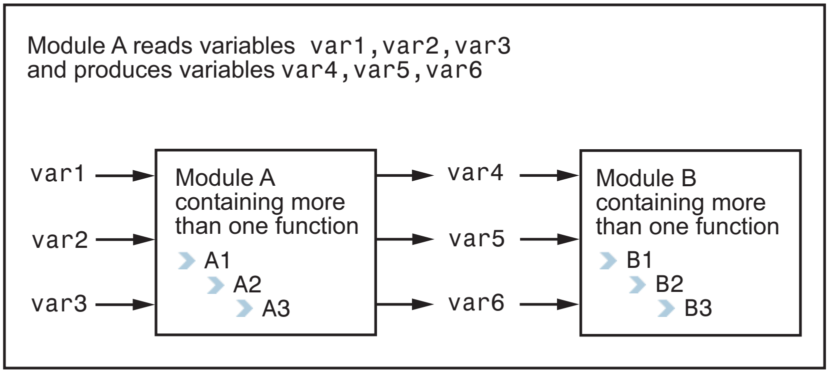
Because x is volatile, a probable consequence is that y contains all possible formatted data. You could remove the procedure complete_treatment_based_on_x completely, and let automatic stubbing work. The verification process considers y as potentially taking any value in the full range data (see “Stubbing” on page 6-2).

```
//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 answers, just like reality.
- **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 any application, in accordance with the logic of the data.
- The results remain valid, because there 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 answers, just like the code would at execution time.

- 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 red errors and bugs 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 all 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.

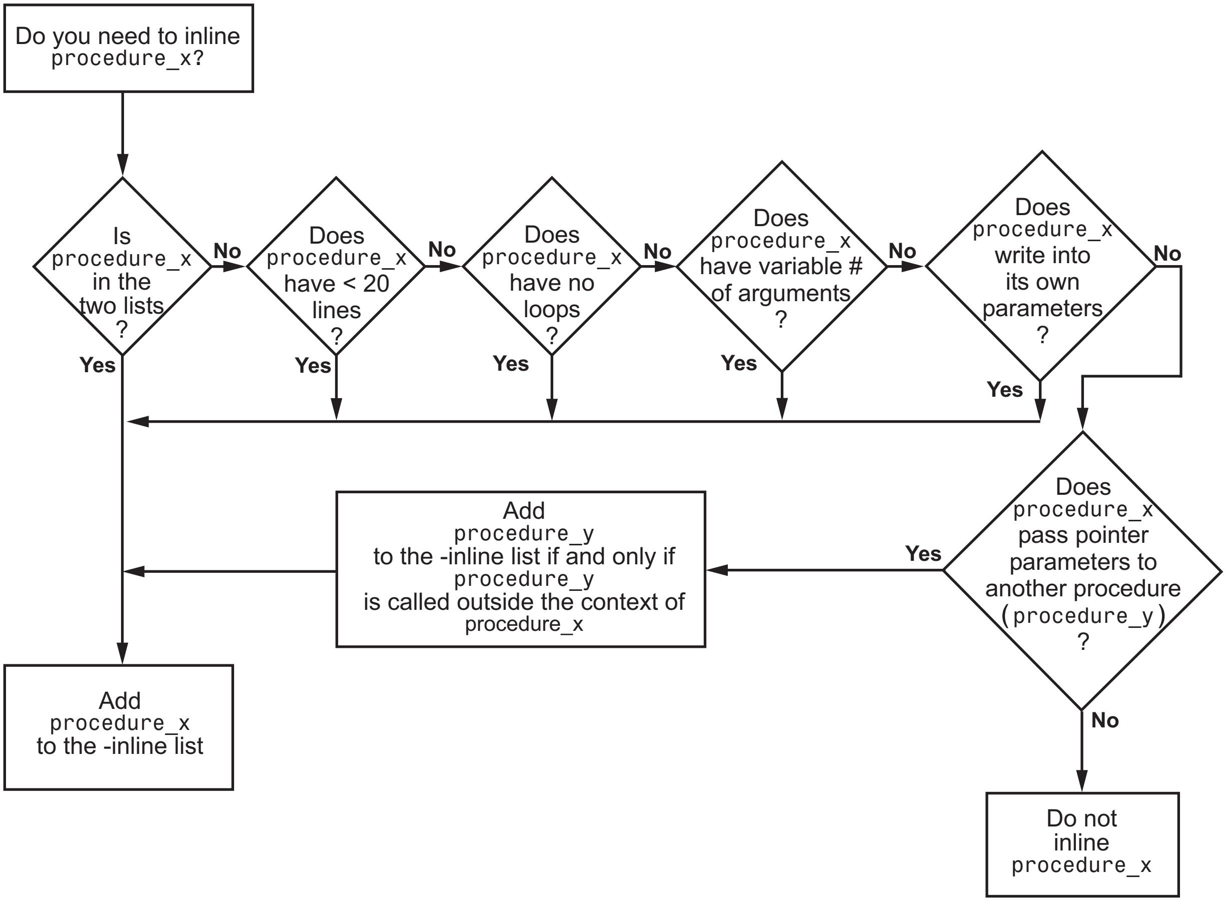
The `-inline` option creates clones of each specified procedure for each call to it. This option reduces the number of aliases in a procedure, and can improve precision in some situations.

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.


Do you need to inline procedure_x?
Is procedure_x in the two lists ?
No
Does procedure_x have < 20 lines ?
No
Does procedure_x have no loops ?
No
Does procedure_x have variable # of arguments ?
No
Does procedure_x write into its own parameters ?
No
Yes
Yes
Yes
Yes
Yes
Add procedure_y to the -inline list if and only if procedure_y is called outside the context of procedure_x
Yes
Does procedure_x pass pointer parameters to another procedure (procedure_y) ?
No
Add procedure_x to the -inline list
Do not inline procedure_x

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.

Does this procedure pass pointer parameters?		
Yes	**No**	**No**

`void procedure_x(int *p)`
`{`
` procedure_y(p)`
`}`
	`void procedure_x(int q)`	`void procedure_x(int *r)`
		`{`
		` *r = 12`
		`}`

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.

Obtain Configuration Information

The `polyspace-ver` command allows you to gather information quickly about your system configuration. Use this information when entering support requests.

Configuration information includes:

- Hardware configuration
- Operating system
- Polyspace and MATLAB licenses
- Specific version numbers for Polyspace products
- Any installed Bug Report patches

To obtain your configuration information, run the following command:

- Linux — *`MATLAB_Install`*`/polyspace/bin/polyspace-ver`
- Windows — *`MATLAB_Install`*`\polyspace\bin\polyspace-ver`

Note You can also obtain configuration information by selecting **Help > About** on the Polyspace Code Prover toolbar.

Remove Preliminary Results Files

By default, the software automatically deletes preliminary results files when they are no longer required by the verification. However, if you run a client verification using the option `-keep-all-files`, preliminary results files are retained in the results folder. This allows you to restart the verification from any stage, but can leave unnecessary files in your results folder.

If you later decide that you no longer need these files, you can remove them.

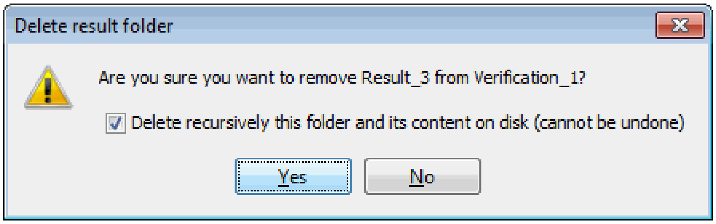
To remove preliminary results files,

1 Open the project containing the results you want to delete in the Project Manager.

2 Select the results you want to delete.

3 Press the **Delete** key on your keyboard.

The Delete Results folder dialog box opens.



Delete result folder

Are you sure you want to remove Result_3 from Verification_1?

☑ Delete recursively this folder and its content on disk (cannot be undone)

4 If you want to delete the entire results folder, select **Delete recursively this folder**, otherwise clear the check-box.

5 Click **Yes**.

The results files are deleted.

Storage of Temporary Files

If you specify the option `-tmp-dir-in-results-dir`, Polyspace does not use the standard `/tmp` or `C:\Temp` folder to store temporary files. Instead, Polyspace uses a subfolder of the results folder. This action 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 **Configuration > Advanced Settings > Other** field.

Disk Defragmentation and Antivirus Software

If a disk defragmentation tool or antivirus software runs on the machine on which your client or server verification is running, the verification might fail, generating an error message like the following:

```
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.          ---
---                                                                    ---
---------------------------------------------------------------------------
```

For your machine, you must do the following:

- Stop the disk defragmentation tool.
- Deactivate the antivirus software, or configure exception rules for the antivirus software that allow Polyspace to run without failure.

If the verification does not fail, the checking of temporary verification files by antivirus software can reduce the speed of your verification. To avoid this reduction of verification speed, you should configure the antivirus software to exclude your Polyspace Code Prover temporary file folder (`C:\Temp`) from the checking process.

Out of Memory Errors During Report Generation

During generation of very large reports, the software might produce errors that indicate insufficient memory. For example:

```
....
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
```

To increase the Java® heap size, modify the `-Mx` option in the *MATLAB_Install*\polyspace\bin\architecture\java.opts file. By default, the heap size is set to 512 MB. For 32-bit machines, you can increase this to 1 GB. For 64-bit machines, you can specify a higher value, for example, 2 GB.

Reviewing Verification Results

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- "Download Remote Verification Results From Command Line" on page 9-4
- "Open Unit-by-Unit Verification Results" on page 9-5
- "Open Local Verification Results" on page 9-6
- "Search Results in Results Manager" on page 9-7
- "Set Character Encoding Preferences" on page 9-11
- "Open Results for Generated Code" on page 9-14
- "Review Checks Progressively" on page 9-15
- "Review and Comment Checks" on page 9-17
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- "Gray Checks" on page 9-97
- "Orange Checks" on page 9-99
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- "Polyspace Report Generator Overview" on page 9-122
- "Generate Verification Reports" on page 9-124
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- "Automatically Generate Verification Reports" on page 9-128
- "Customize Verification Reports" on page 9-129
- "Open Verification Report" on page 9-134

Open Remote Verification Results

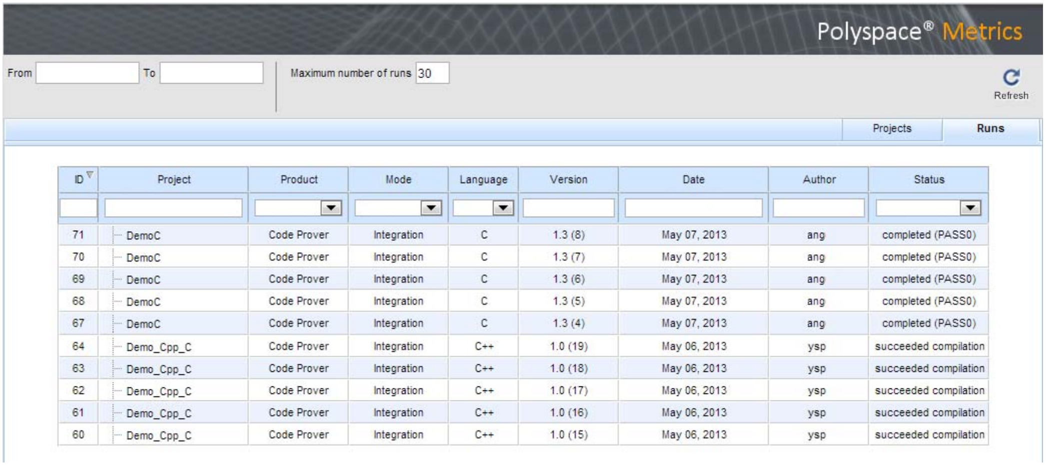
Use Polyspace Metrics to open results from a remote verification.

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.



Maximum number of runs 30

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

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:

- “Configure Server for Remote Verification and Polyspace Metrics”
- “Exploring Results Manager Perspective” on page 9-61

Download Remote Verification Results From Command Line

To download verification results from the command line, use the `polyspace-jobs-manager` command:

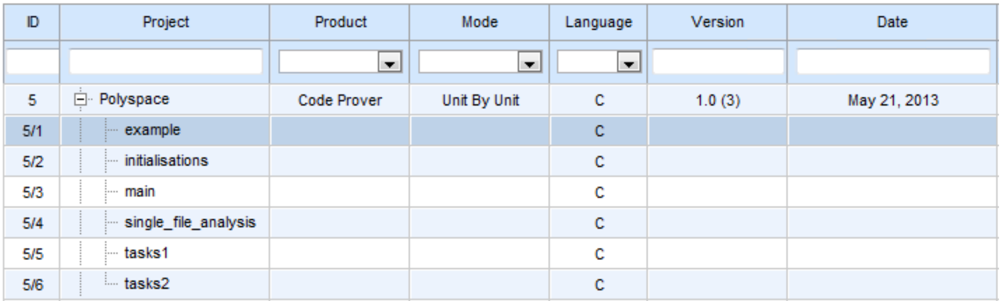
```
MATLAB_Install\polyspace\bin\polyspace-jobs-manager -download
-job Verification_ID -results-folder FolderPath
```

For more information, see "Manage Remote Verifications from the Command Line" on page 7-19.

After downloading results, use the Results Manager to view the results. See "Open Local Verification Results" on page 9-6.

Open Unit-by-Unit Verification Results

If you run a unit-by-unit 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		

To download and open all results for the project:

1. In the parent row, click the **Project** or **Version** cell.
2. Select the **Download all results sets** check box. Then click **OK**.

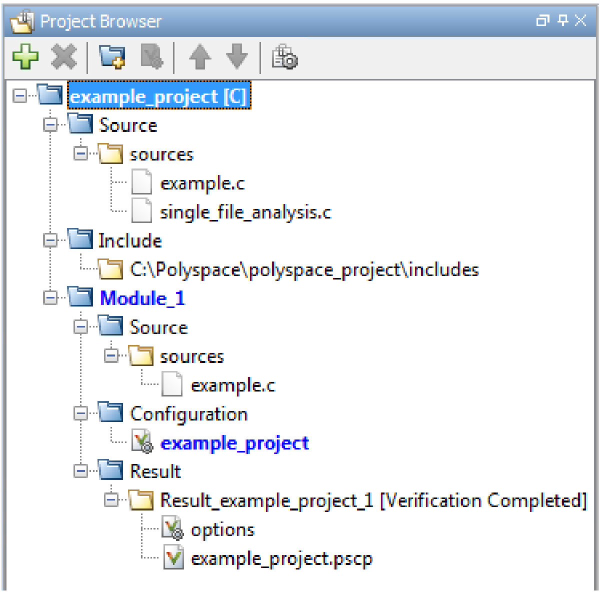
To download and open results for a specific, in the **Project** cell, expand the parent node. Then double-click the required file verification.

Alternatively:

1. In the parent row, click the **Project** or **Version** cell.
2. 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 Local Verification Results

1 From the Project Manager perspective, in the Project Browser, navigate to the results that you want to review.



2 Double-click the results file, for example, `example_project.pscp`.

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:

```
polyspace_project\Module_1\Result_example_project_1
```

3 Select the results file, for example, `example_project.pscp`.

4 Click **Open**.

Search Results in Results Manager

This example shows how to search for all occurrences of a variable or function name in the Results Manager perspective. 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.

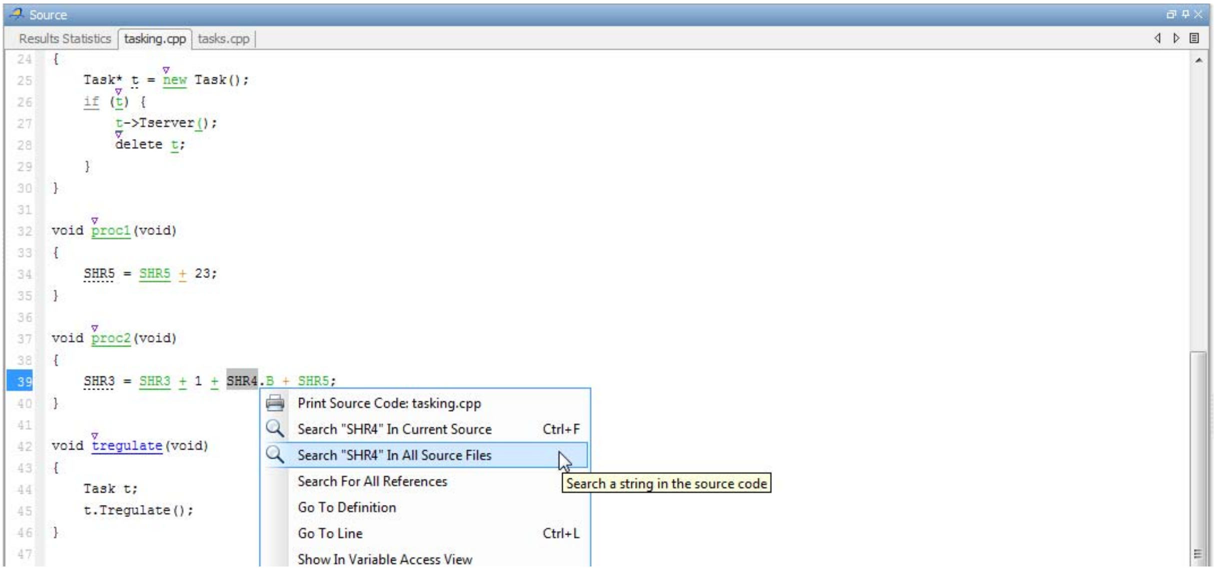
  Selecting a check in the **Results Summary** pane displays the read/write operation only. On the **Source** pane, you can look in the source code for prior instructions containing the variable name. Instead, searching for the occurrences is an easier way to find and quickly navigate to them.

  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.

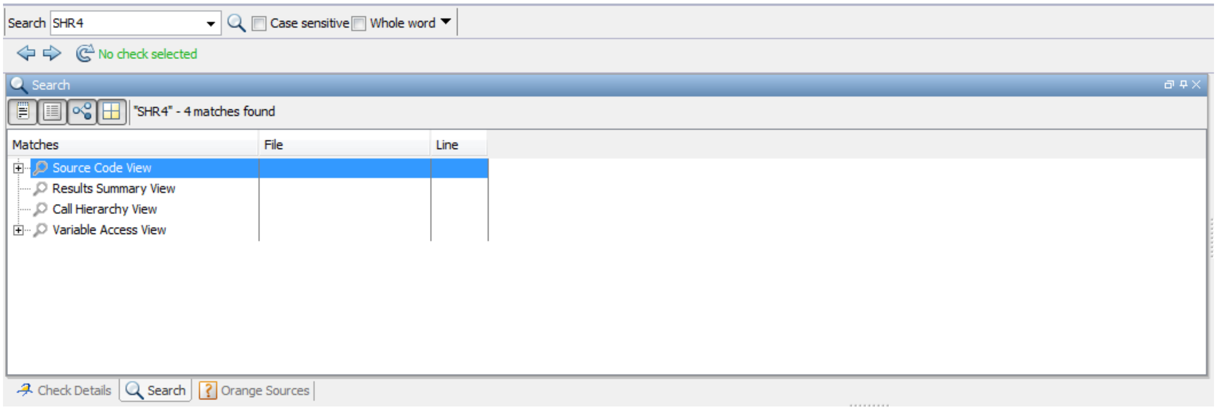
Search Variable Name

1 Enter the variable name in the Search box in the Results Manager perspective toolbar. Alternatively, on the **Source** pane, right-click the variable name and select **Search "*`variable_name`*" In All Source Files**.


Source
Results Statistics
tasking.cpp
tasks.cpp
Print Source Code: tasking.cpp
Search "SHR4" In Current Source Ctrl+F
Search "SHR4" In All Source Files
Search For All References
Go To Definition
Go To Line Ctrl+L
Show In Variable Access View
Search a string in the source code

```
{
    Task* t = new Task();
    if (t) {
        t->Tserver();
        delete t;
    }
}

void proc1(void)
{
    SHR5 = SHR5 + 23;
}

void proc2(void)
{
    SHR3 = SHR3 + 1 + SHR4.B + SHR5;
}

void tregulate(void)
{
    Task t;
    t.Tregulate();
}
```

The **Search** tab displays all occurrences of the variable name under four categories.



"SHR4" - 4 matches found

Matches	File	Line
Source Code View		
Results Summary View		
Call Hierarchy View		
Variable Access View		

2 To see all occurrences of the variable name in the source code, expand the node **Source Code View**.

This node lists each occurrence of the variable name along with the file name and the line number. Use the file name and line number to identify all occurrences of the variable name before a check occurs.

3 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.

4 If the variable is a global variable, to navigate to its declaration quickly, expand the node **Variable Access View**. Select the only search result under this node.

Search Function Name

1 Enter the function name in the Search box in the Results Manager perspective toolbar. Alternatively, on the **Source** pane, right-click the function name and select **Search "*`function_name`*" In All Source Files**.

   The **Search** tab displays all occurrences of the function name under four categories.

2 To see all occurrences of the function name in the source code, expand the node **Source Code View**.

   This node lists each occurrence of the function name along with the file name and the line number.

3 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.

4 To navigate to the function definition quickly:

   a On the **Results Summary** pane, select `Checks by File/Function` from the drop-down list.

      The **Results Summary** pane displays all file names in alphabetical order. Under each file name, the pane displays the function names in alphabetical order.

   b Select the name of the function.

The **Source** pane displays the function definition.

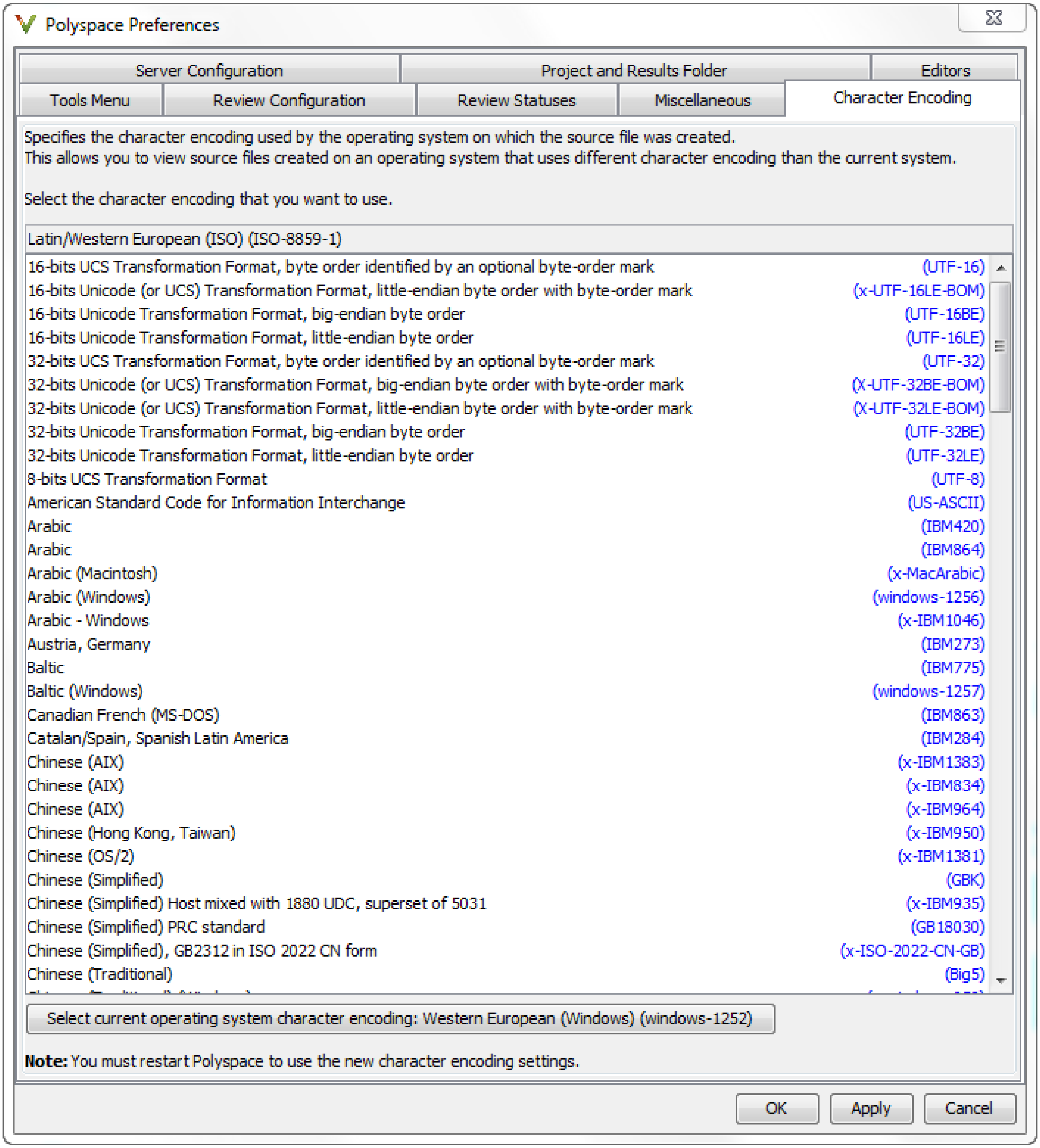
Set Character Encoding Preferences

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 **Options > Preferences**.
2. In the **Polyspace Preferences** dialog box, select the **Character encoding** tab.



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.

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 **Review > 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`.

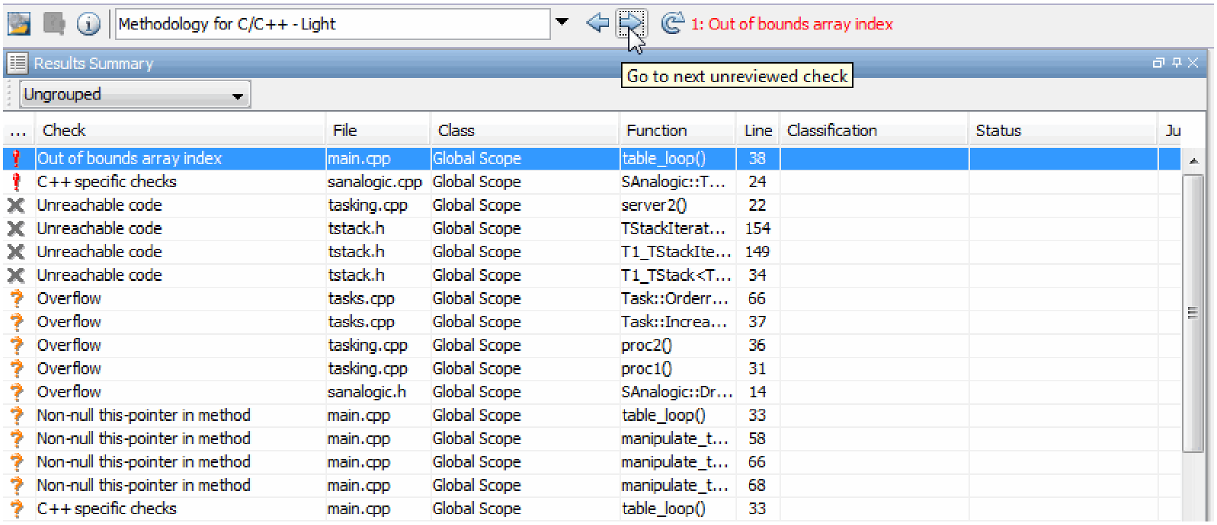
For example:

```
RTWEmbeddedCoder
MATLABROOT=C:\MATLAB\R2010b
ModelVersion=demo_ml:1.94
```

Review Checks Progressively

This example shows how to review checks progressively using the Results Manager perspective.

1 Select the **Results Summary** view.



Methodology for C/C++ - Light
1: Out of bounds array index
Results Summary
Go to next unreviewed check
Ungrouped

...	Check	File	Class	Function	Line	Classification	Status	Ju
!	Out of bounds array index	main.cpp	Global Scope	table_loop()	38			
!	C++ specific checks	sanalogic.cpp	Global Scope	SAnalogic::T...	24			
✗	Unreachable code	tasking.cpp	Global Scope	server2()	22			
✗	Unreachable code	tstack.h	Global Scope	TStackIterat...	154			
✗	Unreachable code	tstack.h	Global Scope	T1_TStackIte...	149			
✗	Unreachable code	tstack.h	Global Scope	T1_TStack<T...	34			
?	Overflow	tasks.cpp	Global Scope	Task::Orderr...	66			
?	Overflow	tasks.cpp	Global Scope	Task::Increa...	37			
?	Overflow	tasking.cpp	Global Scope	proc2()	36			
?	Overflow	tasking.cpp	Global Scope	proc1()	31			
?	Overflow	sanalogic.h	Global Scope	SAnalogic::Dr...	14			
?	Non-null this-pointer in method	main.cpp	Global Scope	table_loop()	33			
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	58			
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	66			
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	68			
?	C++ specific checks	main.cpp	Global Scope	table_loop()	33			

2 Click the forward arrow ⇨ to go to the first check in the set:

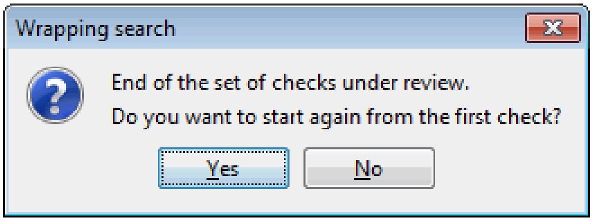
- The **Source** pane displays the source code for this check.
- The **Check Details** pane displays information about this check.

3 Review the current check.

After you review a check, you can classify the check and enter comments to describe the results of your review. You can also mark the check as Justified to help track your review progress.

4 Continue to click the forward arrow until you have gone through all of the checks.

After the last check, a dialog box opens asking if you want to start again from the first check.



Wrapping search

End of the set of checks under review.

Do you want to start again from the first check?

5 Click **No**.

Note If you want to navigate through justified checks, use the justified check forward arrow ▶ and back arrow ◀.

Related Examples

- "Review and Comment Checks" on page 9-17
- "Track Review Progress" on page 9-22
- "Display Call Sequence for a Check" on page 9-41

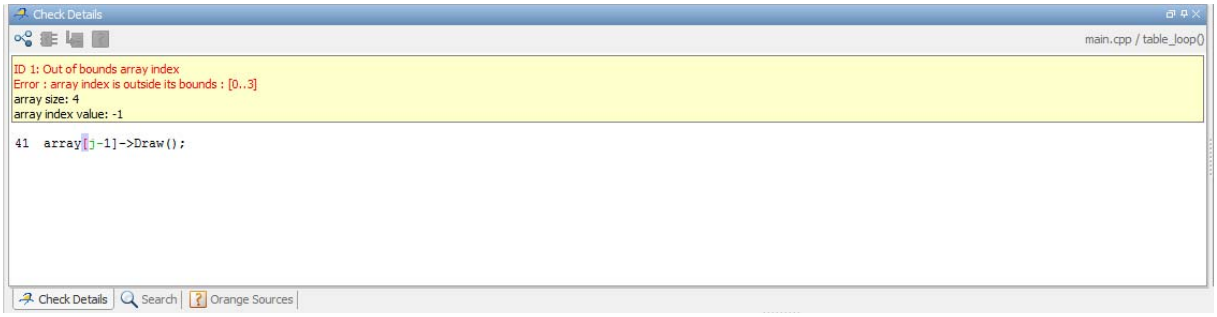
Review and Comment Checks

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 and Comment Individual Check

1 On the **Results Summary** pane, select the check that you want to review.

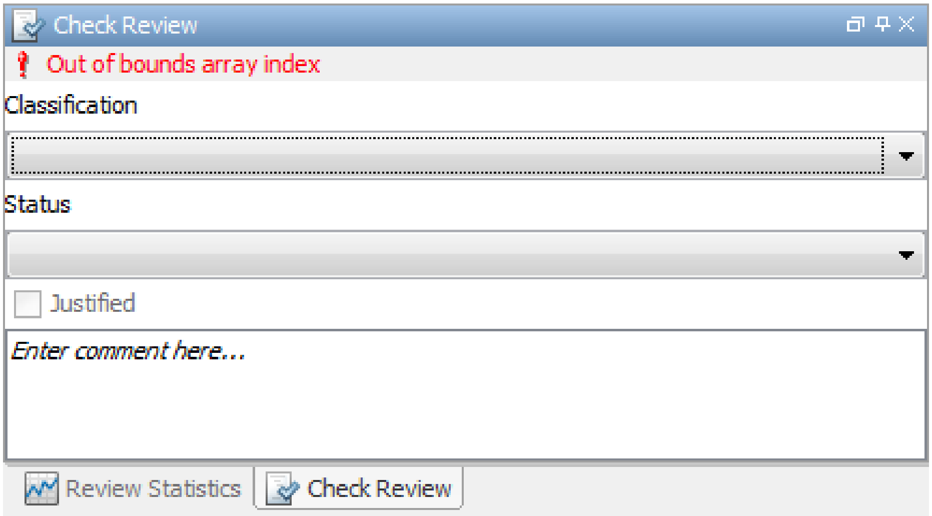
The **Check Details** pane displays information about the current check.



ID 1: Out of bounds array index
Error : array index is outside its bounds : [0..3]
array size: 4
array index value: -1

```
array[j-1]->Draw();
```

The **Check Review** tab displays fields where you can enter review information.



Out of bounds array index

Classification

Status

□ Justified

Enter comment here...

2 Select a **Classification** to describe the severity of the issue:

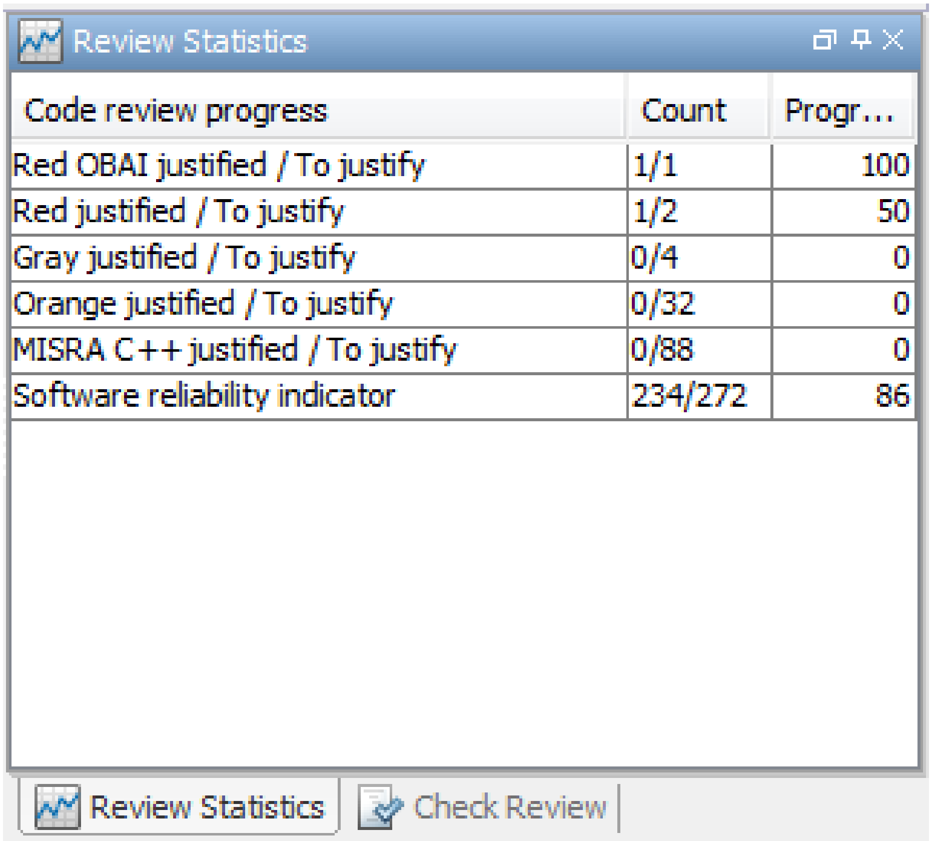
- `Unset`
- `High`
- `Medium`
- `Low`
- `Not a defect`

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`.

On the **Review Statistics** pane, the software updates the ratios of errors justified to total errors.



Code review progress	Count	Progr...
Red OBAI justified / To justify	1/1	100
Red justified / To justify	1/2	50
Gray justified / To justify	0/4	0
Orange justified / To justify	0/32	0
MISRA C++ justified / To justify	0/88	0
Software reliability indicator	234/272	86

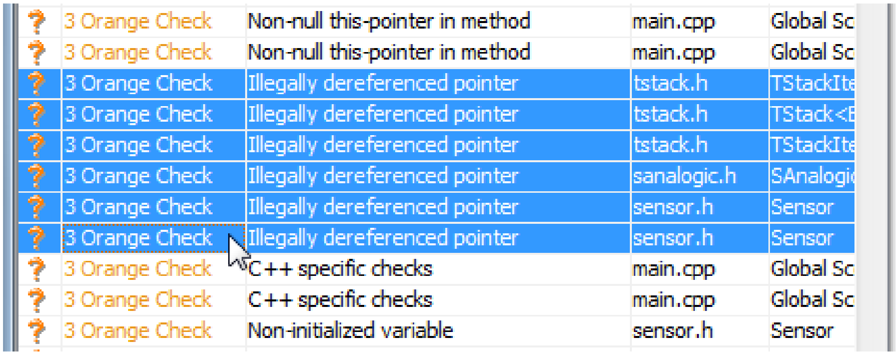
5 In the **Comment** field, enter remarks, for example, defect or justification information.

Note You can also enter the review information through the **Classification**, **Status**, and **Comment** fields on the **Results Summary** pane.

Review and Comment Group of Checks

1 On the **Results Summary** pane, select a group of checks using one of the following methods:

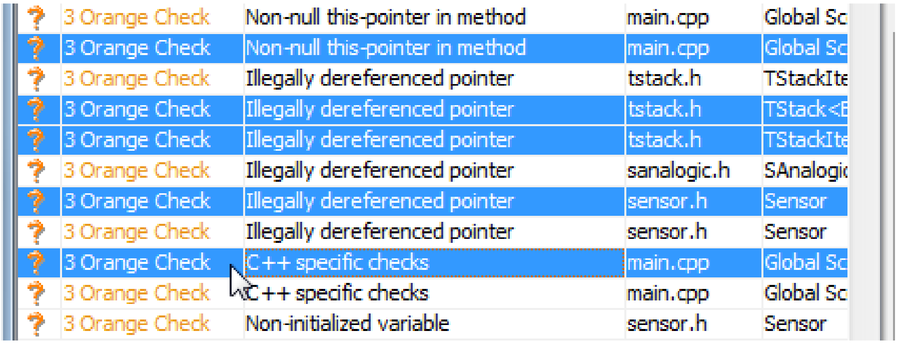
- For contiguous checks, left-click the first check. Then **Shift**-left click the last check.



?	3 Orange Check	Non-null this-pointer in method	main.cpp	Global Sc
?	3 Orange Check	Non-null this-pointer in method	main.cpp	Global Sc
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStackIte
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStack<E
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStackIte
?	3 Orange Check	Illegally dereferenced pointer	sanalogic.h	SAnalogic
?	3 Orange Check	Illegally dereferenced pointer	sensor.h	Sensor
?	3 Orange Check	Illegally dereferenced pointer	sensor.h	Sensor
?	3 Orange Check	C++ specific checks	main.cpp	Global Sc
?	3 Orange Check	C++ specific checks	main.cpp	Global Sc
?	3 Orange Check	Non-initialized variable	sensor.h	Sensor

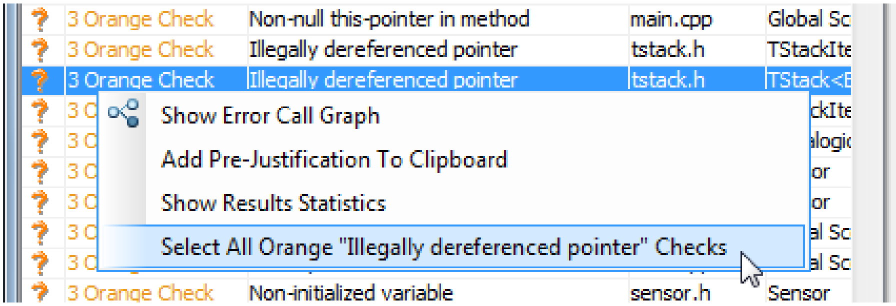
To group together all checks belonging to a certain category, click the **Check** column header on the **Results Summary** pane.

- For non-contiguous checks, **Ctrl**-left click each check.



?	3 Orange Check	Non-null this-pointer in method	main.cpp	Global Sc
?	3 Orange Check	Non-null this-pointer in method	main.cpp	Global Sc
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStackIte
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStack<E
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStackIte
?	3 Orange Check	Illegally dereferenced pointer	sanalogic.h	SAnalogic
?	3 Orange Check	Illegally dereferenced pointer	sensor.h	Sensor
?	3 Orange Check	Illegally dereferenced pointer	sensor.h	Sensor
?	3 Orange Check	C++ specific checks	main.cpp	Global Sc
?	3 Orange Check	C++ specific checks	main.cpp	Global Sc
?	3 Orange Check	Non-initialized variable	sensor.h	Sensor

- For all checks of a similar color and category, right-click one check. From the context menu, select **Select All *`Color Type`*Checks**, for instance, **Select All Orange "Illegally dereferenced pointer" Checks**.



?	3 Orange Check	Non-null this-pointer in method	main.cpp	Global Sc
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStackIte
?	3 Orange Check	Illegally dereferenced pointer	tstack.h	TStack<E
?	3 C			ckIte
?	3 C			alogic
?	3 C			or
?	3 C			or
?	3 C			al Sc
?	3 C			al Sc
?	3 Orange Check	Non-initialized variable	sensor.h	Sensor

Show Error Call Graph
Add Pre-Justification To Clipboard
Show Results Statistics
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.

Related Examples

- "Organize Check Review Using Filters and Groups" on page 9-33
- "Customize Review Status" on page 9-49

Track Review Progress

This example shows how to track review progress using the **Review Statistics** pane.

1 To see how many checks of a certain type you have reviewed, select a check of that type on the **Results Summary** pane.

   The **Count** column on the **Review Statistics** pane displays the number of unreviewed checks as a ratio of total number of checks. The first row on the **Review Statistics** pane displays the ratio for checks of the same color and type as the selected check.

2 To see how many checks of a certain color you have reviewed, select any check on the **Results Summary** pane.

   The **Count** column on the **Review Statistics** pane displays the ratio of unreviewed checks to total number of checks for all check colors.

   The **Progress (%)** column displays the same ratio as a percentage.

   For more information, see "Review Statistics" on page 9-81.

What Are Review Methodologies?

To facilitate your review of verification results, with Polyspace Code Prover, you can specify the number and type of checks displayed in the **Results Summary** pane of the Results Manager perspective. These specifications are known as review methodologies.

By choosing a methodology, you can review a subset of checks. Polyspace Code Prover provides four predefined review methodologies.

Select the predefined review methodologies in the following order to incrementally view the checks displayed. For more information, see “Review Checks Using Predefined Methodologies” on page 9-25. For information on the check colors, see “Understanding Polyspace Results” on page 9-94.

1. **First checks to review** — The software displays all red and gray checks. It also displays a few orange checks that are most likely to be run-time errors. For more information, see “Orange Check Identified as Potential Errors” on page 9-99. When reviewing code for the first time, choose this methodology.

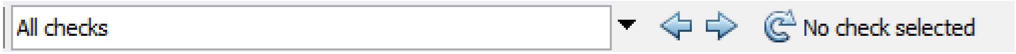
2. **Methodology for C/C++ > Light** — The software displays all red, gray, and purple checks. The software also displays a subset of orange checks based on specifications in **Polyspace Preferences > Review Configuration**.

3. **Methodology for C/C++ > Moderate** — The software displays all red, gray, and purple checks. The software also displays a larger subset of orange checks based on specifications in **Polyspace Preferences > Review Configuration**.

4. **All** — The software displays all red, gray, purple, green, and orange checks. When you want to carry out an exhaustive review of your verification results, use this methodology.

You can also define review methodologies customized to your priorities. For more information, see “Review Checks Using Custom Methodologies” on page 9-29.

In the Results Manager perspective, the following toolbar provides controls related to review methodologies.



The controls include:

- A menu for selecting the review methodology.
- Arrows for navigating through checks.

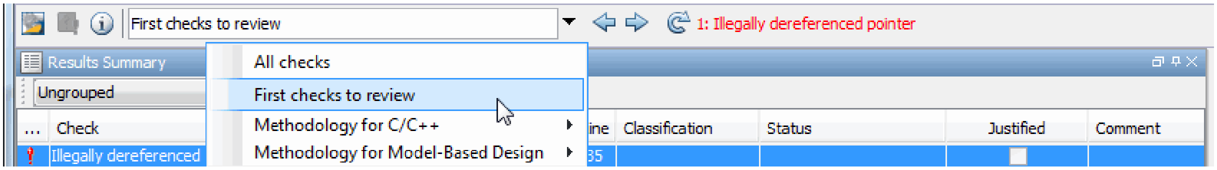
Review Checks Using Predefined Methodologies

This example shows how to incrementally view the checks using predefined review methodologies provided by Polyspace Code Prover.

Review methodologies specify the number and type of checks displayed in the **Results Summary** pane.

Review Checks Incrementally

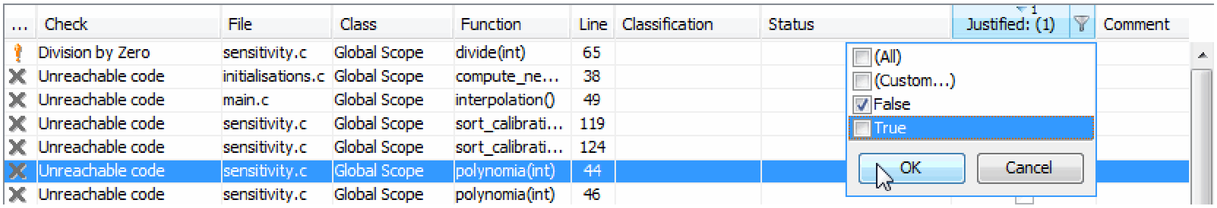
1. In the Results manager perspective, from the drop-down list above the **Results Summary** pane, select the methodology, **First checks to review**.



   The **Results Summary** pane displays all red and gray checks, as well as orange checks most likely to be run-time errors. Investigate and fix the errors. Assign a **Status** and **Classification** to the checks. To mark a check as justified, select the status `Justify with annotation` or `No action planned`. You can also create custom statuses or add justification to existing statuses.

2. Once all the checks have been justified, select the methodology, **Methodology for C/C++ > Light**.

   In the **Results Summary** pane, you can view all red, gray, and purple checks, as well as a subset of orange checks. To filter the unjustified checks, from the drop-down list beside the **Justified** column header, clear all boxes except **False** and select **OK**.



...	Check	File	Class	Function	Line	Classification	Status	Justified: (1)	Comment
!	Division by Zero	sensitivity.c	Global Scope	divide(int)	65				
✕	Unreachable code	initialisations.c	Global Scope	compute_ne...	38				
✕	Unreachable code	main.c	Global Scope	interpolation()	49				
✕	Unreachable code	sensitivity.c	Global Scope	sort_calibrati...	119				
✕	Unreachable code	sensitivity.c	Global Scope	sort_calibrati...	124				
✕	Unreachable code	sensitivity.c	Global Scope	polynomia(int)	44				
✕	Unreachable code	sensitivity.c	Global Scope	polynomia(int)	46				

Investigate and fix the errors. Assign a **Status** and **Classification** to the checks.

3 Once all the checks have been justified, to see a larger subset of orange checks, select **Methodology for C/C++ > Moderate**. The number of orange checks in the **Results Summary** pane increases.

To refresh the list to show unjustified checks only, reopen the drop-down list beside the **Justified** column header and select **OK**.

Investigate and fix the errors. Assign a **Status** and **Classification** to the remaining checks.

4 To exhaustively review all of the checks, select **All checks**. In addition to all orange checks, this methodology also reveals all the green checks in the **Results Summary** pane.

View Light and Moderate Methodology Requirements

You can view the requirements of the methodologies, **Methodology for C/C++ > Light** and **Methodology for C/C++ > Moderate** through the Polyspace Preferences dialog box.

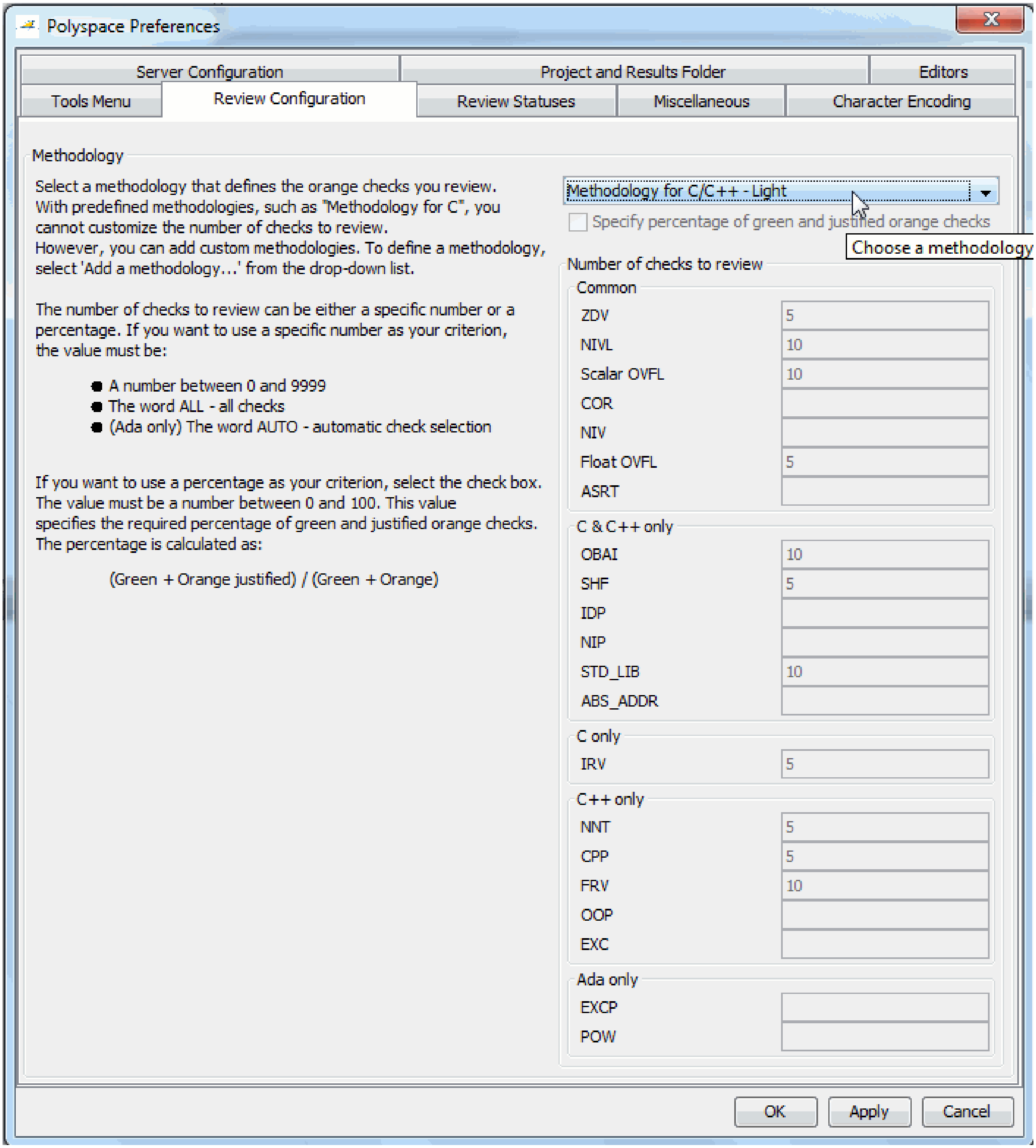
Note You cannot change the parameters specified in any of the predefined methodologies. However, you can create your own custom methodologies.

1 In the Polyspace verification environment, select **Options > Preferences**.

2 In the Polyspace Preferences dialog box, select the **Review configuration** tab.

3 From the drop-down list on this tab, select `Methodology for C/C++-Light`.

The table shows the number of orange checks of each type you review when you select this methodology in the Results Manager perspective.



Methodology

Select a methodology that defines the orange checks you review. With predefined methodologies, such as "Methodology for C", you cannot customize the number of checks to review. However, you can add custom methodologies. To define a methodology, select 'Add a methodology...' from the drop-down list.

The number of checks to review can be either a specific number or a percentage. If you want to use a specific number as your criterion, the value must be:

- A number between 0 and 9999
- The word ALL - all checks
- (Ada only) The word AUTO - automatic check selection

If you want to use a percentage as your criterion, select the check box. The value must be a number between 0 and 100. This value specifies the required percentage of green and justified orange checks. The percentage is calculated as:

(Green + Orange justified) / (Green + Orange)

Methodology for C/C++ - Light

□ Specify percentage of green and justified orange checks

Choose a methodology

Number of checks to review

Common	
ZDV	5
NIVL	10
Scalar OVFL	10
COR	
NIV	
Float OVFL	5
ASRT	
C & C++ only	
OBAI	10
SHF	5
IDP	
NIP	
STD_LIB	10
ABS_ADDR	
C only	
IRV	5
C++ only	
NNT	5
CPP	5
FRV	10
OOP	
EXC	
Ada only	
EXCP	
POW	

For example, the table specifies that you review five orange ZDV checks when you select the methodology, `Methodology for C/C++-Light`. The number of checks of each type increases as you move from `Methodology for C/C++-Light` to `Methodology for C/C++-Moderate`.

Related Examples

- "Review and Comment Checks" on page 9-17
- "Review Checks Using Custom Methodologies" on page 9-29
- "Customize Review Status" on page 9-49

Concepts

- "What Are Review Methodologies?" on page 9-23

Review Checks Using Custom Methodologies

This example shows how to define and use a custom review methodology to specify the number and type of checks displayed in the **Results Summary** pane. Define a custom methodology to:

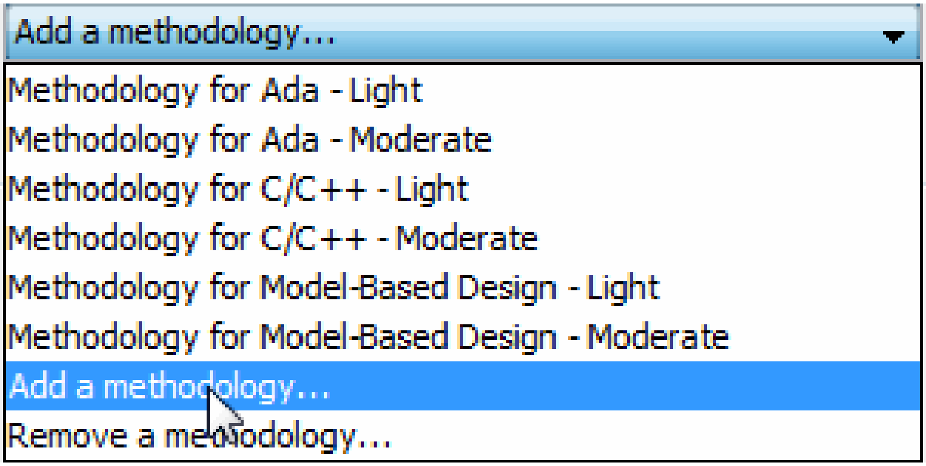
- Prioritize the checks that you review.
- Set standards that all developers of this software must meet.

Define a Custom Methodology

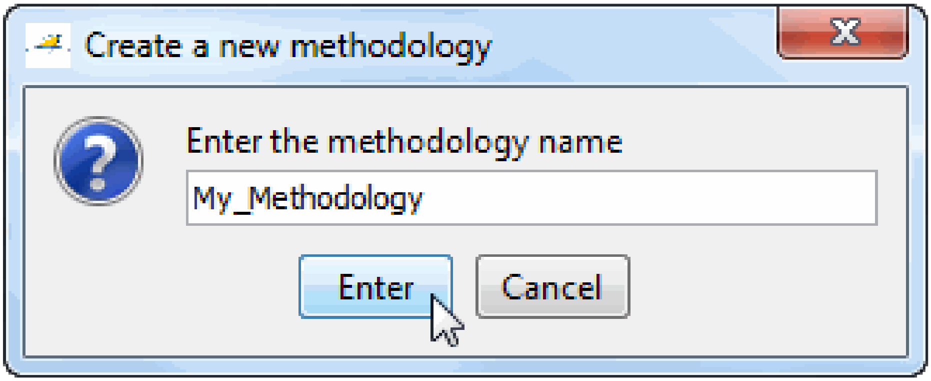
1 In the Polyspace verification environment, select **Options > Preferences**.

2 In the Polyspace Preferences dialog box, select the **Review configuration** tab.

3 From the drop-down list on this tab, select `Add a methodology....`


Add a methodology...
Methodology for Ada - Light
Methodology for Ada - Moderate
Methodology for C/C++ - Light
Methodology for C/C++ - Moderate
Methodology for Model-Based Design - Light
Methodology for Model-Based Design - Moderate
Add a methodology...
Remove a methodology...

4 Enter a name for your methodology in the Create a new methodology dialog box. For this example, enter the name, `My_Methodology`. Then, click **Enter**.



Create a new methodology

Enter the methodology name

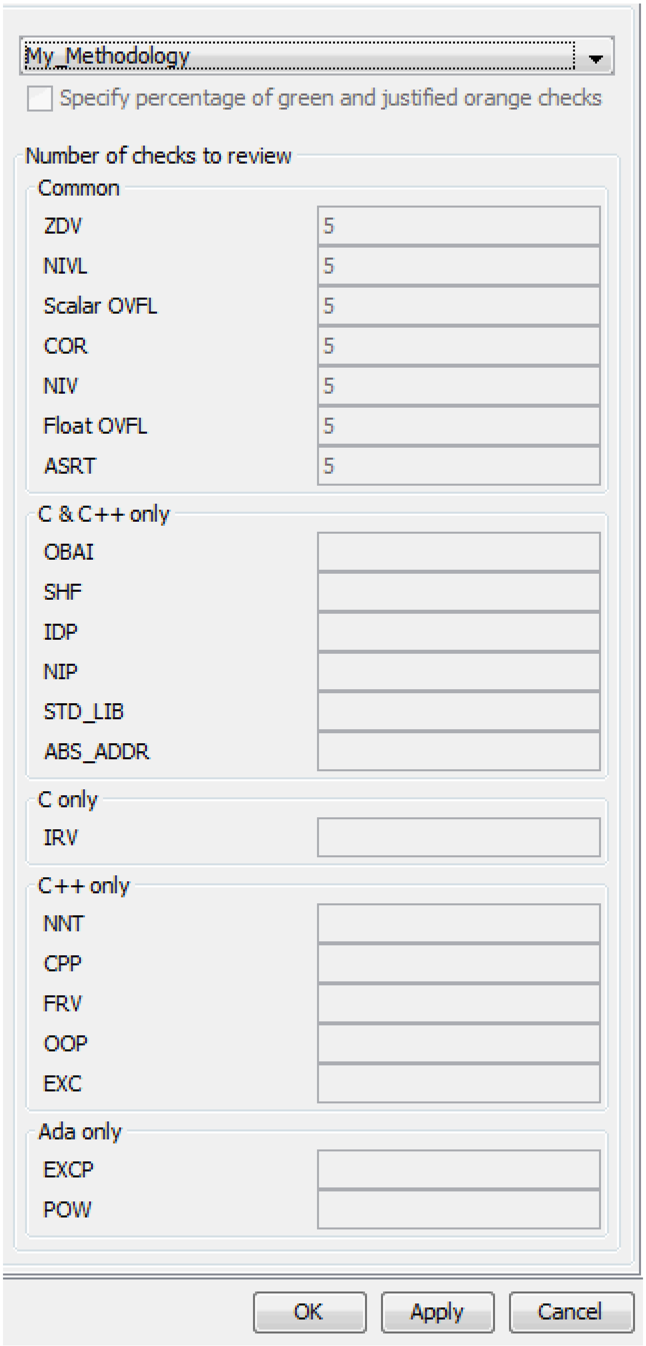
My_Methodology

5 If you want to review orange checks by percentage, select the **Specify percentage of green and justified orange checks** check box.

With custom methodologies, you can specify either a specific number of orange checks to review or a minimum percentage of orange checks that must be reviewed. 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 review for each type of check for your methodology.



My_Methodology

□ Specify percentage of green and justified orange checks

Number of checks to review

Common

ZDV	5
NIVL	5
Scalar OVFL	5
COR	5
NIV	5
Float OVFL	5
ASRT	5

C & C++ only

OBAI	
SHF	
IDP	
NIP	
STD_LIB	
ABS_ADDR	

C only

IRV	

C++ only

NNT	
CPP	
FRV	
OOP	
EXC	

Ada only

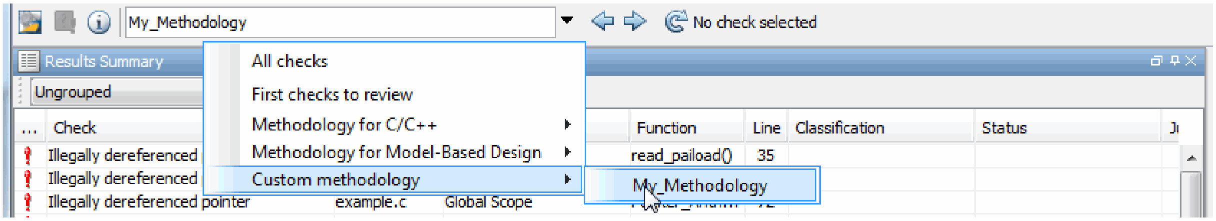
EXCP	
POW	

In this example, 5 was entered for ZDV indicating that 5 Division by Zero orange checks must be displayed when you choose **Custom methodology > My_Methodology** from the Results Manager perspective.

7 Click **OK** to save the methodology and close the dialog box.

Use Your Custom Methodology

In the Results manager perspective, from the drop-down list above the **Results Summary** pane, select the methodology, **Custom methodology > My_Methodology**.



The **Results Summary** pane displays orange checks according to the definition specified for **My_Methodology**. For instance, it displays 5 Division by Zero orange checks.

Related Examples

- "Review Checks Using Predefined Methodologies" on page 9-25

Concepts

- "What Are Review Methodologies?" on page 9-23

Organize Check Review 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 all 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 all these checks together can help you organize your review process.

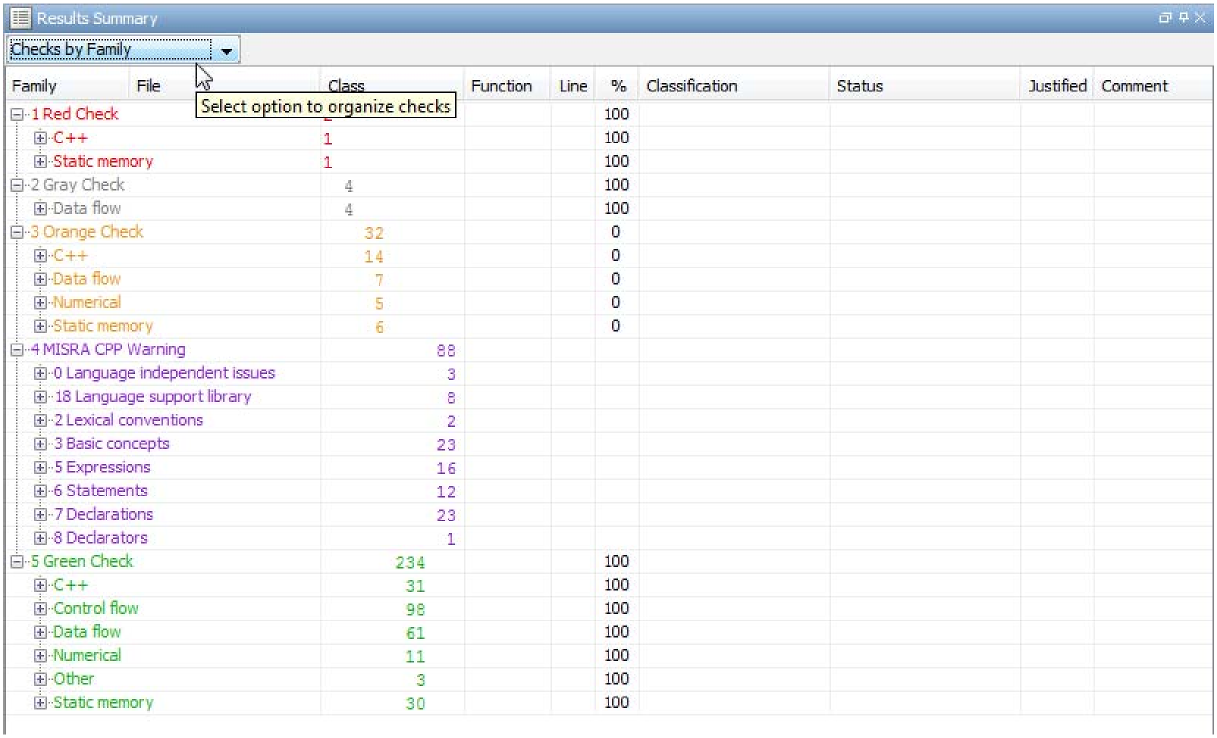
  You can also review all checks in a file if you have written the code for that file only and not the entire set of source files used for verification.
- Not review the checks in automatically generated functions.
- C++ only: Review all checks dealing with a class definition.

Review Checks in a Given Category

To review all checks resulting from `Out of bounds array index`:

1. Open the results file, with extension, `.pscp`.
2. On the **Results Summary** pane, from the drop-down list, select `Checks by Family`.

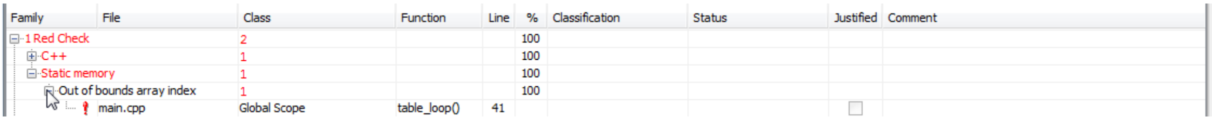
   The checks are grouped by type of check.



Family	File	Class	Function	Line	%	Classification	Status	Justified	Comment
1 Red Check		2			100				
C++		1			100				
Static memory		1			100				
2 Gray Check		4			100				
Data flow		4			100				
3 Orange Check		32			0				
C++		14			0				
Data flow		7			0				
Numerical		5			0				
Static memory		6			0				
4 MISRA CPP Warning		88							
0 Language independent issues		3							
18 Language support library		8							
2 Lexical conventions		2							
3 Basic concepts		23							
5 Expressions		16							
6 Statements		12							
7 Declarations		23							
8 Declarators		1							
5 Green Check		234			100				
C++		31			100				
Control flow		98			100				
Data flow		61			100				
Numerical		11			100				
Other		3			100				
Static memory		30			100				

3 Under the category **1 Red Check**, expand the subcategory **Static memory**.

You see the subcategory **Out of bounds array index**.



Family	File	Class	Function	Line	%	Classification	Status	Justified	Comment
1 Red Check		2			100				
C++		1			100				
Static memory		1			100				
Out of bounds array index		1			100				
	main.cpp	Global Scope	table_loop()	41				□	

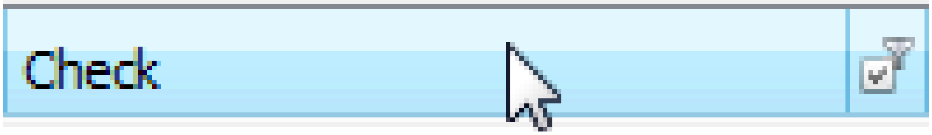
Expand **Out of bounds array index** to view all red checks resulting from this error.

To see further information about a check, select it. The information appears on the **Check Details** pane.

4 To view all orange checks resulting from this error, repeat step 3 for the subcategory **Static memory** under the category **3 Orange Check**.

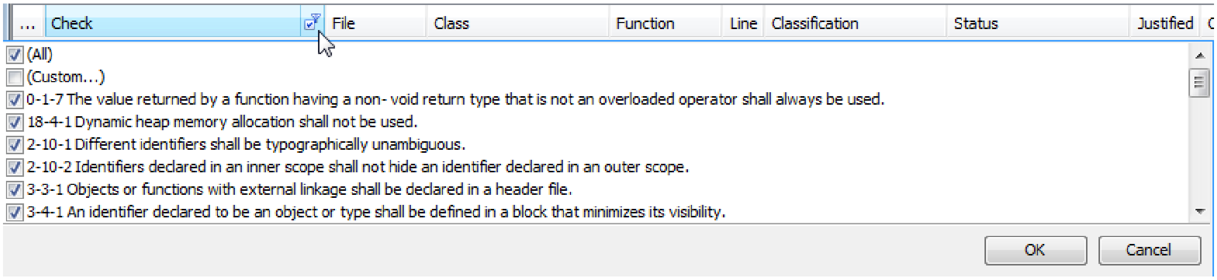
5 To view only the checks resulting from the error, `Out of bounds array index`, on the **Results Summary** pane, from the drop-down list, select `List of Checks`.

6 Place your cursor on the **Check** column head.



7 Click the filter icon.

A context menu lists all the filter options available.



☑ (All)
□ (Custom...)
☑ 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.
☑ 18-4-1 Dynamic heap memory allocation shall not be used.
☑ 2-10-1 Different identifiers shall be typographically unambiguous.
☑ 2-10-2 Identifiers declared in an inner scope shall not hide an identifier declared in an outer scope.
☑ 3-3-1 Objects or functions with external linkage shall be declared in a header file.
☑ 3-4-1 An identifier declared to be an object or type shall be defined in a block that minimizes its visibility.

8 Clear the **All** check box.

9 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

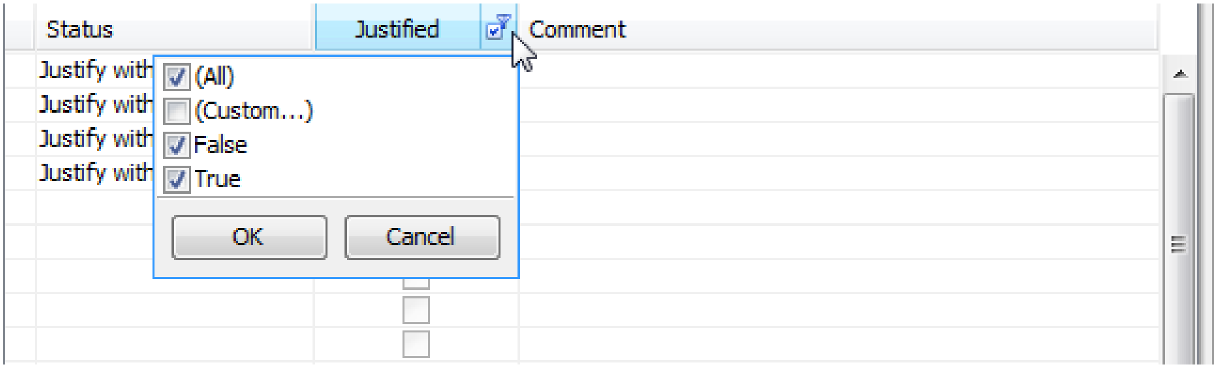
To review only the checks that you have not justified:

1 Open the results file, with extension, `.pscp`.

2 On the **Results Summary** pane, place your cursor on the **Justified** column head.

3 Click the filter icon.

A context menu lists all the filter options available.



4 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

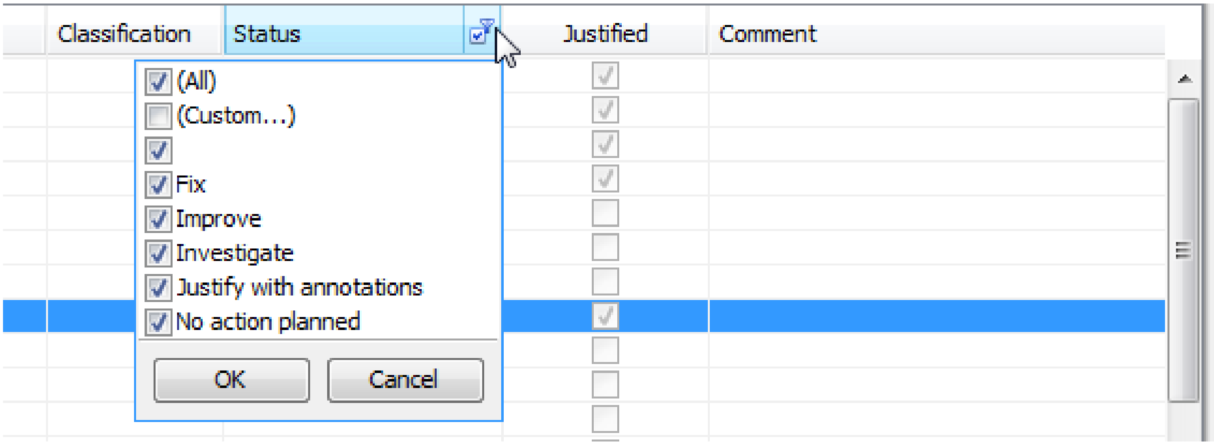
To review only the checks with `Investigate` status:

1 Open the results file, with extension, `.pscp`.

2 On the **Results Summary** pane, place your cursor on the **Status** column head.

3 Click the filter icon.

A context menu lists all the filter options available.



4 Clear the **All** check box.

5 Select the **Investigate** check box. Click **OK**.

The **Results Summary** pane displays only the checks with the `Investigate` status.

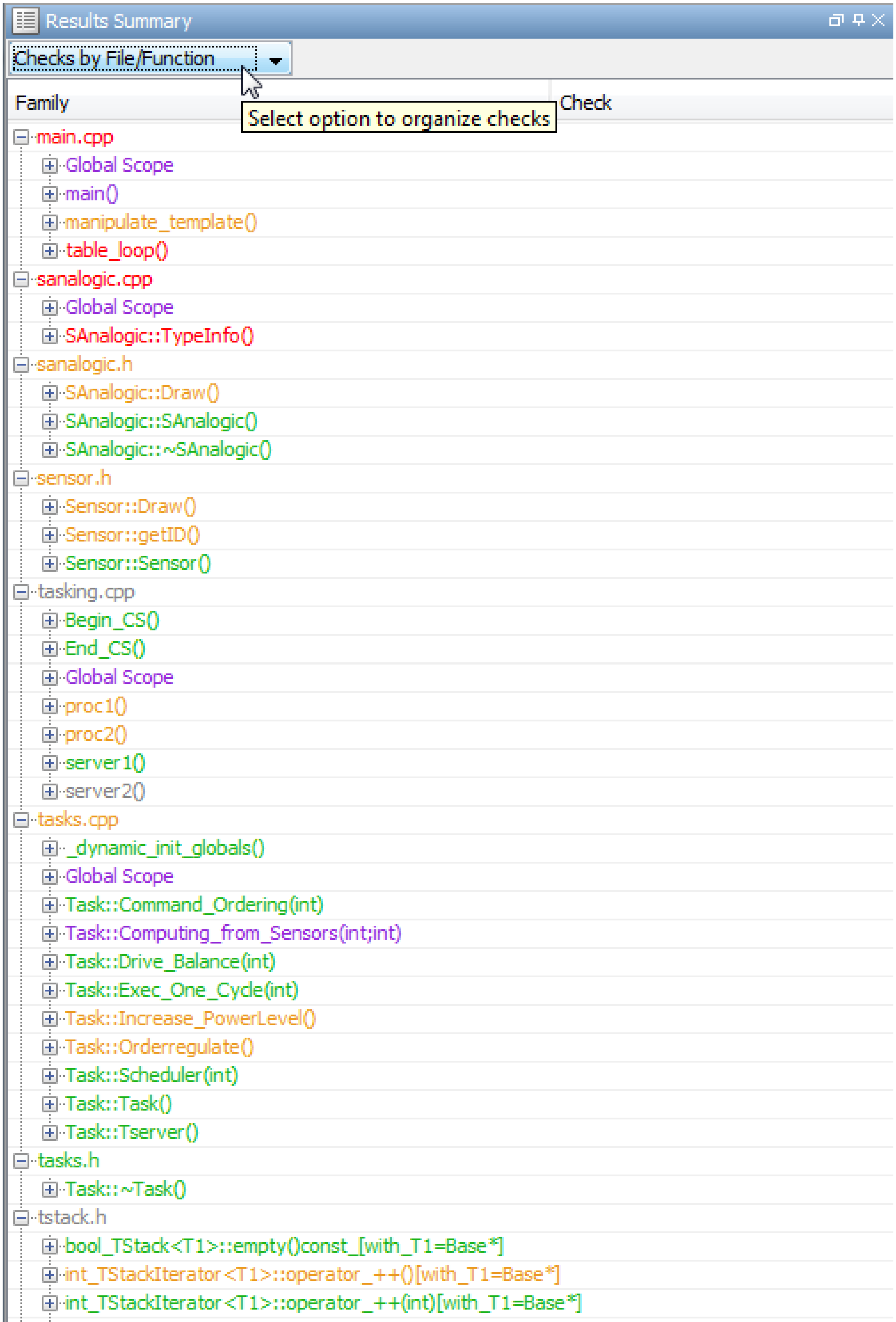
Review All Checks in a File

To review the checks in the file, `tasks.cpp`:

1 On the **Results Summary** pane, from the drop-down list, select `Checks by File/Function`.

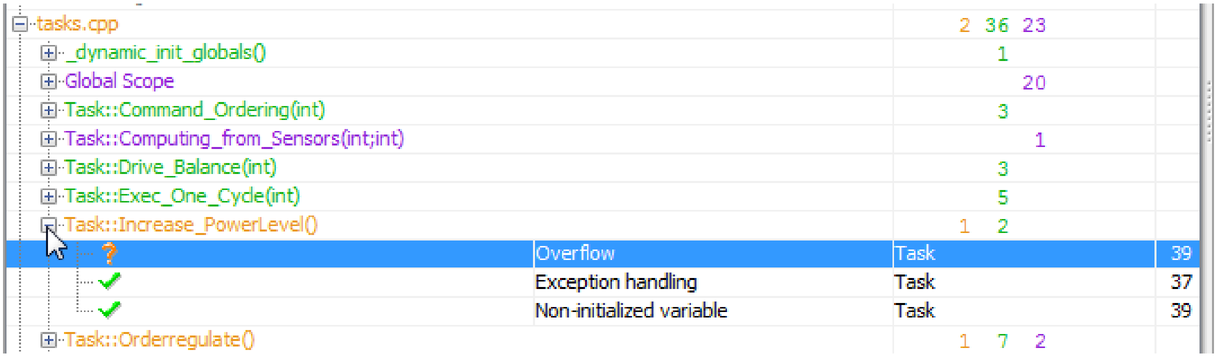
The checks displayed are grouped by files. The file names are sorted alphabetically. Within each file name, the checks are grouped by functions, sorted alphabetically. Each file or function is colored by the most severe check that occurs. The severity decreases in this order:

- Red
- Gray
- Orange
- Purple
- Green



- main.cpp
  - Global Scope
  - main()
  - manipulate_template()
  - table_loop()
- sanalogic.cpp
  - Global Scope
  - SAnalogic::TypeInfo()
- sanalogic.h
  - SAnalogic::Draw()
  - SAnalogic::SAnalogic()
  - SAnalogic::~SAnalogic()
- sensor.h
  - Sensor::Draw()
  - Sensor::getID()
  - Sensor::Sensor()
- tasking.cpp
  - Begin_CS()
  - End_CS()
  - Global Scope
  - proc1()
  - proc2()
  - server1()
  - server2()
- tasks.cpp
  - _dynamic_init_globals()
  - Global Scope
  - Task::Command_Ordering(int)
  - Task::Computing_from_Sensors(int;int)
  - Task::Drive_Balance(int)
  - Task::Exec_One_Cycle(int)
  - Task::Increase_PowerLevel()
  - Task::Orderregulate()
  - Task::Scheduler(int)
  - Task::Task()
  - Task::Tserver()
- tasks.h
  - Task::~Task()
- tstack.h
  - bool_TStack<T1>::empty()const_[with_T1=Base*]
  - int_TStackIterator<T1>::operator_++()[with_T1=Base*]
  - int_TStackIterator<T1>::operator_++(int)[with_T1=Base*]

2 To view the checks in `tasks.cpp`, expand any function name under the category, **tasks.cpp**.



⊟ tasks.cpp			2	36	23	
⊞ _dynamic_init_globals()				1		
⊞ Global Scope					20	
⊞ Task::Command_Ordering(int)				3		
⊞ Task::Computing_from_Sensors(int;int)					1	
⊞ Task::Drive_Balance(int)				3		
⊞ Task::Exec_One_Cycle(int)				5		
⊟ Task::Increase_PowerLevel()			1	2		
?	Overflow	Task				39
✓	Exception handling	Task				37
✓	Non-initialized variable	Task				39
⊞ Task::Orderregulate()			1	7	2	

To view further information on a check, select the check. The information on the check appears on the **Check Details** pane.

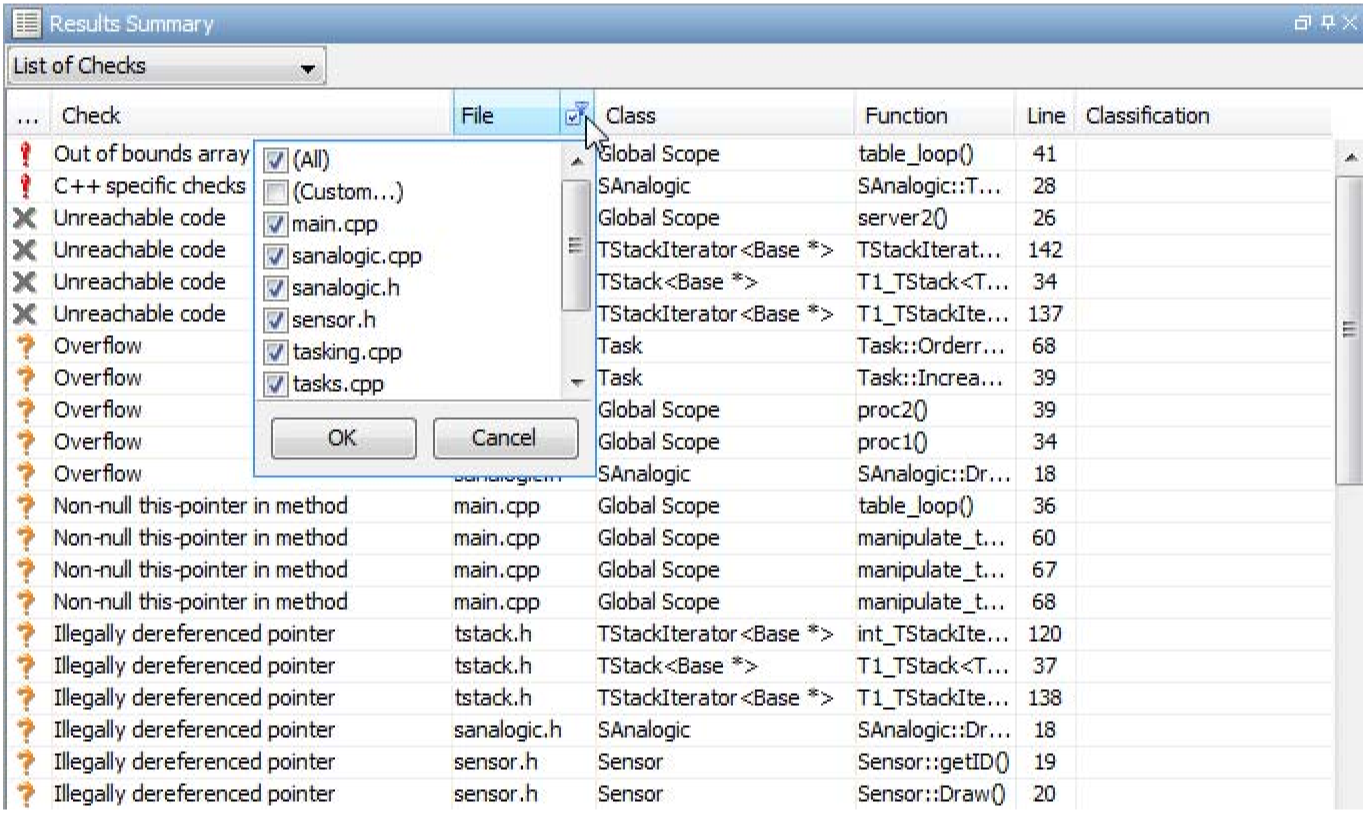
3 To view only the checks in `tasks.cpp`, on the Results Summary pane, from the drop-down list, select `List of Checks`.

The **Results Summary** pane displays all checks without any grouping.

4 Place your cursor on the **File** column head.

5 Click the filter icon.

A context menu lists all the filter options available.



...	Check	File	Class	Function	Line	Classification
!	Out of bounds array		Global Scope	table_loop()	41	
!	C++ specific checks		SAnalogic	SAnalogic::T...	28	
✗	Unreachable code		Global Scope	server2()	26	
✗	Unreachable code		TStackIterator<Base *>	TStackIterat...	142	
✗	Unreachable code		TStack<Base *>	T1_TStack<T...	34	
✗	Unreachable code		TStackIterator<Base *>	T1_TStackIte...	137	
?	Overflow		Task	Task::Orderr...	68	
?	Overflow		Task	Task::Increa...	39	
?	Overflow		Global Scope	proc2()	39	
?	Overflow		Global Scope	proc1()	34	
?	Overflow	sanalogic.h	SAnalogic	SAnalogic::Dr...	18	
?	Non-null this-pointer in method	main.cpp	Global Scope	table_loop()	36	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	60	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	67	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	68	
?	Illegally dereferenced pointer	tstack.h	TStackIterator<Base *>	int_TStackIte...	120	
?	Illegally dereferenced pointer	tstack.h	TStack<Base *>	T1_TStack<T...	37	
?	Illegally dereferenced pointer	tstack.h	TStackIterator<Base *>	T1_TStackIte...	138	
?	Illegally dereferenced pointer	sanalogic.h	SAnalogic	SAnalogic::Dr...	18	
?	Illegally dereferenced pointer	sensor.h	Sensor	Sensor::getID()	19	
?	Illegally dereferenced pointer	sensor.h	Sensor	Sensor::Draw()	20	

☑ (All)
□ (Custom...)
☑ main.cpp
☑ sanalogic.cpp
☑ sanalogic.h
☑ sensor.h
☑ tasking.cpp
☑ tasks.cpp

6 Clear the **All** check box.

7 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 check boxes selected in the filter menu. Use this information to keep track of any filters that you have applied.

Related Examples

- "Apply Coding Rule Violation Filters" on page 11-36
- "Review Coding Rule Violations" on page 11-40

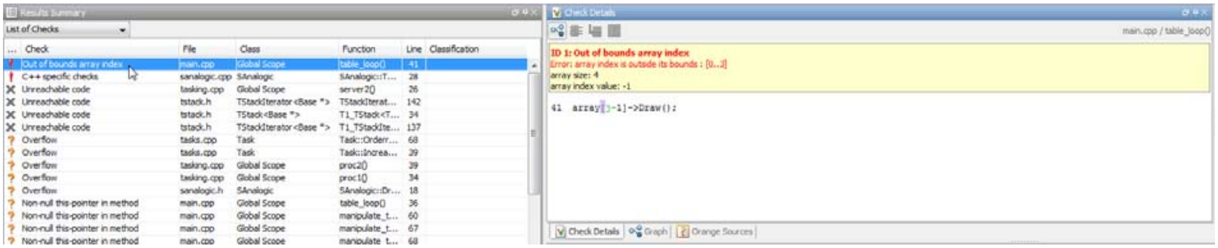
Display Call Sequence for a Check

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.

On the **Check Details** pane, the **Check Details** tab displays further information about the check.

The **Source** pane displays the code line associated with the check.



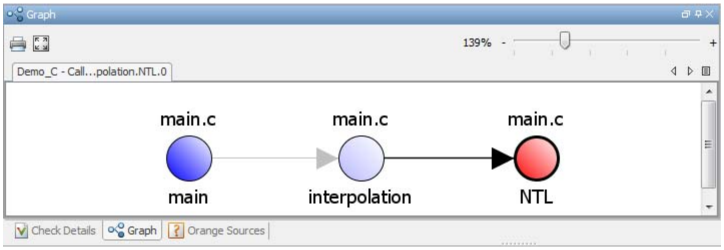
...	Check	File	Class	Function	Line	Classification
!	Out of bounds array index	main.cpp	Global Scope	table_loop()	41	
!	C++ specific checks	sanalogic.cpp	SAnalogic	SAnalogic::T...	28	
✗	Unreachable code	tasking.cpp	Global Scope	server2()	26	
✗	Unreachable code	tstack.h	TStackIterator <Base *>	TStackIterat...	142	
✗	Unreachable code	tstack.h	TStack<Base *>	T1_TStack<T...	34	
✗	Unreachable code	tstack.h	TStackIterator <Base *>	T1_TStackIte...	137	
?	Overflow	tasks.cpp	Task	Task::Orderr...	68	
?	Overflow	tasks.cpp	Task	Task::Increa...	39	
?	Overflow	tasking.cpp	Global Scope	proc2()	39	
?	Overflow	tasking.cpp	Global Scope	proc1()	34	
?	Overflow	sanalogic.h	SAnalogic	SAnalogic::Dr...	18	
?	Non-null this-pointer in method	main.cpp	Global Scope	table_loop()	36	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	60	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	67	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	68	

ID 1: Out of bounds array index
Error: array index is outside its bounds : [0..3]
array size: 4
array index value: -1

```
41  array[i-1]->Draw();
```

2 On the **Check Details** tab toolbar, click the Show error call graph button, .

On the **Check Details** pane, the **Graph** tab displays the call graph.



The call graph displays the call sequence leading to the code associated with the check. Each node on the graph, except for the terminal node, represents a function. The function name is below the node. The name of the file containing the function is above the node.

3. Select a node to navigate to the function definition in the source code.

   The **Source** pane displays the function definition.

4. Select the terminal node to navigate back to the code line associated with the check.

View Call Tree

In this section...

"View Callers and Callees of a Function" on page 9-44

"Navigate Call Tree" on page 9-46

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" on page 9-113.

You can perform all these tasks from the **Call Hierarchy Pane** in the Results Manager perspective.

For a complete description of the **Call Hierarchy** pane, see "Call Hierarchy" on page 9-91.

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 from the **Call Hierarchy** pane.

1 View the function in the **Call Hierarchy** pane.

Begin from function name.

To view a function starting from its name, group the checks in the **Results Summary** pane by function names first. Select **Checks by File/Function** from the dropdown menu at the top of this pane.

Then, list the checks under a function by double-clicking the function name. Select any check. The function appears in the **Call Hierarchy** pane. This pane also lists the names of callers and callees.

Begin from check in function.

To view a function starting from a check inside the function, select the check in the **Results Summary** pane (under the Results Manager perspective).

The function containing the check appears in the **Call Hierarchy** pane. This pane also lists the names of callers and callees.

Begin from global variable access in function

To view the callers and callees starting from a global variable access inside the function, first list the functions performing read/write access on the variable. Double-click the variable name in the **Variable Access** pane.

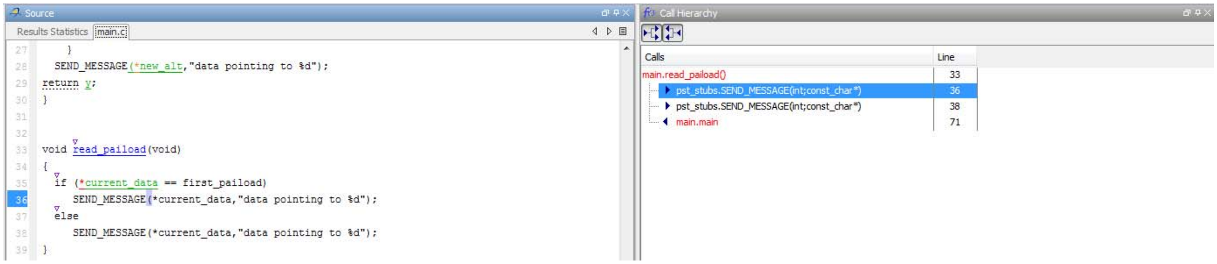
Select the name of a function. The function appears in the **Call Hierarchy** pane. This pane also lists the names of callers and callees.

2 Select the function name.

In the **Source** pane, the current line shows the beginning of the function definition.

3 Select a callee name. These are listed below the function name and marked by ▶ (functions) or ||▶ (tasks).

In the **Source** pane, the current line shows where the callee is called.

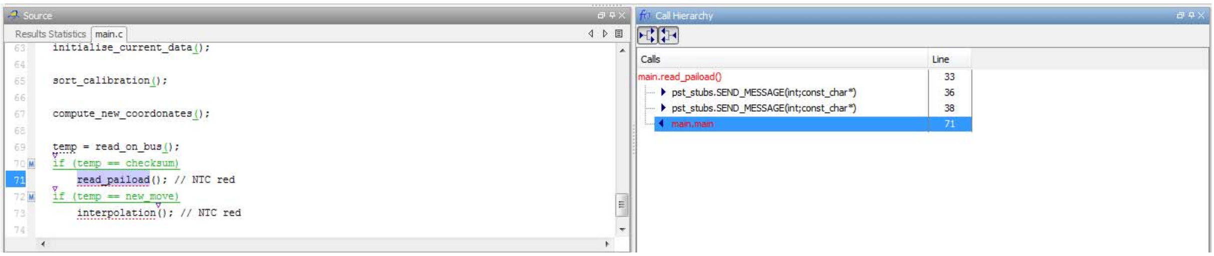


```
    }
  SEND_MESSAGE(*new_alt,"data pointing to %d");
return y;
}


void read_paiload(void)
{
  if (*current_data == first_paiload)
     SEND_MESSAGE(*current_data,"data pointing to %d");
  else
     SEND_MESSAGE(*current_data,"data pointing to %d");
}
```

Calls	Line
main.read_paiload()	33
pst_stubs.SEND_MESSAGE(int;const_char*)	36
pst_stubs.SEND_MESSAGE(int;const_char*)	38
main.main	71

4 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.

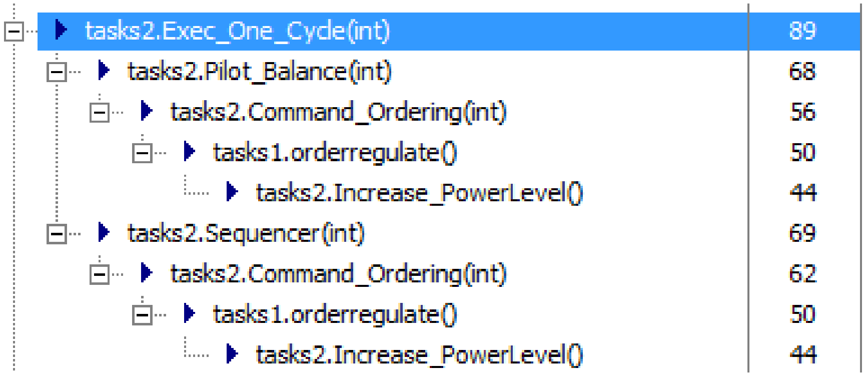


```
  initialise_current_data();

  sort_calibration();

  compute_new_coordonates();

  temp = read_on_bus();
  if (temp == checksum)
      read_paiload(); // NTC red
  if (temp == new_move)
      interpolation(); // NTC red

```

Calls	Line
main.read_paiload()	33
pst_stubs.SEND_MESSAGE(int;const_char*)	36
pst_stubs.SEND_MESSAGE(int;const_char*)	38
main.main	71

5 View all branches of a callee by progressively clicking ⊞ next to the callee name.

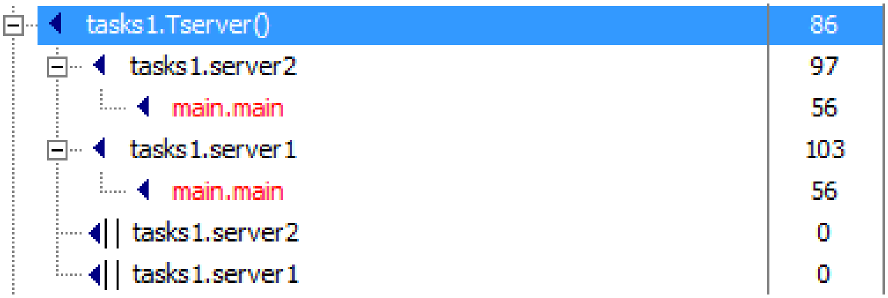
This figure displays the callee, `Exec_One_Cycle`, defined in the file, `tasks2.c`, with all branches shown.



tasks2.Exec_One_Cycle(int)	89
tasks2.Pilot_Balance(int)	68
tasks2.Command_Ordering(int)	56
tasks1.orderregulate()	50
tasks2.Increase_PowerLevel()	44
tasks2.Sequencer(int)	69
tasks2.Command_Ordering(int)	62
tasks1.orderregulate()	50
tasks2.Increase_PowerLevel()	44

6 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.



tasks1.Tserver()	86
tasks1.server2	97
main.main	56
tasks1.server1	103
main.main	56
tasks1.server2	0
tasks1.server1	0

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**. Likewise, 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.

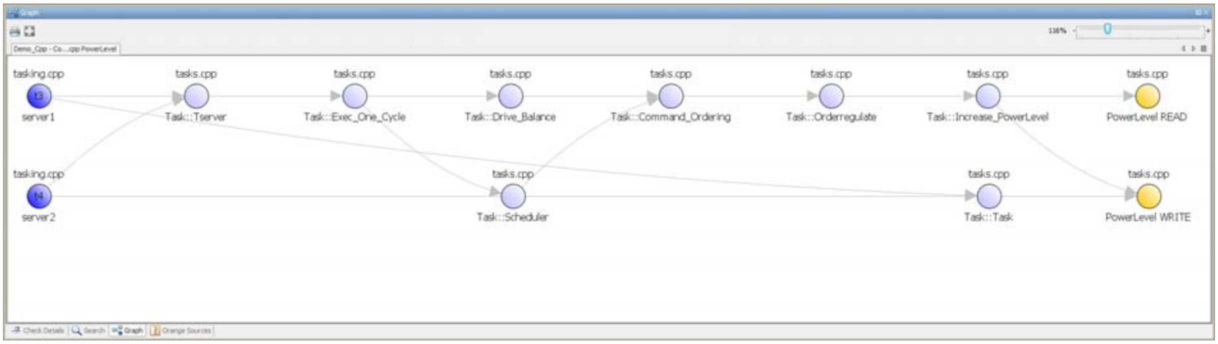
Display Access Graph for Variables

This example shows how to display the access sequence for any global variable that is read or written 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 read and write accesses for the variable. Each node represents a function.

3 On the graph, click any node to navigate to the corresponding function on the **Source** pane. The **Call Hierarchy** pane displays the call tree of the function.

Customize Review Status

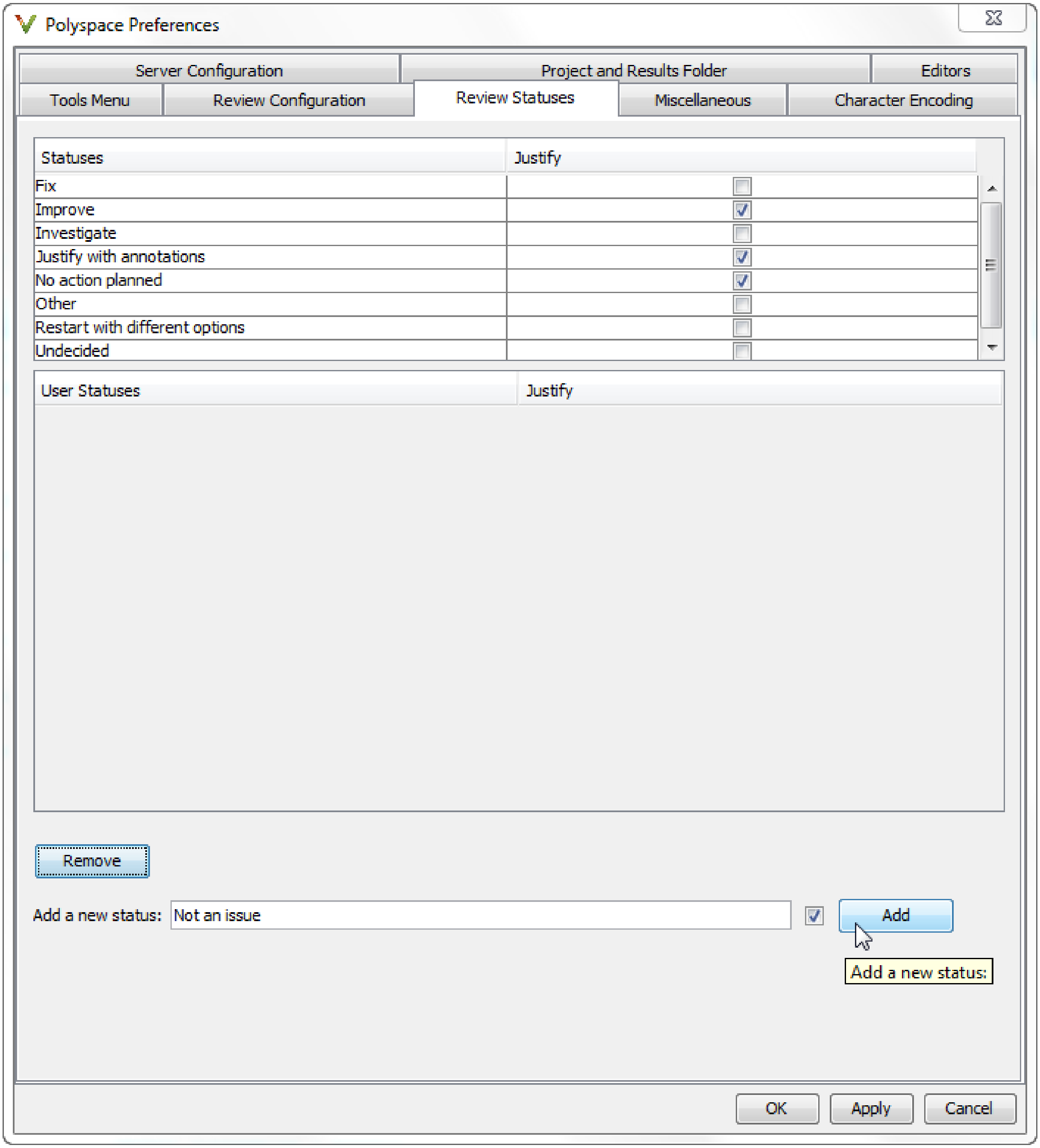
This example shows how to customize the statuses you assign on the **Check Review** pane.

Define Custom Status

1 Select **Options > Preferences**.

2 Select the **Review Statuses** tab.

3 Enter your new status at the bottom of the dialog box, then click **Add**.



Statuses	Justify
Fix	□
Improve	☑
Investigate	□
Justify with annotations	☑
No action planned	☑
Other	□
Restart with different options	□
Undecided	□

User Statuses	Justify

Add a new status: Not an issue ☑

The new status appears in the **Status** list.

4 Click **OK** to save your changes and close the dialog box.

When reviewing checks, you can select the new status from the **Check Review > Status** drop-down list.

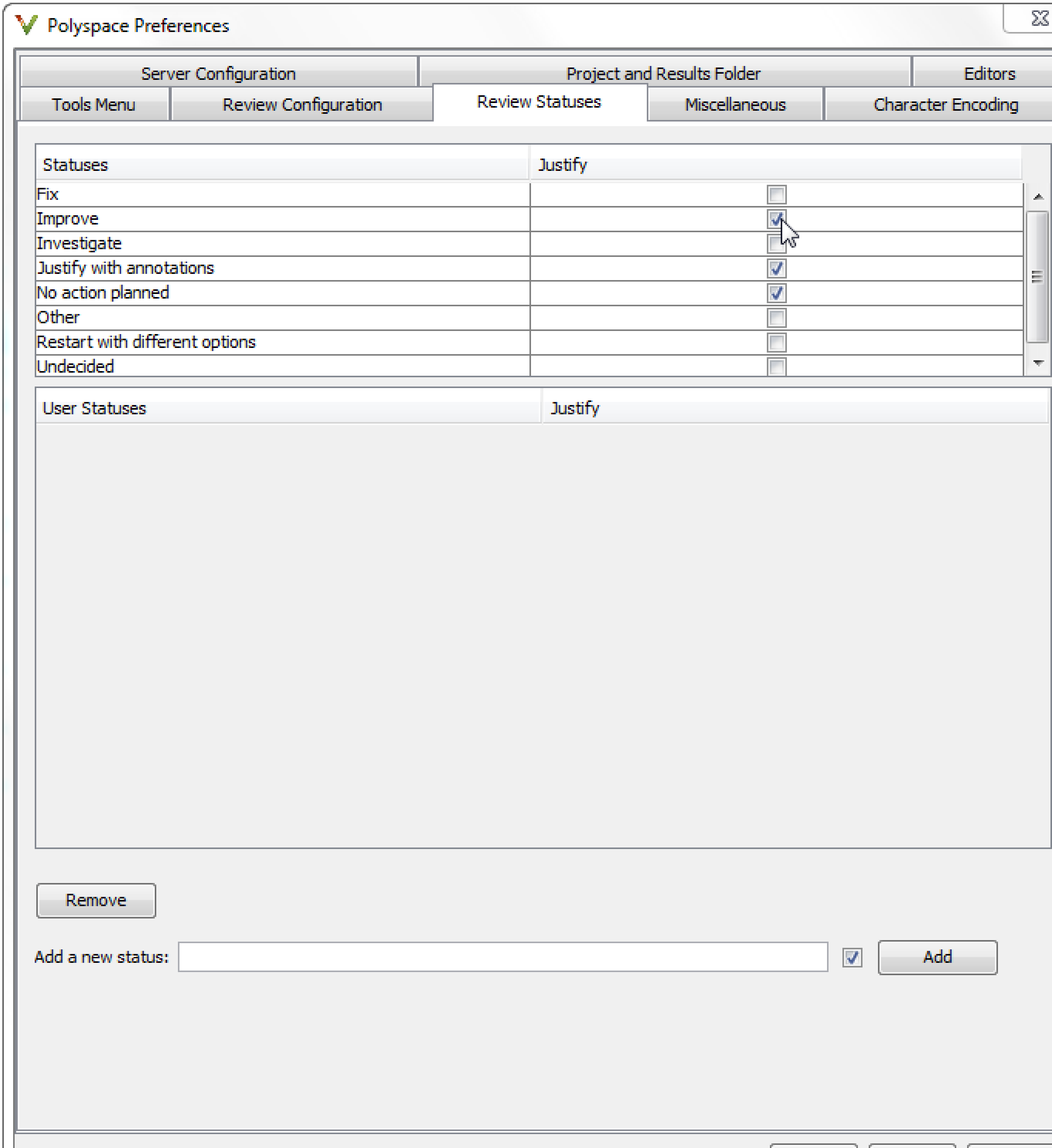
Add Justification to Existing Status

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 **Options > Preferences**.

2 Select the **Review Statuses** tab. For the `Improve` status, select the check box in the **Justify** column. Click **OK**.



Statuses	Justify
Fix	□
Improve	☑
Investigate	□
Justify with annotations	☑
No action planned	☑
Other	□
Restart with different options	□
Undecided	□

User Statuses	Justify

Add a new status: ☑

Use Range Information in the 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.

   The displayed range information represents a superset of dynamic values, which the software computes using static methods.

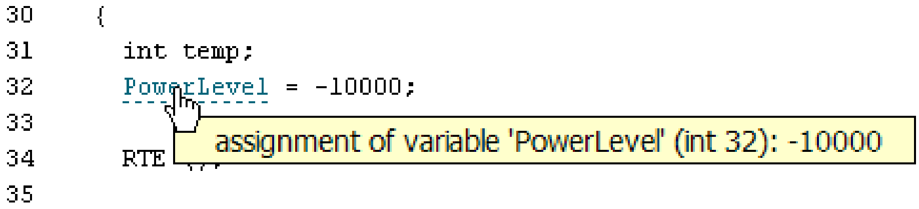
2. On the **Source** pane, select a check to display the error or warning message along with range information on the **Check Details** pane.

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:

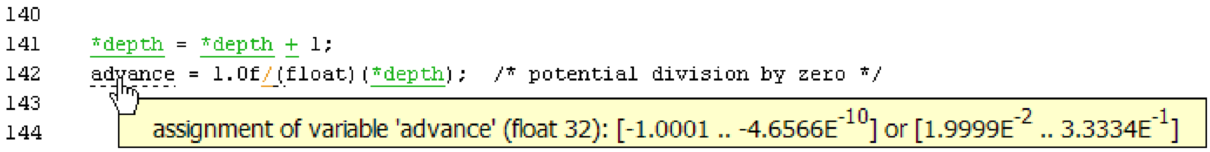
- 

  ```
  {
    int temp;
    PowerLevel = -10000;

    RTE
  ```

  assignment of variable 'PowerLevel' (int 32): -10000

  The tooltip message indicates the variable `PowerLevel` is a 32-bit integer with the value –10000.

-

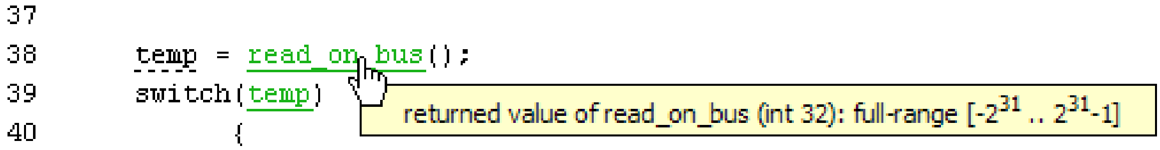


```
*depth = *depth + 1;
advance = 1.0f/(float)(*depth);  /* potential division by zero */
```

assignment of variable 'advance' (float 32): [-1.0001 .. -4.6566E^{-10}] or [1.9999E^{-2} .. 3.3334E^{-1}]

The tooltip message indicates that the variable `advance` is a 32-bit `float` that lies between either –1.0001 and –4.6566E-10 or 1.9999E-2 and 3.3334E-1.

•

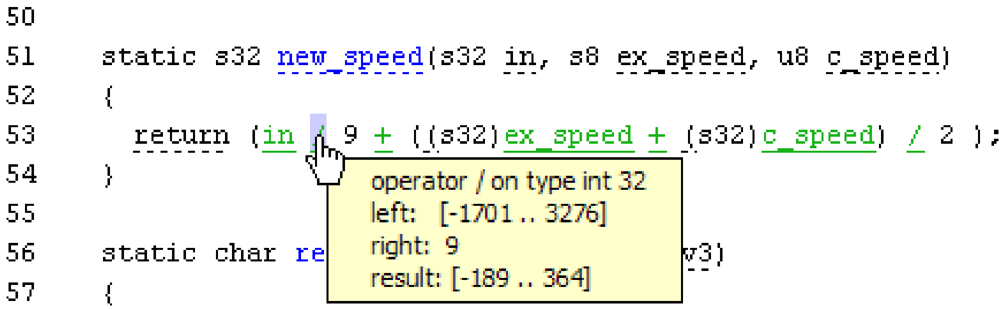


```
    temp = read_on_bus();
    switch(temp)
          {
```

returned value of read_on_bus (int 32): full-range [-2^{31} .. 2^{31}-1]

The tooltip message indicates that the returned value of the function `read_on_bus` is a 32-bit integer that occupies the full range of the data type, -2147483648 to 2147483647.

•



```
static s32 new_speed(s32 in, s8 ex_speed, u8 c_speed)
{
  return (in / 9 + ((s32)ex_speed + (s32)c_speed) / 2 );
}

static char re                          v3)
{
```

operator / on type int 32
left: [-1701 .. 3276]
right: 9
result: [-189 .. 364]

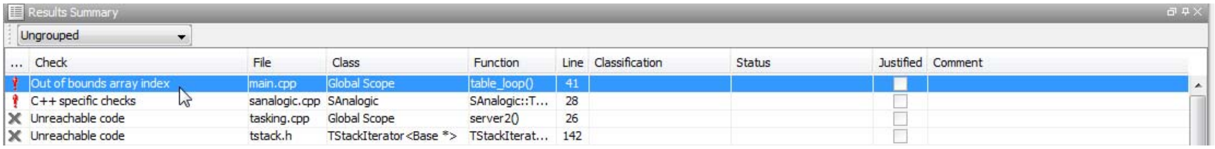
The tooltip message for the division operator / indicates that the:

- Operation is performed on 32-bit integers
- Dividend (`left`) is a value between –1701 and 3276

- Divisor (`right`) is an exact value, 9
- Quotient (`result`) lies between –189 and 364

Diagnose Errors with Range Information

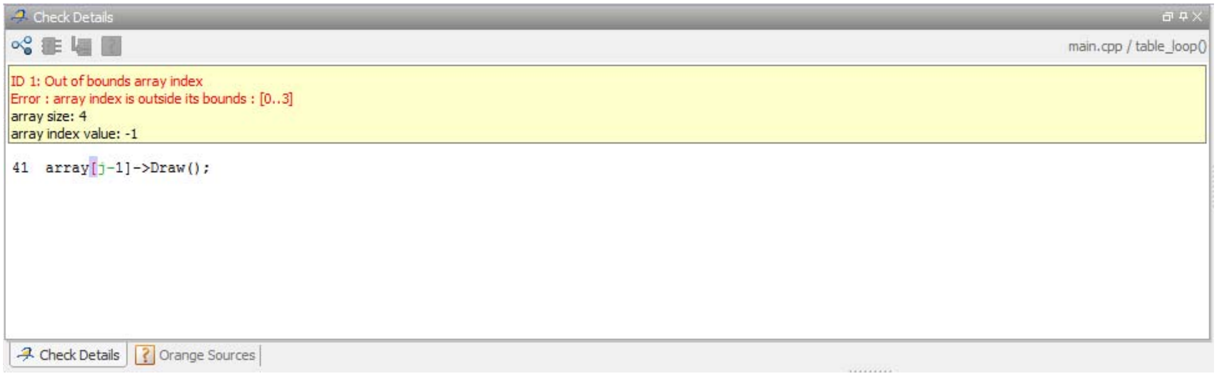
Use range information to diagnose errors. Consider the check **Out of bounds array index** in the following example:



...	Check	File	Class	Function	Line	Classification	Status	Justified	Comment
!	Out of bounds array index	main.cpp	Global Scope	table_loop()	41			□	
!	C++ specific checks	sanalogic.cpp	SAnalogic	SAnalogic::T...	28			□	
✕	Unreachable code	tasking.cpp	Global Scope	server2()	26			□	
✕	Unreachable code	tstack.h	TStackIterator<Base *>	TStackIterat...	142			□	

1 On the **Results Summary** pane, select the red check. Alternatively, select [on line 41 in the **Source** pane.

   The **Check Details** pane displays the error message along with range information.

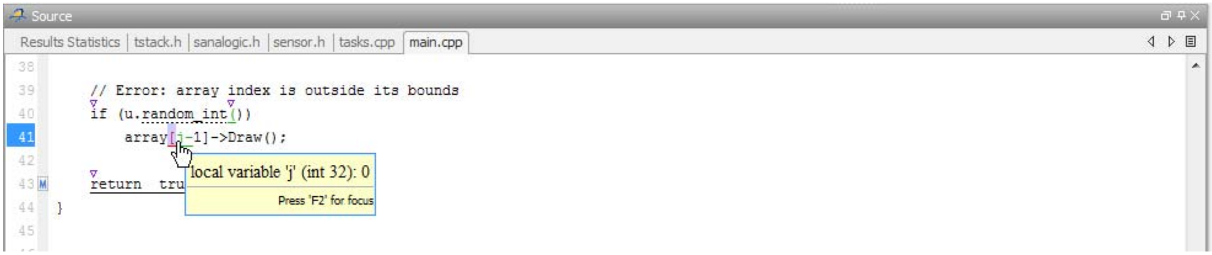


```
ID 1: Out of bounds array index
Error : array index is outside its bounds : [0..3]
array size: 4
array index value: -1
```

```
41  array[j-1]->Draw();
```

   The error message shows that the array size is 4, but the array index has a negative value of –1.

2 Place the cursor over `j` in line 41 in the source code.



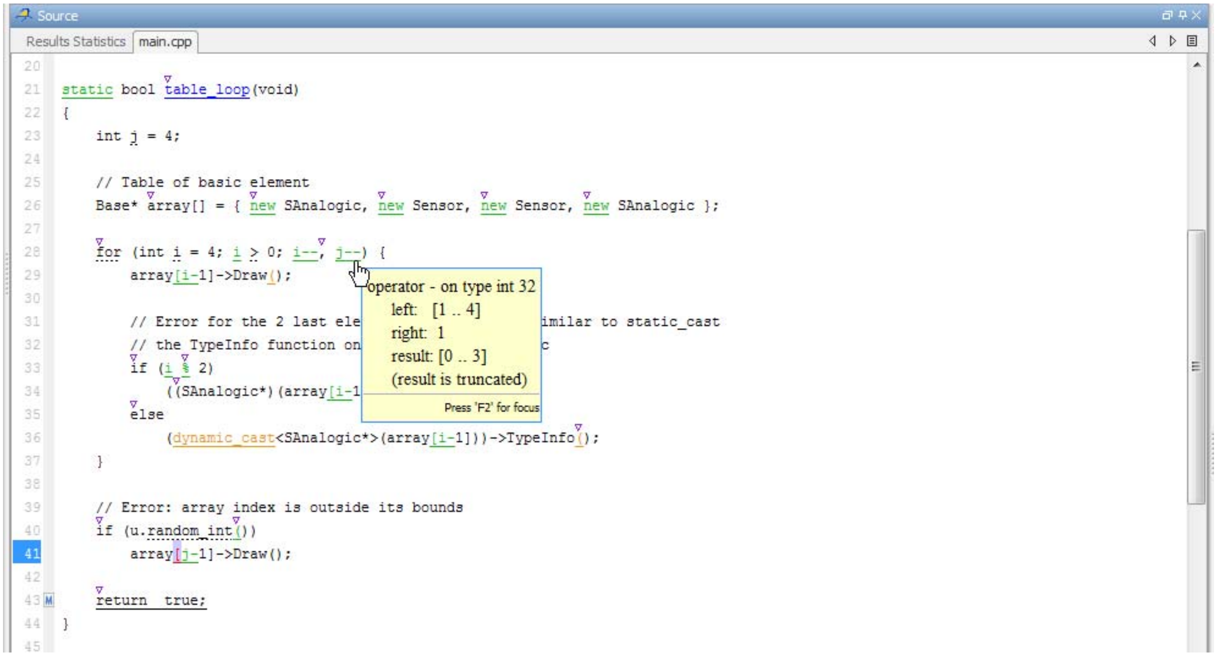
```
    // Error: array index is outside its bounds
    if (u.random_int())
        array[j-1]->Draw();

    return  tru
}
```

local variable 'j' (int 32): 0

Press 'F2' for focus

Although j is green (as a local variable), it has a value 0. This results in a negative index range.

3 Look through the source code to identify the cause of the red check.



```
static bool table_loop(void)
{
    int j = 4;

    // Table of basic element
    Base* array[] = { new SAnalogic, new Sensor, new Sensor, new SAnalogic };

    for (int i = 4; i > 0; i--, j--) {
        array[i-1]->Draw();

        // Error for the 2 last ele                          imilar to static_cast
        // the TypeInfo function on                          c
        if (i % 2)
            ((SAnalogic*)(array[i-1
        else
            (dynamic_cast<SAnalogic*>(array[i-1]))->TypeInfo();
    }

    // Error: array index is outside its bounds
    if (u.random_int())
        array[j-1]->Draw();

    return  true;
}
```

operator - on type int 32
left: [1 .. 4]
right: 1
result: [0 .. 3]
(result is truncated)

Press 'F2' for focus

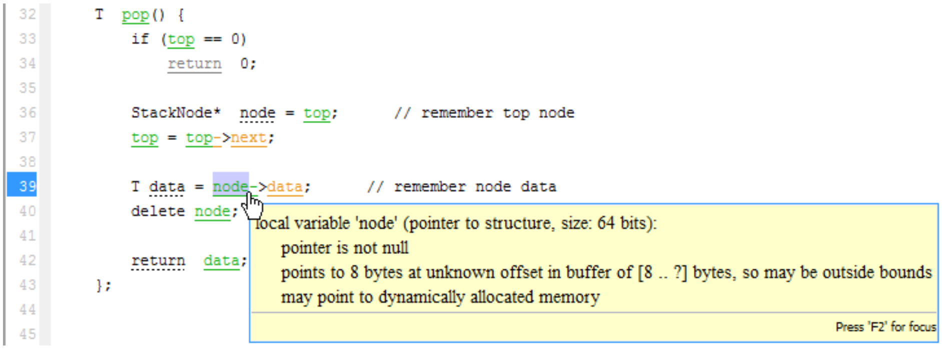
In this case, j is initialized to 4 and decreased by 1 four times in the for-loop. Therefore the value of j after the for-loop is 0.

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.

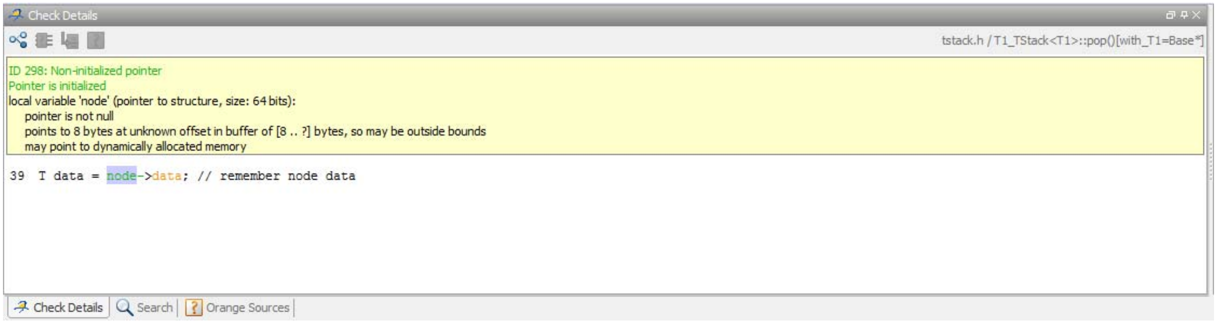


```
    T  pop() {
        if (top == 0)
            return  0;

        StackNode*  node = top;      // remember top node
        top = top->next;

        T data = node->data;      // remember node data
        delete node;

        return  data;
    };
```

local variable 'node' (pointer to structure, size: 64 bits):
    pointer is not null
    points to 8 bytes at unknown offset in buffer of [8 .. ?] bytes, so may be outside bounds
    may point to dynamically allocated memory

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.



ID 298: Non-initialized pointer
Pointer is initialized
local variable 'node' (pointer to structure, size: 64 bits):
    pointer is not null
    points to 8 bytes at unknown offset in buffer of [8 .. ?] bytes, so may be outside bounds
    may point to dynamically allocated memory

```
T data = node->data; // remember node data
```

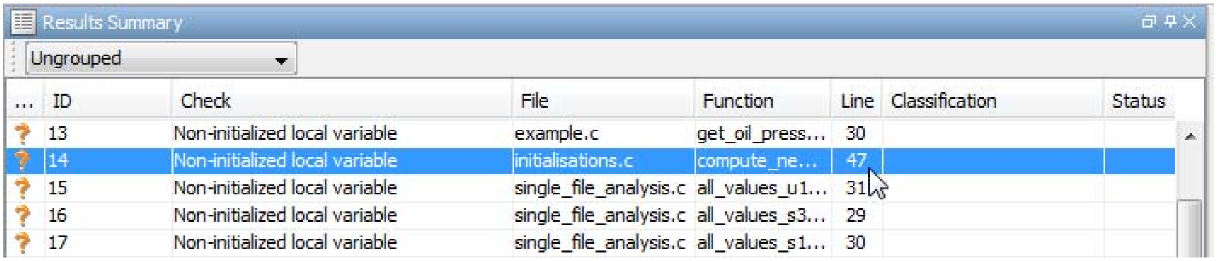
View Probable Cause for Check

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 Open the results file with extension `.pscp`.

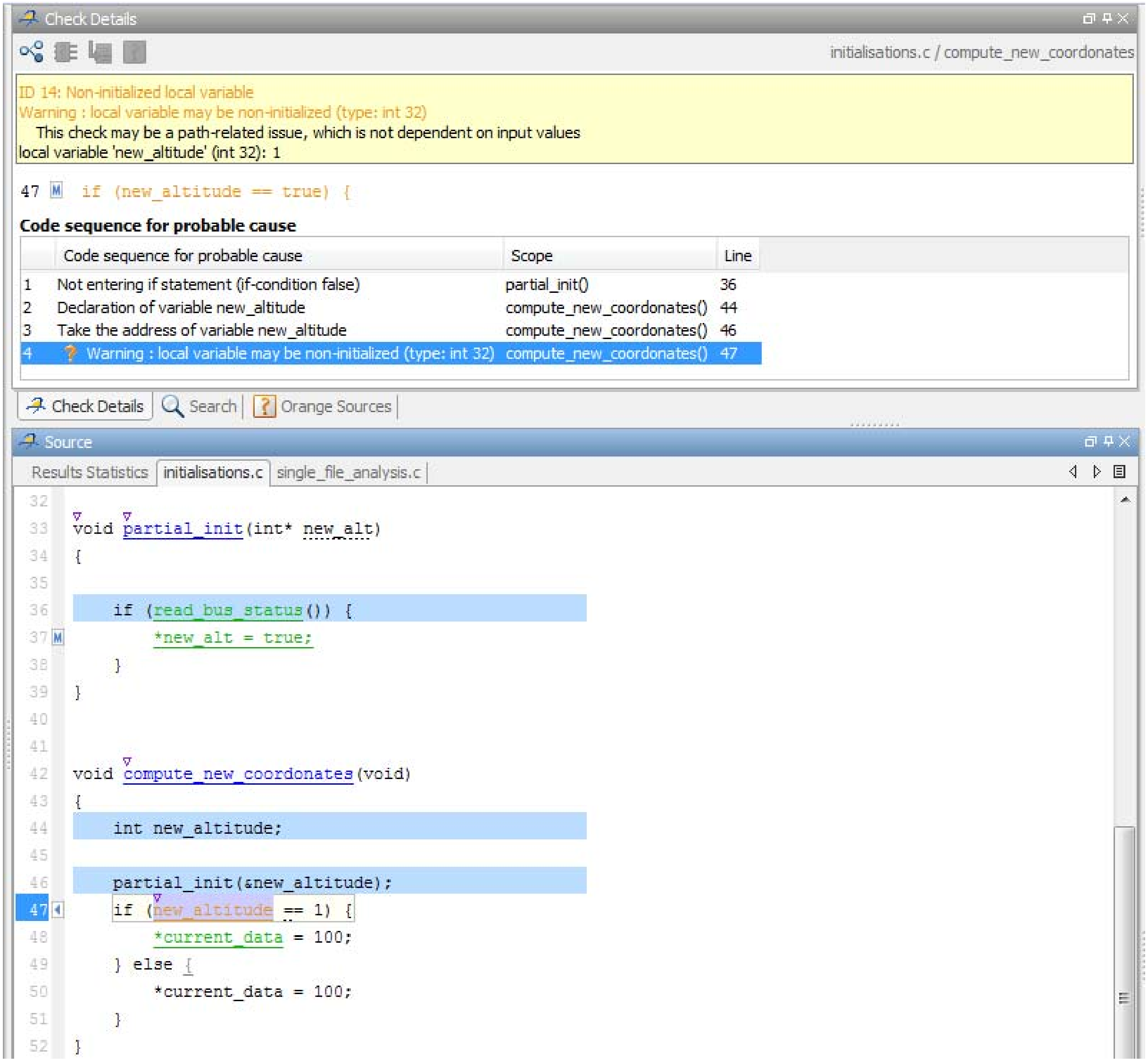
2 On the **Results Summary** pane, select a check.



...	ID	Check	File	Function	Line	Classification	Status
?	13	Non-initialized local variable	example.c	get_oil_press...	30		
?	14	Non-initialized local variable	initialisations.c	compute_ne...	47		
?	15	Non-initialized local variable	single_file_analysis.c	all_values_u1...	31		
?	16	Non-initialized local variable	single_file_analysis.c	all_values_s3...	29		
?	17	Non-initialized local variable	single_file_analysis.c	all_values_s1...	30		

In this example, the check `Non-initialized local variable` on line 47 is selected.

3 On the **Check Details** pane, view the code sequence causing the check.



ID 14: Non-initialized local variable
Warning : local variable may be non-initialized (type: int 32)
This check may be a path-related issue, which is not dependent on input values
local variable 'new_altitude' (int 32): 1

```
47  if (new_altitude == true) {
```

Code sequence for probable cause

	Code sequence for probable cause	Scope	Line
1	Not entering if statement (if-condition false)	partial_init()	36
2	Declaration of variable new_altitude	compute_new_coordonates()	44
3	Take the address of variable new_altitude	compute_new_coordonates()	46
4	Warning : local variable may be non-initialized (type: int 32)	compute_new_coordonates()	47

```
32
33  void partial_init(int* new_alt)
34  {
35
36      if (read_bus_status()) {
37          *new_alt = true;
38      }
39  }
40
41
42  void compute_new_coordonates(void)
43  {
44      int new_altitude;
45
46      partial_init(&new_altitude);
47      if (new_altitude == 1) {
48          *current_data = 100;
49      } else {
50          *current_data = 100;
51      }
52  }
```

Each statement of the sequence contains a line number and a comment. The statements are also highlighted on the **Source** pane. You can use the information to understand and rectify your code.

4 To navigate to a statement in the code sequence, on the **Check Details** pane, click the statement. The **Source** pane displays the relevant code.

5 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**.

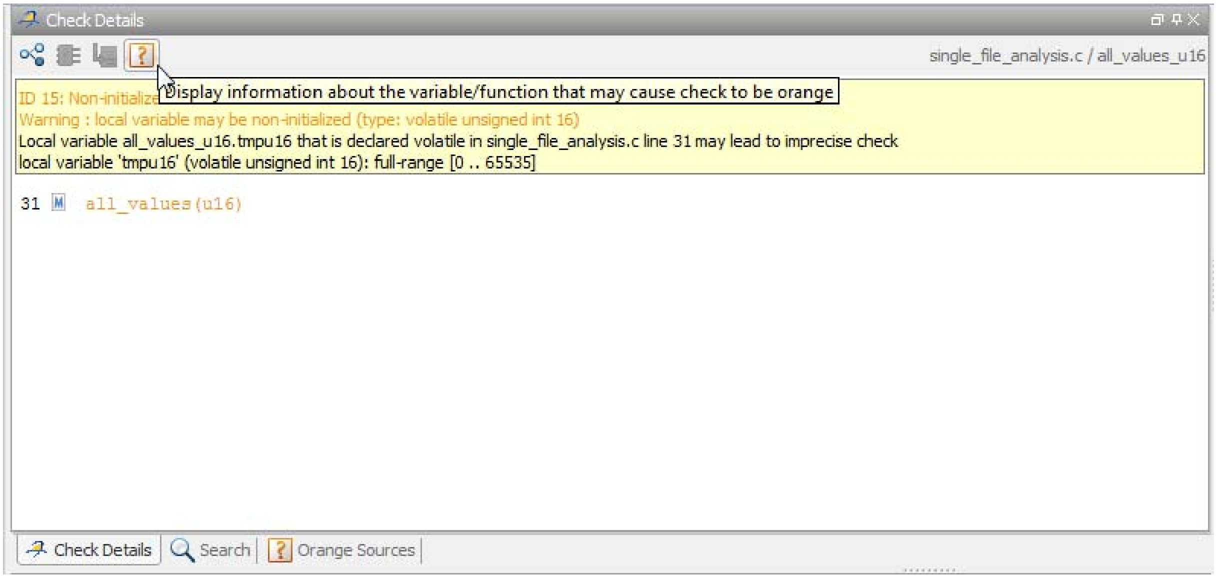
View Input Variables or Functions Causing Check

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.


Check Details
single_file_analysis.c / all_values_u16
Display information about the variable/function that may cause check to be orange
Check Details
Search
Orange Sources

```
ID 15: Non-initialize
Warning : local variable may be non-initialized (type: volatile unsigned int 16)
Local variable all_values_u16.tmpu16 that is declared volatile in single_file_analysis.c line 31 may lead to imprecise check
local variable 'tmpu16' (volatile unsigned int 16): full-range [0 .. 65535]

31  all_values(u16)
```

Information on source variables or functions causing the orange check appears on the **Orange Sources** tab in the **Check Details** pane.

Exploring Results Manager Perspective

In this section...

"Overview" on page 9-61

"Results Summary" on page 9-63

"Results Statistics" on page 9-66

"Source" on page 9-72

"Check Details" on page 9-79

"Check Review" on page 9-80

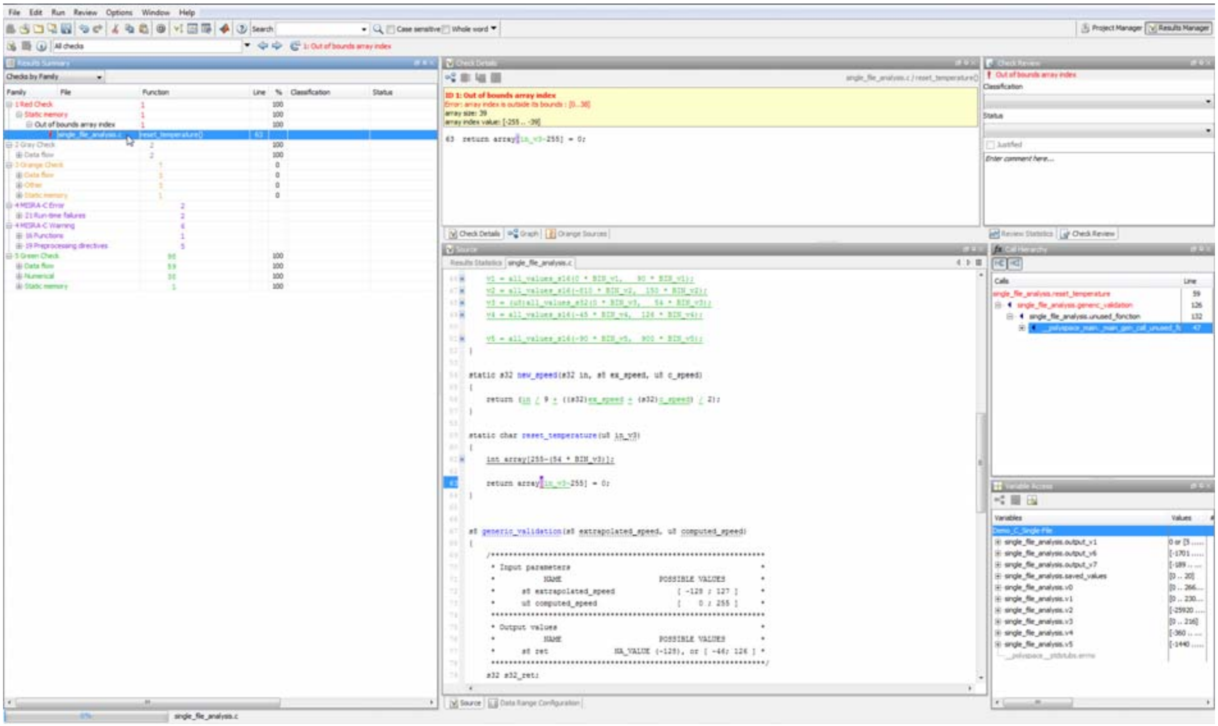
"Review Statistics" on page 9-81

"Variable Access" on page 9-83

"Call Hierarchy" on page 9-91

Overview

The Results Manager perspective looks like the following figure.



Family	File	Function	Line	%	Classification	Status
1 Red Check		1		100		
Static memory		1		100		
Out of bounds array index		1		100		
	single_file_analysis.c	reset_temperature()	63			
2 Gray Check		2		100		
Data flow		2		100		
3 Orange Check		7		0		
Data flow		3		0		
Other		3		0		
Static memory		1		0		
4 MISRA-C Error		2				
21 Run-time failures		2				
4 MISRA-C Warning		6				
16 Functions		1				
19 Preprocessing directives		5				
5 Green Check		90		100		
Data flow		59		100		
Numerical		30		100		
Static memory		1		100		

single_file_analysis.c / reset_temperature()

ID 1: Out of bounds array index
Error: array index is outside its bounds : [0...38]
array size: 39
array index value: [-255 .. -39]

```
63  return array[in_v3-255] = 0;
```

```
    v1 = all_values_s16(0 * BIN_v1,   90 * BIN_v1);
    v2 = all_values_s16(-810 * BIN_v2,  150 * BIN_v2);
    v3 = (u8)all_values_s32(0 * BIN_v3,   54 * BIN_v3);
    v4 = all_values_s16(-45 * BIN_v4,  126 * BIN_v4);

    v5 = all_values_s16(-90 * BIN_v5,  900 * BIN_v5);
}

static s32 new_speed(s32 in, s8 ex_speed, u8 c_speed)
{
    return (in / 9 + ((s32)ex_speed + (s32)c_speed) / 2);
}

static char reset_temperature(u8 in_v3)
{
    int array[255-(54 * BIN_v3)];

    return array[in_v3-255] = 0;
}


s8 generic_validation(s8 extrapolated_speed, u8 computed_speed)
{
    /*************************************************************
     * Input parameters                                          *
     *          NAME                        POSSIBLE VALUES      *
     *      s8 extrapolated_speed             [ -128 ; 127 ]     *
     *      u8 computed_speed                 [    0 ; 255 ]     *
     *************************************************************
     * Output values                                             *
     *          NAME                        POSSIBLE VALUES      *
     *      s8 ret                 NA_VALUE (-128), or [ -46; 126 ] *
     *************************************************************/
    s32 s32_ret;
```

Calls	Line
single_file_analysis.reset_temperature	59
single_file_analysis.generic_validation	126
single_file_analysis.unused_function	132
__polyspace_main_main_gen_call_unused_fc	47

Variables	Values
Demo_C_Single-File	
single_file_analysis.output_v1	0 or [0 ...
single_file_analysis.output_v6	[-1701 ...
single_file_analysis.output_v7	[-189 ...
single_file_analysis.saved_values	[0 .. 20]
single_file_analysis.v0	[0 .. 266...
single_file_analysis.v1	[0 .. 230...
single_file_analysis.v2	[-25920 ...
single_file_analysis.v3	[0 .. 216]
single_file_analysis.v4	[-360 .. ...
single_file_analysis.v5	[-1440 ...
__polyspace__stdstubs.errno	

he Results Manager perspective has the following sections below the toolbar:

This pane or view ...	Displays ...
Results Summary	List of checks (diagnostics) for each file and function in the project
Results Statistics	• 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

This pane or view ...	Displays ...
Check Details	Details about the selected check
Review Statistics	Statistics about the review progress for checks with the same type and category as 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 any of 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:

- `List of checks`: Lists all checks without any grouping. The checks are sorted in the following order:

  1. **Red**: Indicates code that is proven to contain an error. The check indicates that the code will fail every time it is executed.
  2. **Gray** — Indicates unreachable code.
  3. **Orange** — Indicates unproven code that might contain an error.
  4. **Purple**. — Indicates coding rule violation.
  5. **Green** — Indicates code that is proven to not contain an error.

- `Checks 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.

- `Checks 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.

- `Checks by File/Function`: 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.
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

Attribute	Description
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.
%	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`

Attribute	Description
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

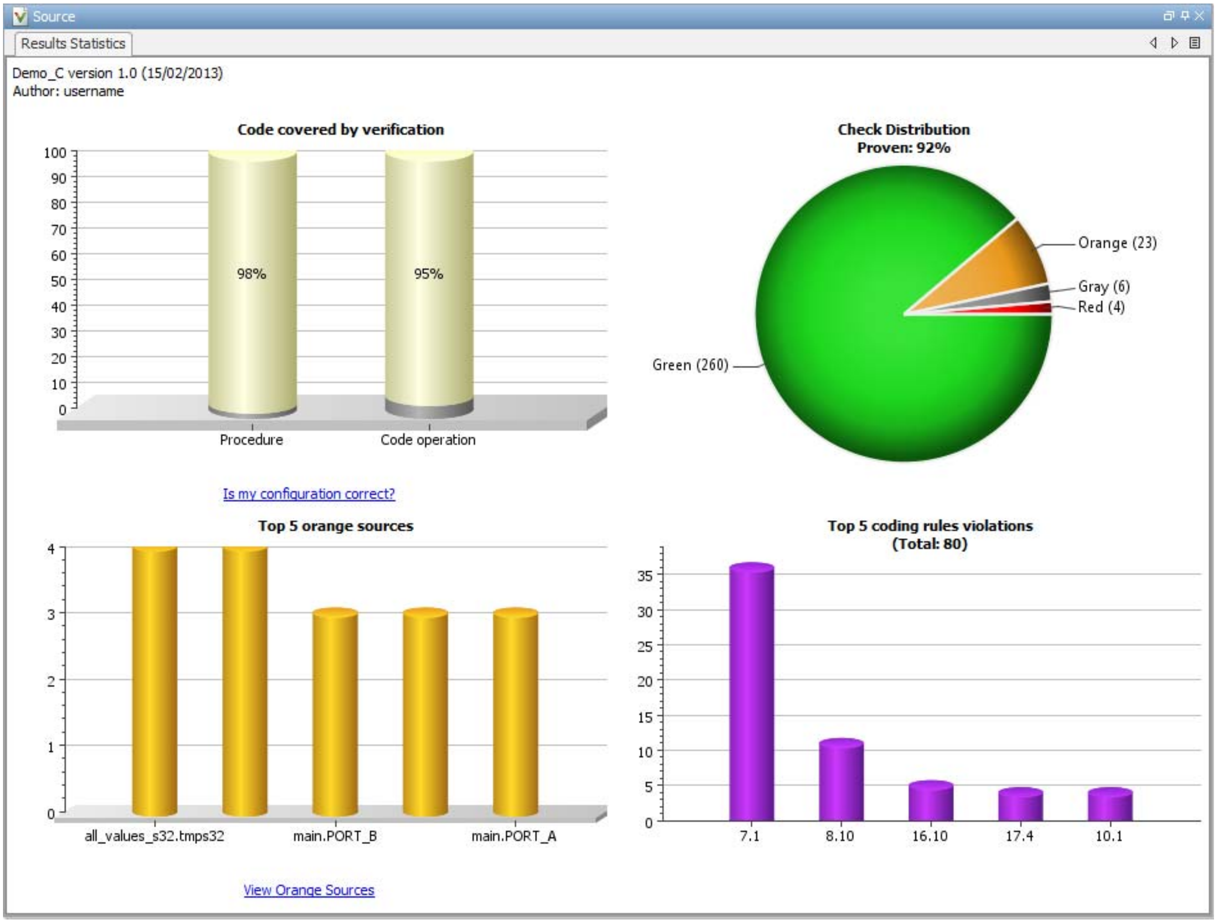
To show or hide any of the columns, right-click anywhere on the column titles. From the context menu, select or clear the title of the column that you want to show or hide.

Using this pane, you can:

- Navigate through all the checks. For more information, see "Review and Comment Checks" on page 9-17.
- Organize your check review using filters on the appropriate columns. For more information, see "Organize Check Review Using Filters and Groups" on page 9-33.

Results Statistics

The **Results Statistics** tab on the **Source** pane provides statistics on the verification results in a graphical format.



Demo_C version 1.0 (15/02/2013)
Author: username

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

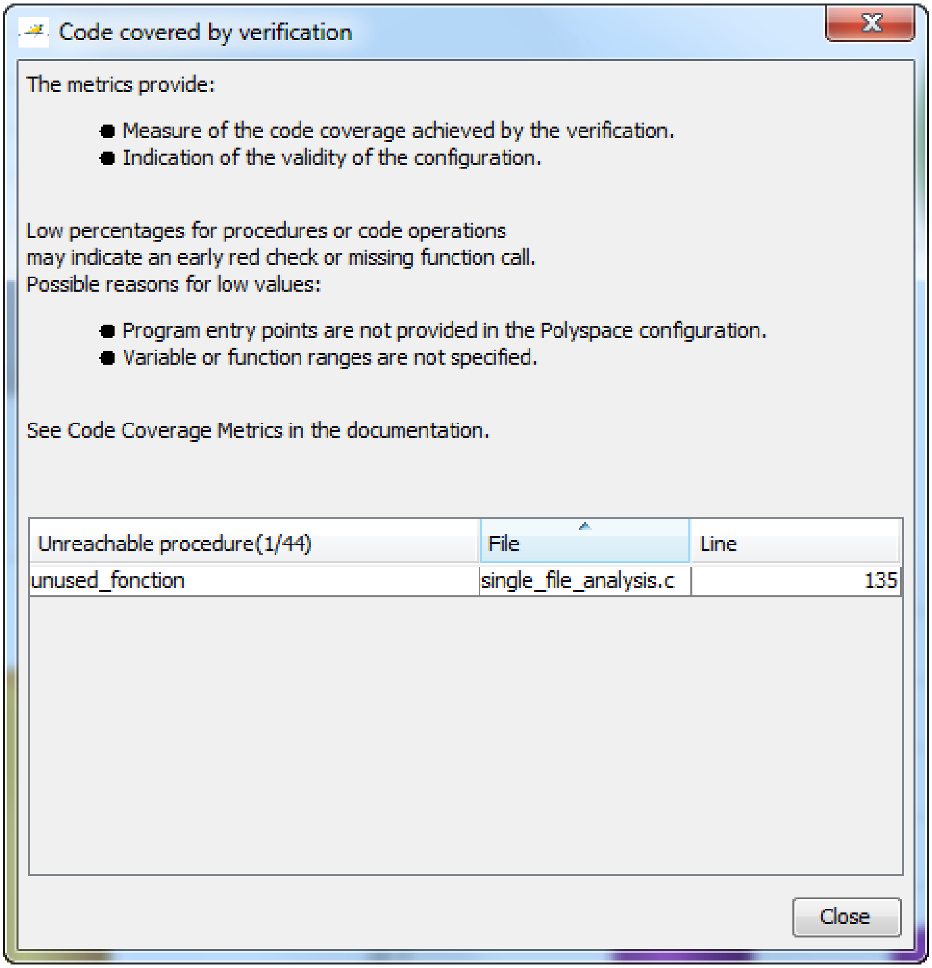
  This column graph displays:

- 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(1/44)	File	Line
unused_fonction	single_file_analysis.c	135

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 “Understanding Polyspace Results” on page 9-94.

Using this pie chart, you can obtain an estimate of:

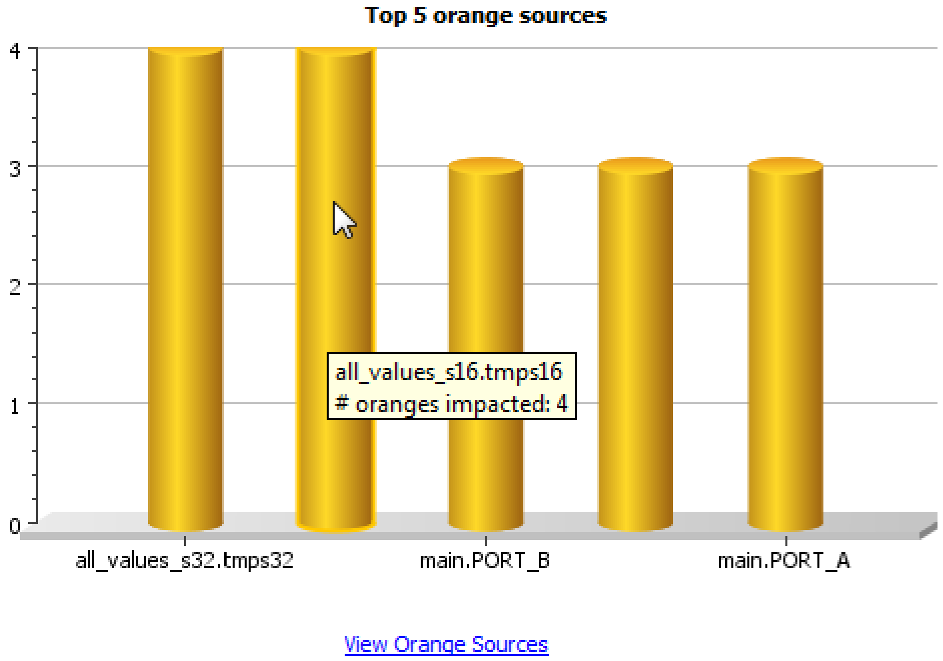
- The number of checks to review.
- The selectivity of your verification — the fraction of checks that are not orange.

•

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. For information on the **Orange Sources** pane, see “View Sources of Orange Checks” on page 10-29.

  - Prioritize your review of orange checks. For more information, see "Prioritize Orange Check Review" on page 10-31. If there are sources affecting a large number of orange checks, using this chart can quickly improve the selectivity of your verification.

-

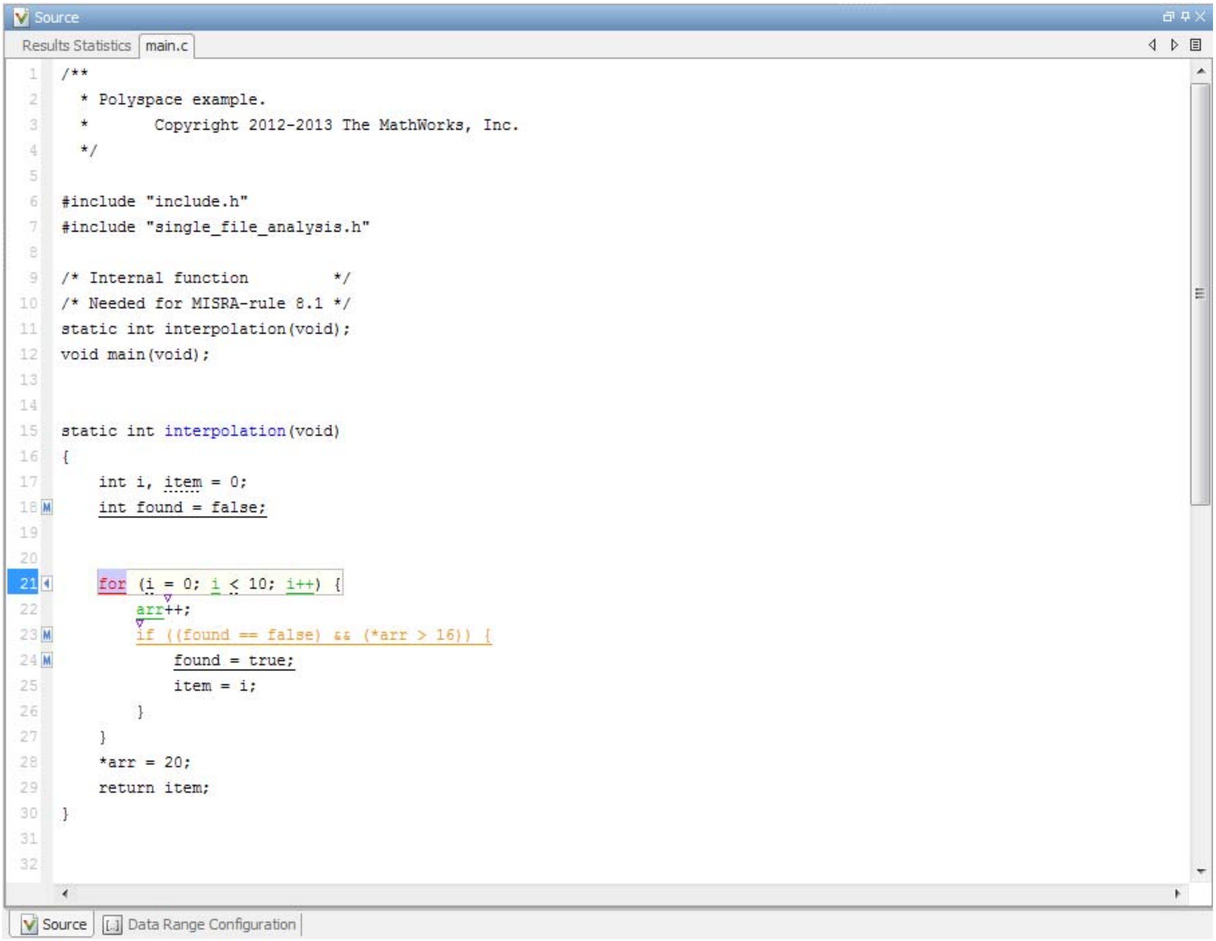
Top 5 coding rule violations

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 Rules" on page 11-60, "Supported MISRA C++ Coding Rules" on page 11-102 and "Supported JSF C++ Coding Rules" on page 11-128.

Source

The **Source** pane shows the source code with colored checks highlighted.



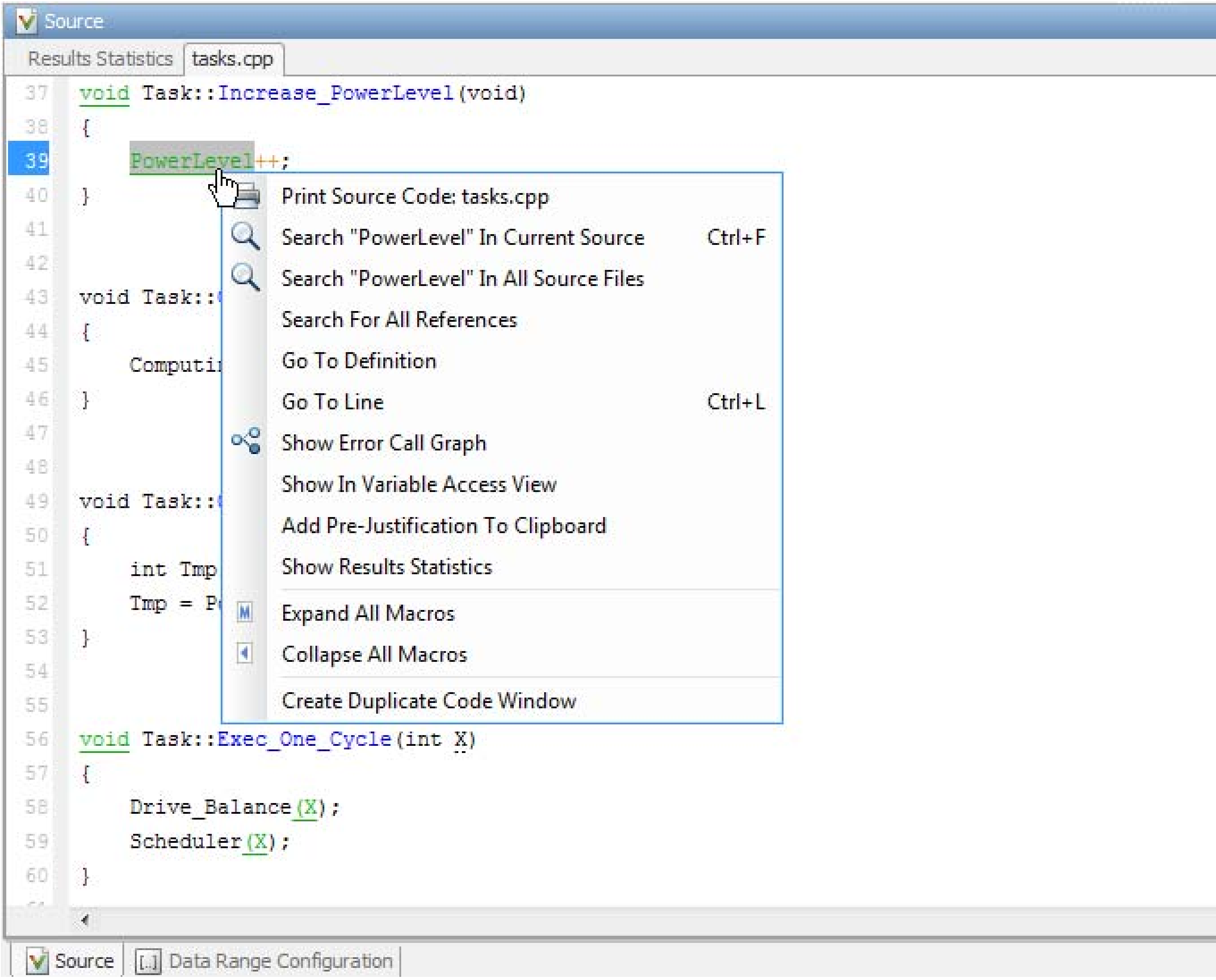
```
/**
 * Polyspace example.
 *       Copyright 2012-2013 The MathWorks, Inc.
 */

#include "include.h"
#include "single_file_analysis.h"

/* Internal function        */
/* Needed for MISRA-rule 8.1 */
static int interpolation(void);
void main(void);


static int interpolation(void)
{
    int i, item = 0;
    int found = false;


    for (i = 0; i < 10; i++) {
        arr++;
        if ((found == false) && (*arr > 16)) {
            found = true;
            item = i;
        }
    }
    *arr = 20;
    return item;
}
```

Tooltips

Placing your cursor over a check displays a tooltip that provides range information for variables, operands, function parameters, and return values. For more information on tooltips, see “Use Range Information in the Results Manager” on page 9-53.

Examine Source Code

In 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`:



Source
Results Statistics
tasks.cpp
Print Source Code: tasks.cpp
Search "PowerLevel" In Current Source	Ctrl+F
Search "PowerLevel" In All Source Files
Search For All References
Go To Definition
Go To Line	Ctrl+L
Show Error Call Graph
Show In Variable Access View
Add Pre-Justification To Clipboard
Show Results Statistics
Expand All Macros
Collapse All Macros
Create Duplicate Code Window
Source
[..] Data Range Configuration

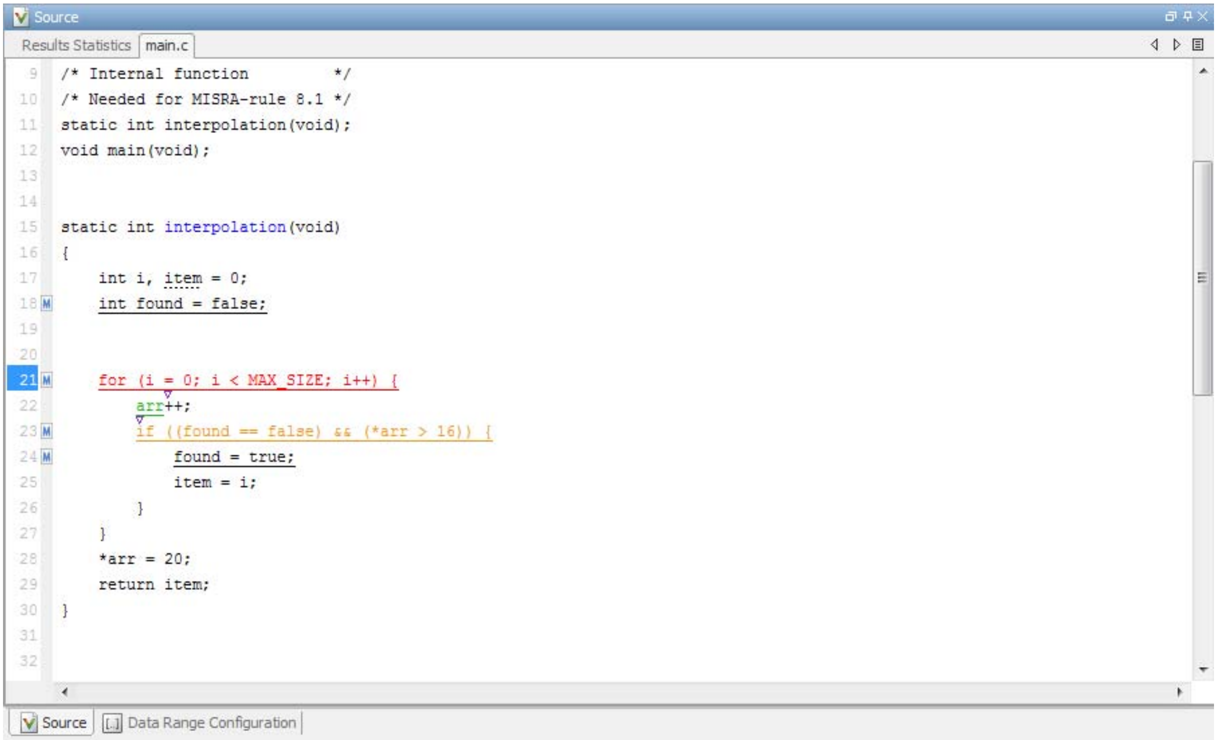
```
void Task::Increase_PowerLevel(void)
{
    PowerLevel++;
}


void Task::(
{
    Computi
}


void Task::(
{
    int Tmp
    Tmp = P
}


void Task::Exec_One_Cycle(int X)
{
    Drive_Balance(X);
    Scheduler(X);
}
```

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 declaration 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 all macros in current source file.

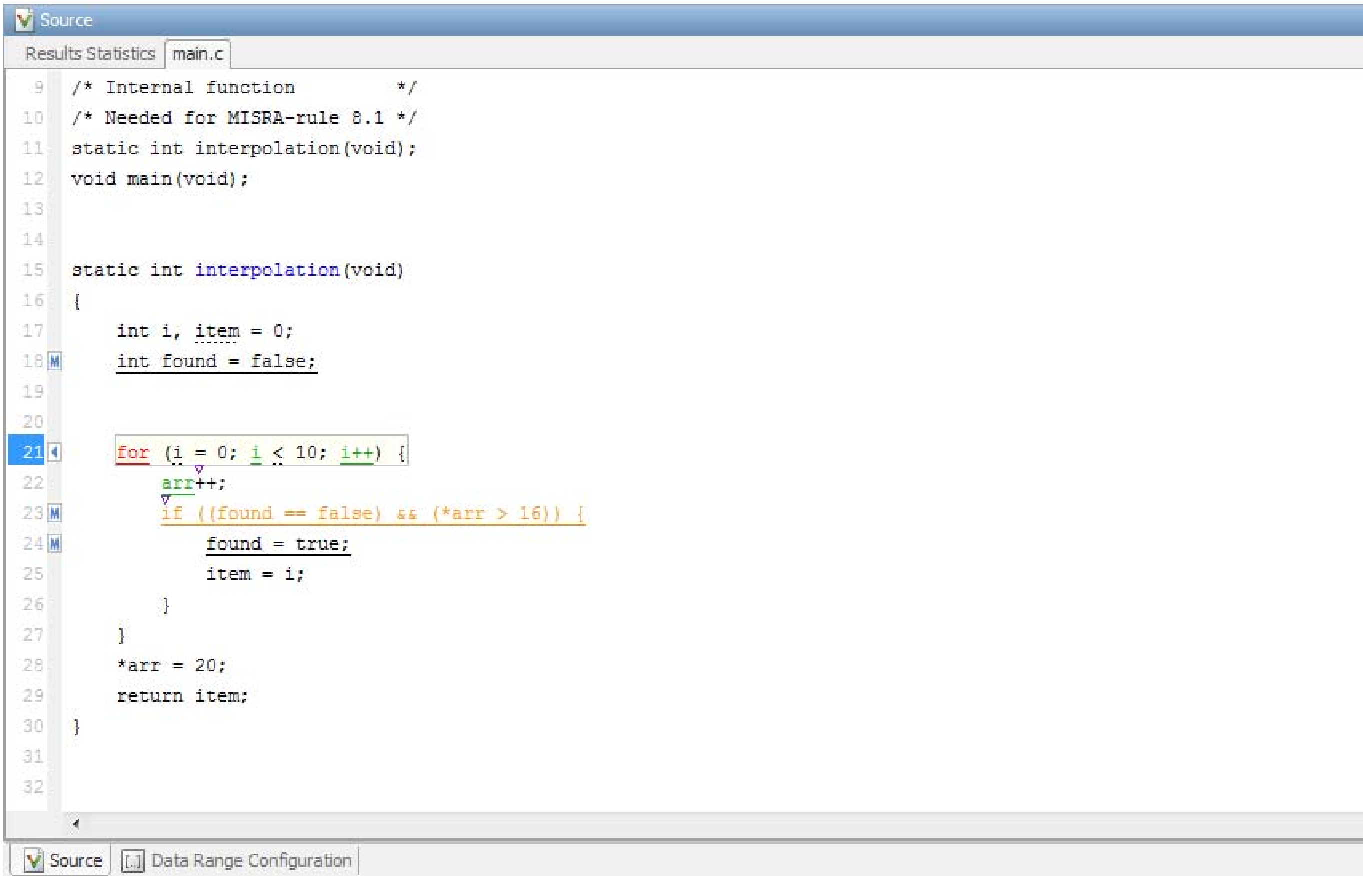
Expand Macros

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.



```
/* Internal function         */
/* Needed for MISRA-rule 8.1 */
static int interpolation(void);
void main(void);


static int interpolation(void)
{
    int i, item = 0;
    int found = false;


    for (i = 0; i < MAX_SIZE; i++) {
        arr++;
        if ((found == false) && (*arr > 16)) {
            found = true;
            item = i;
        }
    }
    *arr = 20;
    return item;
}
```

When you click a line with this icon, the software displays the contents of macros on that line.



```
/* Internal function          */
/* Needed for MISRA-rule 8.1 */
static int interpolation(void);
void main(void);


static int interpolation(void)
{
    int i, item = 0;
    int found = false;


    for (i = 0; i < 10; i++) {
        arr++;
        if ((found == false) && (*arr > 16)) {
            found = true;
            item = i;
        }
    }
    *arr = 20;
    return item;
}
```

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.

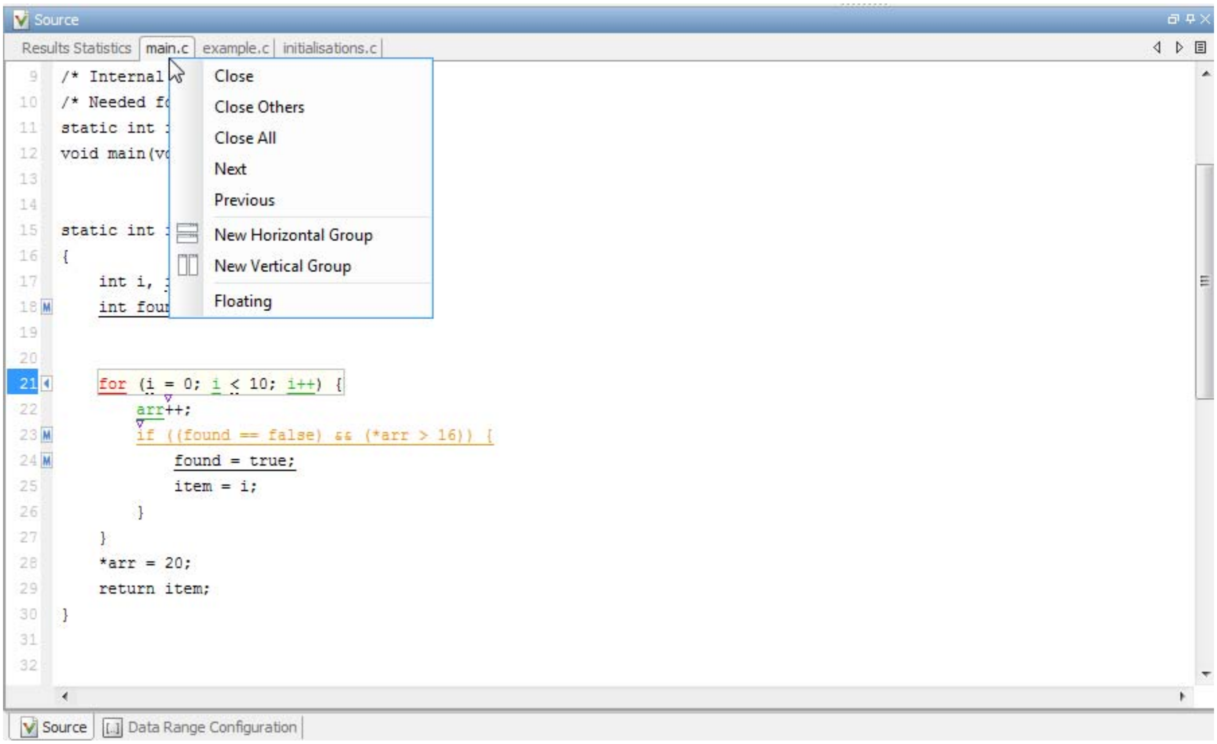
2 From the context menu, select either **Expand All Macros** or **Collapse All Macros**.

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 in Source Pane

You can view multiple source files in the **Source** pane.

On the **Source** pane toolbar, right-click any view to manage source files.



```
/* Internal
/* Needed fo
static int
void main(vo


static int
{
    int i,
    int four


    for (i = 0; i < 10; i++) {
        arr++;
        if ((found == false) && (*arr > 16)) {
            found = true;
            item = i;
        }
    }
    *arr = 20;
    return item;
}
```

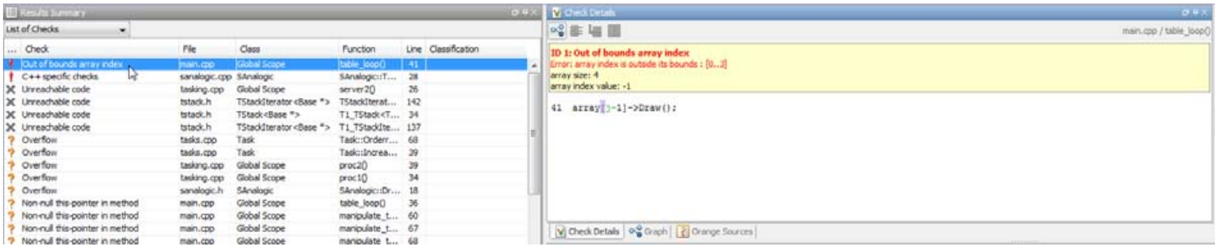
From the **Source** pane context menu, you can:

- **Close** – Close the currently selected source file.
- **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 window horizontally to display the selected source file below another file.
- **New Vertical Group** – Split the Source window 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.

Check Details

On the **Results Summary** pane, if you click a check, you see additional information on the **Check Details** pane.



...	Check	File	Class	Function	Line	Classification
!	Out of bounds array index	main.cpp	Global Scope	table_loop()	41	
!	C++ specific checks	sanalogic.cpp	SAnalogic	SAnalogic::T...	28	
✗	Unreachable code	tasking.cpp	Global Scope	server2()	26	
✗	Unreachable code	tstack.h	TStackIterator<Base *>	TStackIterat...	142	
✗	Unreachable code	tstack.h	TStack<Base *>	T1_TStack<T...	34	
✗	Unreachable code	tstack.h	TStackIterator<Base *>	T1_TStackIte...	137	
?	Overflow	tasks.cpp	Task	Task::Orderr...	68	
?	Overflow	tasks.cpp	Task	Task::Increa...	39	
?	Overflow	tasking.cpp	Global Scope	proc2()	39	
?	Overflow	tasking.cpp	Global Scope	proc1()	34	
?	Overflow	sanalogic.h	SAnalogic	SAnalogic::Dr...	18	
?	Non-null this-pointer in method	main.cpp	Global Scope	table_loop()	36	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	60	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	67	
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	68	

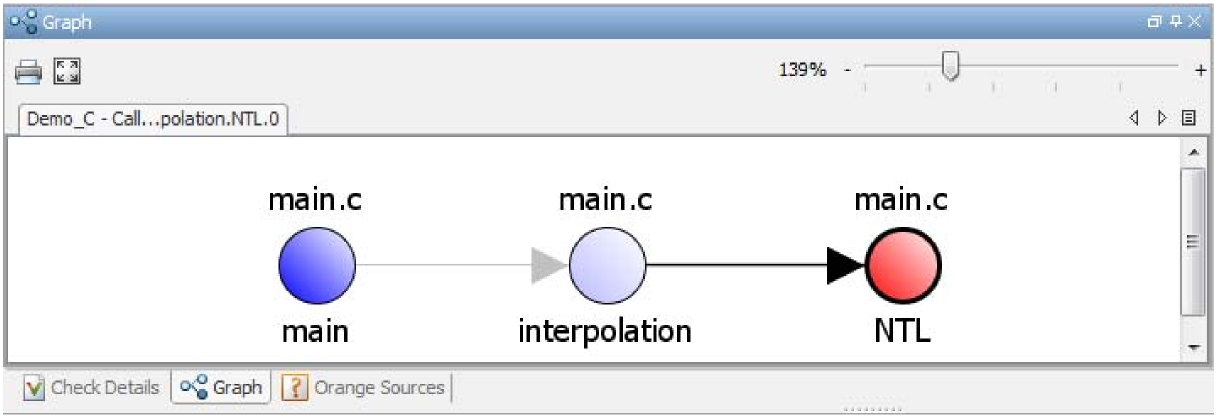
main.cpp / table_loop()

ID 1: Out of bounds array index
Error: array index is outside its bounds : [0..3]
array size: 4
array index value: -1

```
41  array[j-1]->Draw();
```

Error Call Graph

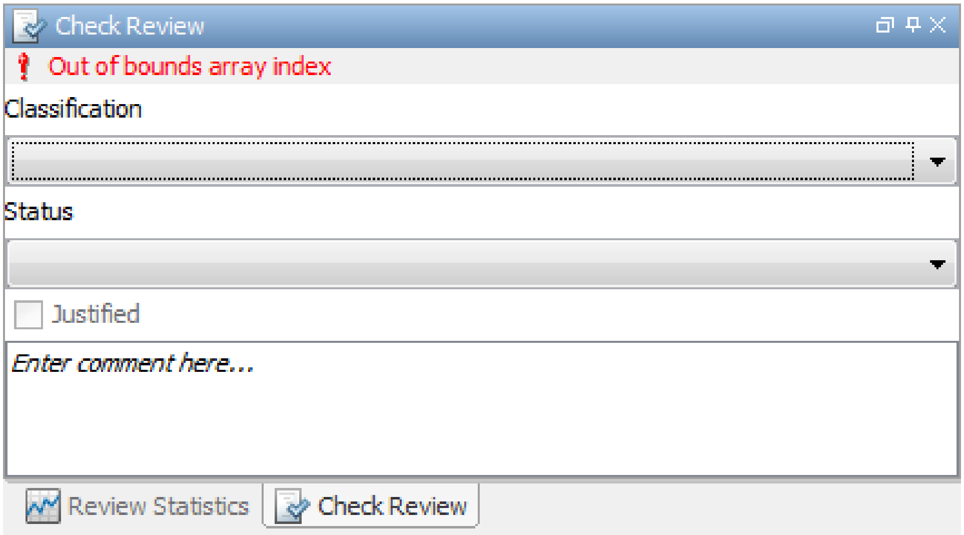
Click the **Show error call graph** icon, in the **Check Details** pane toolbar to display the call sequence that leads to the code associated with a check.



For more information, see “Display Call Sequence for a Check” on page 9-41.

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.


Check Review

Out of bounds array index

Classification

Status

□ Justified

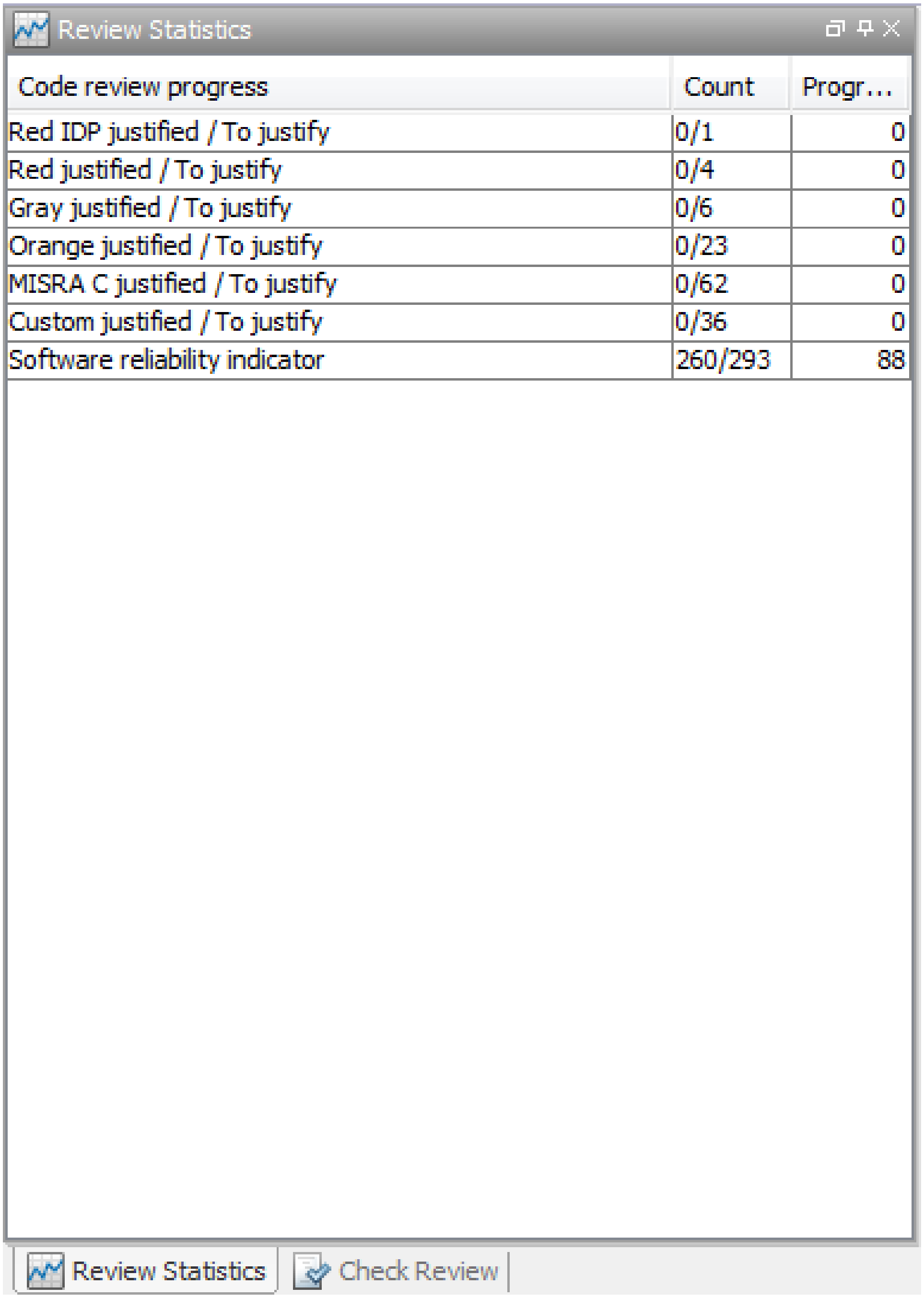
Enter comment here...

For more information, see “Review and Comment Checks” on page 9-17.

Review Statistics

The **Review Statistics** view displays statistics about how many run-time checks and coding rule violations you have reviewed. As you review checks, the software updates these statistics.

Consider the following **Review Statistics** view:



Code review progress	Count	Progr...
Red IDP justified / To justify	0/1	0
Red justified / To justify	0/4	0
Gray justified / To justify	0/6	0
Orange justified / To justify	0/23	0
MISRA C justified / To justify	0/62	0
Custom justified / To justify	0/36	0
Software reliability indicator	260/293	88

The **Count** column displays a ratio and the **Progress** column displays the equivalent percentage.

The first row displays the ratio of justified checks to total checks that have the same color and category of the current check. In this case, the first row displays the ratio of reviewed red IDP checks to total red IDP errors in the project.

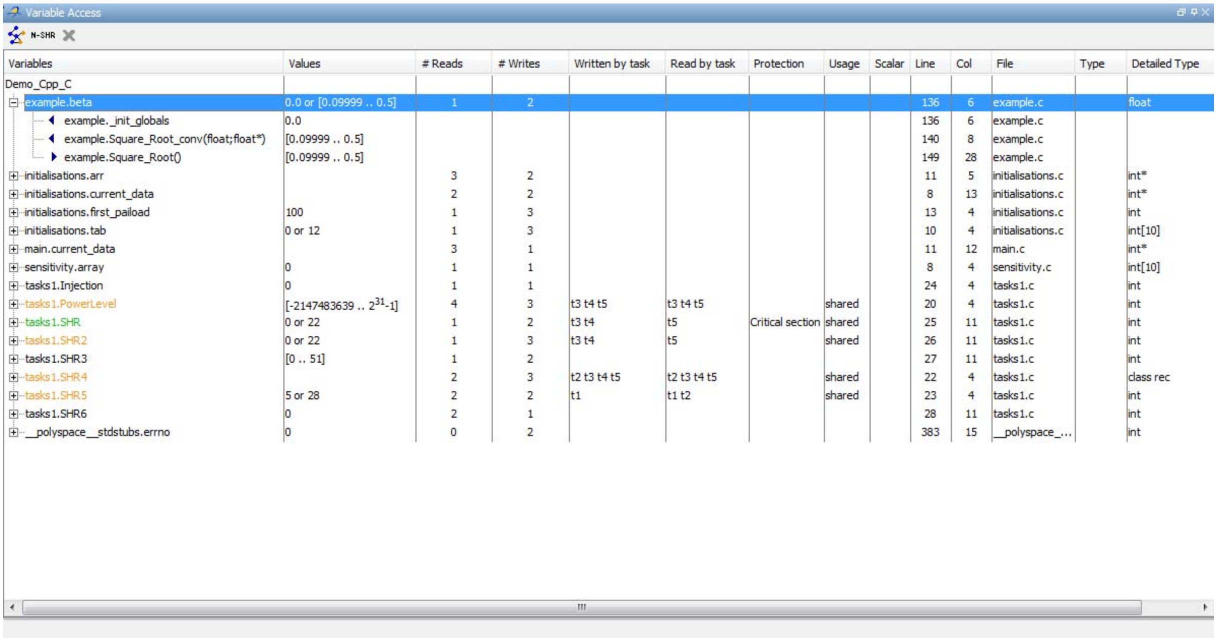
The second, third, and fourth rows display the ratio of justified checks to total checks for red, gray, and orange checks respectively.

If you specified coding rules checking, the next row displays the ratio of justified coding rule violations to total coding rule violations.

The last row displays the ratio of the number of green checks to the total number of run-time checks, providing an indicator of the reliability of the software.

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.



Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Scalar	Line	Col	File	Type	Detailed Type
Demo_Cpp_C													
example.beta	0.0 or [0.09999 .. 0.5]	1	2						136	6	example.c		float
example._init_globals	0.0								136	6	example.c		
example.Square_Root_conv(float;float*)	[0.09999 .. 0.5]								140	8	example.c		
example.Square_Root()	[0.09999 .. 0.5]								149	28	example.c		
initialisations.arr		3	2						11	5	initialisations.c		int*
initialisations.current_data		2	2						8	13	initialisations.c		int*
initialisations.first_paiload	100	1	3						13	4	initialisations.c		int
initialisations.tab	0 or 12	1	3						10	4	initialisations.c		int[10]
main.current_data		3	1						11	12	main.c		int*
sensitivity.array	0	1	1						8	4	sensitivity.c		int[10]
tasks1.Injection	0	1	1						24	4	tasks1.c		int
tasks1.PowerLevel	[-2147483639 .. 2^{31}-1]	4	3	t3 t4 t5	t3 t4 t5		shared		20	4	tasks1.c		int
tasks1.SHR	0 or 22	1	2	t3 t4	t5	Critical section	shared		25	11	tasks1.c		int
tasks1.SHR2	0 or 22	1	3	t3 t4	t5		shared		26	11	tasks1.c		int
tasks1.SHR3	[0 .. 51]	1	2						27	11	tasks1.c		int
tasks1.SHR4		2	3	t2 t3 t4 t5	t2 t3 t4 t5		shared		22	4	tasks1.c		class rec
tasks1.SHR5	5 or 28	2	2	t1	t1 t2		shared		23	4	tasks1.c		int
tasks1.SHR6	0	2	1						28	11	tasks1.c		int
__polyspace__stdstubs.errno	0	0	2						383	15	__polyspace_...		int

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_NameFile_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

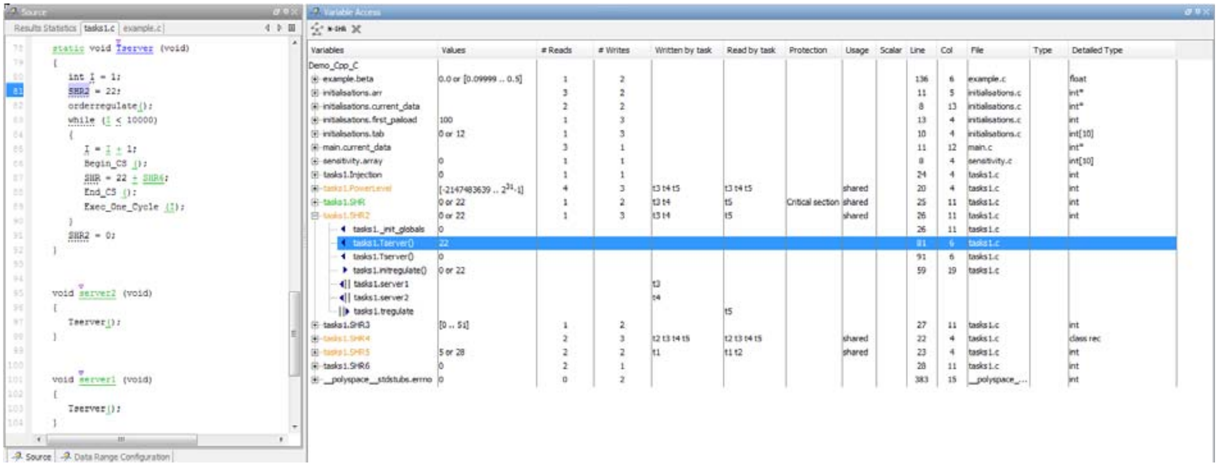
Attribute	Description
Written by task	Name of all tasks writing on variable using aliases, `t1,t2,t3` **Tip** To see the full names for aliases, right-click anywhere on the **Variable Access** pane and select **Show Legend**.
Read by task	Name of all tasks reading variable using aliases, `t1,t2,t3`
Protection	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 "Shared Variables" on page 6-37.
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
Detailed Type	Data type of variable (C/C++ data types or structures/classes)

Double-click a variable name to view all 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 (`-entry-points`)".

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_NameFile_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`:



```
static void Tserver (void)
{
   int I = 1;
   SHR2 = 22;
   orderregulate();
   while (I < 10000)
   {
      I = I + 1;
      Begin_CS ();
      SHR = 22 + SHR6;
      End_CS ();
      Exec_One_Cycle (I);
   }
   SHR2 = 0;
}


void server2 (void)
{
   Tserver();
}


void server1 (void)
{
   Tserver();
}
```

Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Scalar	Line	Col	File	Type	Detailed Type
Demo_Cpp_C													
example.beta	0.0 or [0.09999 .. 0.5]	1	2						136	6	example.c		float
initialisations.arr		3	2						11	5	initialisations.c		int*
initialisations.current_data		2	2						8	13	initialisations.c		int*
initialisations.first_paload	100	1	3						13	4	initialisations.c		int
initialisations.tab	0 or 12	1	3						10	4	initialisations.c		int[10]
main.current_data		3	1						11	12	main.c		int*
sensitivity.array	0	1	1						8	4	sensitivity.c		int[10]
tasks1.Injection	0	1	1						24	4	tasks1.c		int
tasks1.PowerLevel	[-2147483639 .. 2^{31}-1]	4	3	t3 t4 t5	t3 t4 t5		shared		20	4	tasks1.c		int
tasks1.SHR	0 or 22	1	2	t3 t4	t5	Critical section	shared		25	11	tasks1.c		int
tasks1.SHR2	0 or 22	1	3	t3 t4	t5		shared		26	11	tasks1.c		int
◀ tasks1._init_globals	0								26	11	tasks1.c		
◀ tasks1.Tserver()	22								81	6	tasks1.c		
◀ tasks1.Tserver()	0								91	6	tasks1.c		
▶ tasks1.initregulate()	0 or 22								59	19	tasks1.c		
◀|| tasks1.server1				t3									
◀|| tasks1.server2				t4									
||▶ tasks1.tregulate					t5								
tasks1.SHR3	[0 .. 51]	1	2						27	11	tasks1.c		int
tasks1.SHR4		2	3	t2 t3 t4 t5	t2 t3 t4 t5		shared		22	4	tasks1.c		class rec
tasks1.SHR5	5 or 28	2	2	t1	t1 t2		shared		23	4	tasks1.c		int
tasks1.SHR6	0	2	1						28	11	tasks1.c		int
__polyspace__stdstubs.errno	0	0	2						383	15	__polyspace_...		int

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 color scheme for variables in the **Variable Access** pane is:

- Black: global variable.
- Orange: global variable, shared between tasks with no protection against concurrent access.
- Green: global variable, shared between tasks and protected against concurrent access.

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" on page 9-113.

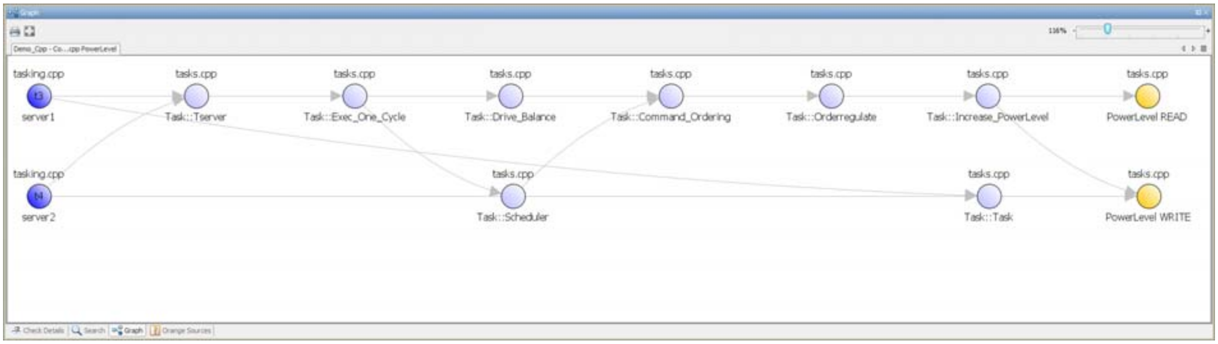
You can also perform the following actions from the **Variable Access** pane.

-

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 “Display Access Graph for Variables” on page 9-48.

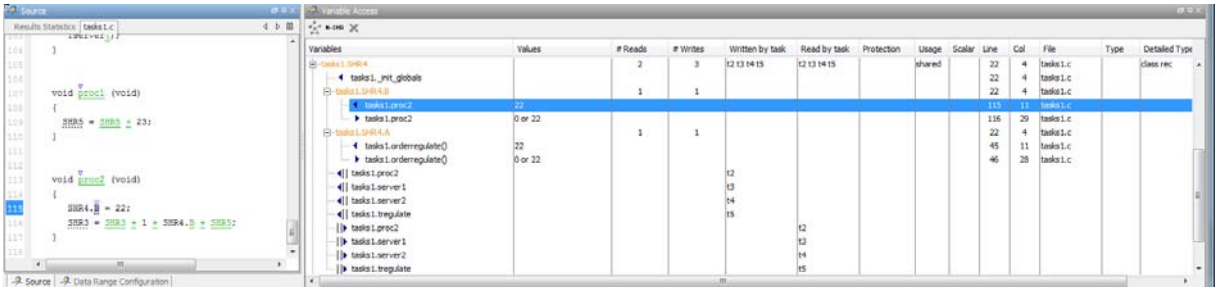
Here is an example of an access graph:



-

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.



```
      tserver();
    }


    void proc1 (void)
    {
      SHR5 = SHR5 + 23;
    }


    void proc2 (void)
    {
      SHR4.B = 22;
      SHR3 = SHR3 + 1 + SHR4.B + SHR5;
    }
```

Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Scalar	Line	Col	File	Type	Detailed Type
tasks1.SHR4		2	3	t2 t3 t4 t5	t2 t3 t4 t5		shared		22	4	tasks1.c		class rec
tasks1._init_globals									22	4	tasks1.c		
tasks1.SHR4.B		1	1						22	4	tasks1.c		
tasks1.proc2	22								115	11	tasks1.c		
tasks1.proc2	0 or 22								116	29	tasks1.c		
tasks1.SHR4.A		1	1						22	4	tasks1.c		
tasks1.orderregulate()	22								45	11	tasks1.c		
tasks1.orderregulate()	0 or 22								46	28	tasks1.c		
tasks1.proc2				t2									
tasks1.server1				t3									
tasks1.server2				t4									
tasks1.tregulate				t5									
tasks1.proc2					t2								
tasks1.server1					t3								
tasks1.server2					t4								
tasks1.tregulate					t5								

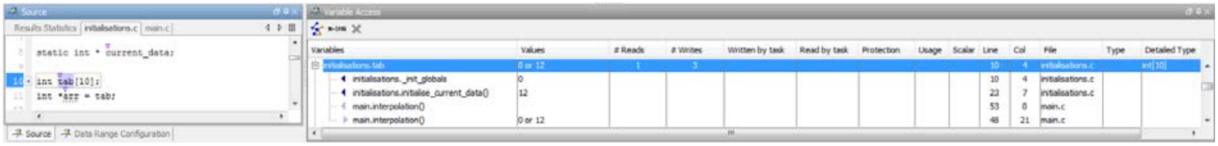
-

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).

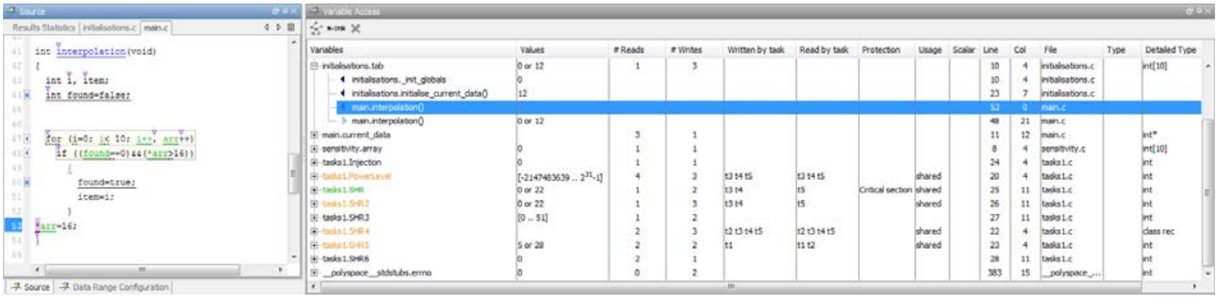
For instance, in the file, `initialisations.c`, the variable, `arr`, is declared as a pointer to the array, `tab`.



```
static int * current_data;

int tab[10];
int *arr = tab;
```

Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Scalar	Line	Col	File	Type	Detailed Type
initialisations.tab	0 or 12	1	3						10	4	initialisations.c		int[10]
initialisations._init_globals	0								10	4	initialisations.c		
initialisations.initialise_current_data()	12								23	7	initialisations.c		
main.interpolation()									53	0	main.c		
main.interpolation()	0 or 12								48	21	main.c		

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.



```
int interpolation(void)
{
  int i, item;
  int found=false;


  for (i=0; i< 10; i++, arr++)
    if ((found==0)&&(*arr>16))
    {
      found=true;
      item=i;
    }
*arr=16;
}
```

Variables	Values	# Reads	# Writes	Written by task	Read by task	Protection	Usage	Scalar	Line	Col	File	Type	Detailed Type
initialisations.tab	0 or 12	1	3						10	4	initialisations.c		int[10]
initialisations._init_globals	0								10	4	initialisations.c		
initialisations.initialise_current_data()	12								23	7	initialisations.c		
main.interpolation()									53	0	main.c		
main.interpolation()	0 or 12								48	21	main.c		
main.current_data		3	1						11	12	main.c		int*
sensitivity.array	0	1	1						8	4	sensitivity.c		int[10]
tasks1.Injection	0	1	1						24	4	tasks1.c		int
tasks1.PowerLevel	[-2147483639 .. 2^{31}-1]	4	3	t3 t4 t5	t3 t4 t5		shared		20	4	tasks1.c		int
tasks1.SHR	0 or 22	1	2	t3 t4	t5	Critical section	shared		25	11	tasks1.c		int
tasks1.SHR2	0 or 22	1	3	t3 t4	t5		shared		26	11	tasks1.c		int
tasks1.SHR3	[0 .. 51]	1	2						27	11	tasks1.c		int
tasks1.SHR4		2	3	t2 t3 t4 t5	t2 t3 t4 t5		shared		22	4	tasks1.c		class rec
tasks1.SHR5	5 or 28	2	2	t1	t1 t2		shared		23	4	tasks1.c		int
tasks1.SHR6	0	2	1						28	11	tasks1.c		int
__polyspace__stdstubs.errno	0	0	2						383	15	__polyspace_...		int

-

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 NS 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 C0
{
public:
  C0() {}
  int get_flag()
  {
    volatile int rd;
    return rd;
  }
  ~C0() {}
private:
  int a;                /* Never read/written */
};

C0 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`.

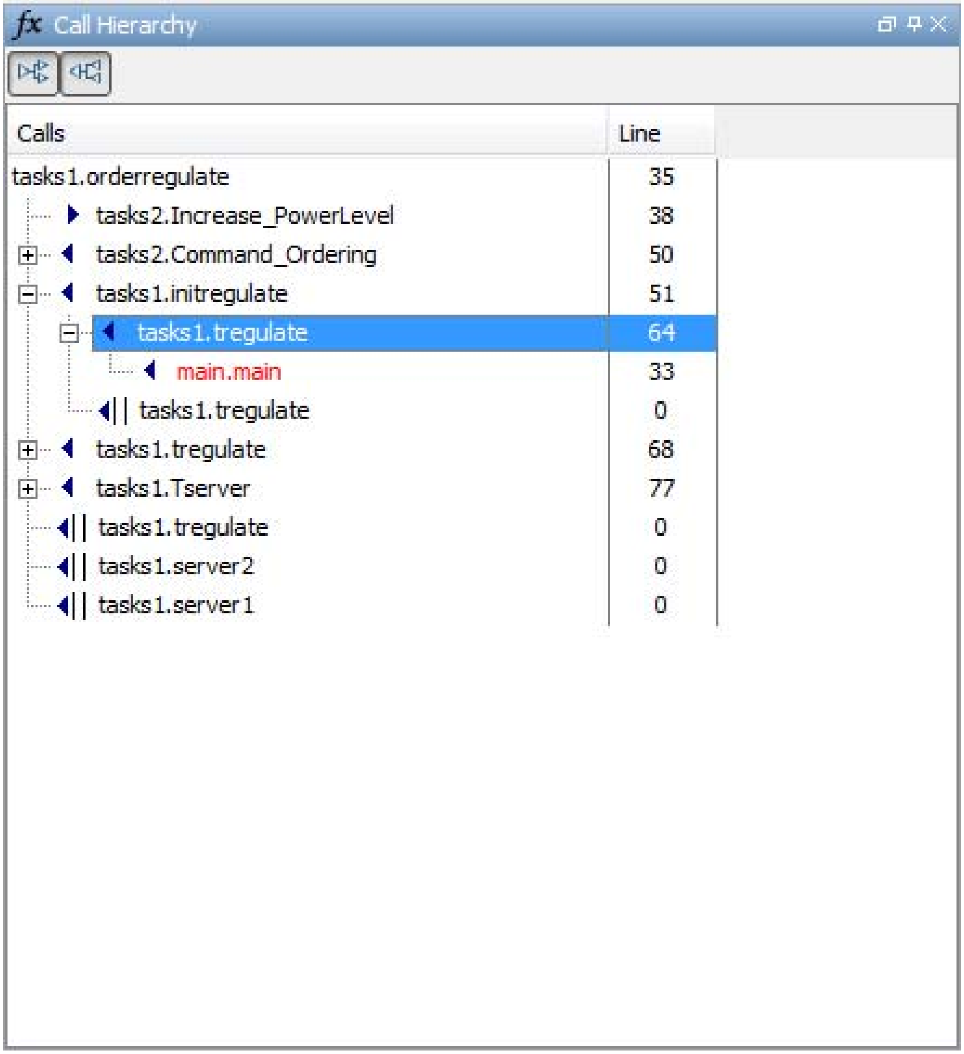
Call Hierarchy

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” on page 9-43.

In the following example, the **Call Hierarchy** pane displays the function, `orderregulate`, in the file, `tasks1.c`. It also displays all the callers and the callees of `orderregulate`.



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.

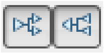
- For a callee name, the number refers to the line where the callee is called. In the preceding example, callee, `tasks2.Increase_PowerLevel`, is called by `tasks1.orderregulate` on line 38.
- For a caller name, the number refers to the line where the caller calls the function. In the preceding example, caller, `tasks2.Command_Ordering`, calls `tasks1.orderregulate` on line 50.

Tip Select a caller or callee name to navigate to the line of code, referred to by the line number, in the **Source** pane (not possible if the caller or callee is a task).

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” on page 9-46.

Understanding Polyspace Results

Polyspace software presents verification results as colored entries in the source code. There are four main colors in the results:

- **Red** – Indicates code that always has an error (errors occur every time the code is executed).
- **Gray** – Indicates unreachable code (dead code).
- **Orange** – Indicates unproven code (code might have a run-time error).
- **Green** – Indicates code proved not to have a run-time error.
- **Dark Orange** – Indicates unproven code that most likely has a run-time error

When reviewing verification results, remember these rules:

- An instruction is verified only if no run-time error is detected in the previous instruction.
- The verification assumes that each run-time error causes a "core dump." The corresponding instruction is considered to have stopped, even if the actual run-time execution of the code might not stop. With orange checks, only the green parts propagate through to subsequent checks.
- Focus on the verification message. Do not jump to false conclusions. You must understand the color of a check step by step, until you find the root cause of a problem.
- Determine the cause by examining the actual code. Do not focus on what the code is supposed to do.

Red Checks

Red checks indicate code that always causes a run-time error.

All 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. Any 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.

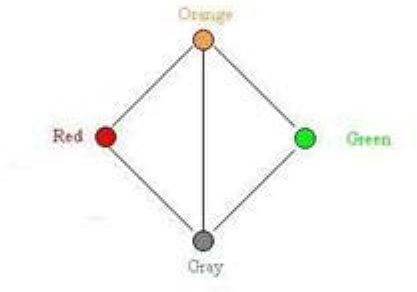
Polyspace verification identifies two kinds of red checks:

- 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 bugs.

Red Checks Where Gray Checks Are Expected

Polyspace Code Prover verification estimates a range for every variable based on the code and the data range specifications. Because of this range estimation, the software can sometimes approximate a check color by a color immediately above it in the following figure:



For instance, the software can approximate a gray check or unreachable code by a red check or proven run-time error. This approximation happens because the software estimate for a variable range is sometimes a superset of actual run-time values of the variable.

A gray check or unreachable code occurs when a variable is tested for values outside its range. For example, consider the statement

```
If (test_var == 5) {
  // Code Section
}
```

If the software finds that `test_var` does not contain the value 5 during the `if` statement, it treats the code section within braces as unreachable. Inside the unreachable code, `test_var` has no valid values. The software however can sometimes estimate the empty range for `test_var` by a non-empty superset. This non-empty superset can lead to a red check inside the unreachable section of code.

This approximation does not cause problems during check review. For both gray and red checks, the execution of the relevant section of code is aborted. Therefore, you must review both checks.

Gray Checks

In this section...

"Gray Checks" on page 9-97

"Common Causes for Gray Checks" on page 9-97

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 9-99
- “Bounded Input Values” on page 9-100

Here, input values refer to all 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 (`-main-generator-calls`)”.
- 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.

```
1 void path(int x) {
2   int result;
3   result = 1 / (x - 10); // Orange ZDV
4  }
5
6  void calls_for_path(void) {
7    path(1);
8    path(10);
9  }
```

The software identifies the orange ZDV check on line 3 as a potential error. The **Check Details** pane indicates the potential error:

```
...
Warning: scalar division by zero may occur
...
```

This ZDV check is orange because, of the two paths that propagate, one path leads to a green ZDV while the other leads to a red ZDV. The first path propagates the value 1, leading to a green ZDV on line 7. The second path propagates the value 10, leading to a red ZDV on line 8. If you select the red check, 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 drs_value; // In addition, you specify DRS [5..10]

void bounded(int x) {
  int result;

  result = tab[x];  // Orange OBAI as x can be equal to 10
}
```

```
9
10 void call_for_bounded(void) {
11   bounded(drs_value);
12 }
```

If you specify a permanent data range of 5 to 10 for the variable `drs_value`, verification generates an orange OBAI check (line 7). 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
```

Understanding 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`.

  All possible 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 stops after this statement. 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 NIV : non initialised variable
   { x++; }     // gray code
  }
  ```

  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 %%

1 void f(int);
2 int read_an_input(void);
3
4 int main(void)
5 {
6  int x,old_x;
7
8   x = read_an_input();
9  old_x = x;
10
11  if (x<0 || x>10)
12   return 0;
13
14  f(x);
15
16  x = 1 / old_x; // division is red
17
18 }
```

```
%% file2.c %%

1 #include <math.h>
2
3 void f(int a)
4 {
5  int tmp;
6  tmp = sqrt(0-a);
7 }
```

A red check occurs on line 16 in `file1.c` because of the following sequence of steps during verification:

1. When `x` is assigned to `old_x` on line 9 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 on line 11 in `file1.c`, `x` is in `[0,10]`. Because `x` and `old_x` are equal, the software assumes that `old_x` is in `[0,10]` as well.
3. When `x` is passed to `f` on line 14 in `file1.c`, the only possible value that `x` can have is 0. All other values lead to a run-time exception on line 6 in `file2.c`, that is `tmp = sqrt(0 a);`.
4. A red error occurs on line 16 in `file1.c` because the software assumes `old_x` to be 0 as well.

- The following example shows how tracing a check backwards 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; // [array index within bounds]
   y[x-1] = (1 / x) + x ;
   if (x == 0)
    y[x] = 1; // gray code on this line
  }
  ```

  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 check on `y[x]=0;` means that subsequent lines deal with `x` in `[0,99]`.
  - The orange 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 all 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 any 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 (`-entry-points`)”.

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” on page 9-83.

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 (`-critical-section-begin/end`)” and “Temporally exclusive tasks (`-temporal-exclusions-file`)”.

Defects Related to Pointers

In this section...

"Messages on Dereferences" on page 9-108

"Variables in Structures (C)" on page 9-110

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" on page 9-108.
- 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)" on page 9-110.

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).

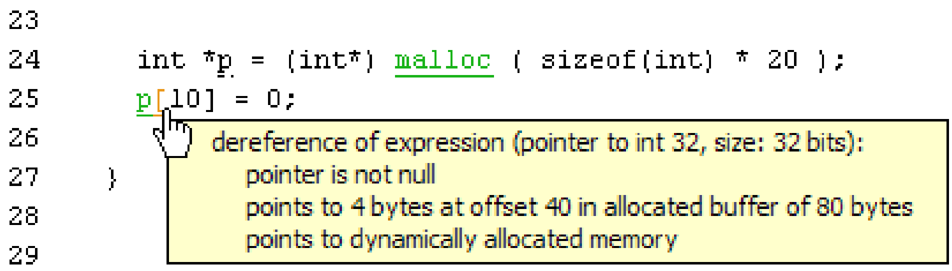
Messages on Dereferences

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.



```
    int *p = (int*) malloc ( sizeof(int) * 20 );
    p[10] = 0;

}
```

dereference of expression (pointer to int 32, size: 32 bits):
pointer is not null
points to 4 bytes at offset 40 in allocated buffer of 80 bytes
points to dynamically allocated memory

`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 (-allow-ptr-arith-on-struct)` .

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

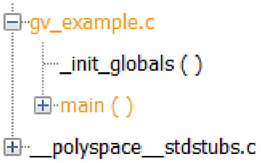
Initializing Global Variables

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`.

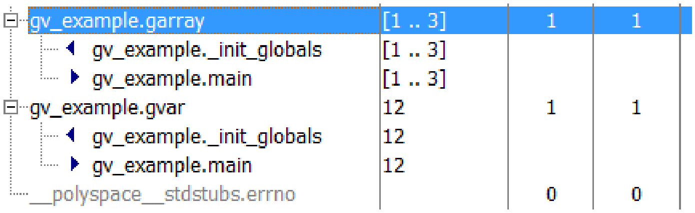
```
extern int func(int);  /* External function */

/* 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:



```
⊟ gv_example.c
    _init_globals ( )
  ⊞ main ( )
⊞ __polyspace__stdstubs.c
```

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.



gv_example.garray	[1 .. 3]	1	1
◀ gv_example._init_globals	[1 .. 3]		
▶ gv_example.main	[1 .. 3]		
gv_example.gvar	12	1	1
◀ gv_example._init_globals	12		
▶ gv_example.main	12		
__polyspace__stdstubs.errno		0	0

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) with no 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" on page 9-43.

  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" on page 9-91.
  - 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 all 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 all global variables and their attributes. For more information, see "Variable Access" on page 9-83. You can also access a graphical representation of the call sequence for global variables using this pane. For more information, see "Display Access Graph for Variables" on page 9-48
  - In text format. Open the file, `*projectname*_Variable_View.txt`, in the folder, `Polyspace-doc`, in your results folder.

Results Folder Contents

In this section...

“Files in the Results Folder” on page 9-114

“Files in the `ALL` Subfolder” on page 9-115

“Files in the `Polyspace-Doc` Subfolder” on page 9-115

“Files in the `Polyspace-Instrumented` Subfolder” on page 9-115

Every time you run a verification, Polyspace Code Prover generates files and folders that contain information about configuration options and verification results. The contents of results folders depend on the configuration options. To learn more about configuration options, see “Analysis Options for C Code”.

By default, each verification produces a new results folder, `Result_project_#`. If you do not want to create a new results folder for every verification, you can write over previous results. On the Project Manager toolbar, clear the **Create new results folder** check box.

Files in the Results Folder

- `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 all 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.

Files in the 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 all expanded source files with a .ci suffix.
- _deadproc.txt — A text file of all unreachable procedures.
- SRC*.[c or h] — Source code file needed for the verification. The file contains user source code and code generated by Polyspace Code Prover.

Files in the Polyspace-Doc Subfolder

The Polyspace-Doc subfolder contains reports generated with the -report-template, -report-output-name, or -report-ouput-format options.

- Code_Metrics.xml — A list of metrics from the most recent verification.
- *CODING_RULES_STD*-report.xml and *CODING_RULES_STD*-summary-report.xml — These files are lists of coding rules violated during the most recent verification. For example:
  - If you specify the -misra2 option, the software generates MISRA-report.xml and MISRA-summary-report.xml, which are lists of violated MISRA rules.
  - If you specify the -jsf-coding-rules option, the software generates JSF-report.xml and JSF-summary-report.xml, which are lists of violated JSF® rules.

Files in the Polyspace-Instrumented Subfolder

The Polyspace-Instrumented folder and files are generated only when you use the Automatic Orange Tester (AOT), that is, when you specify the -automatic-orange-tester option.

- _testgen.tgf — A configuration file for the AOT. The software uses this file to open the AOT user interface.

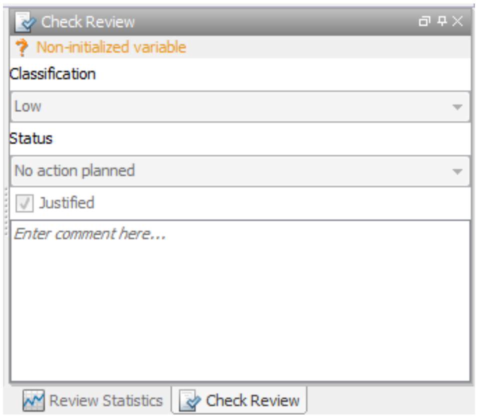
- `reachedchecks.txt` — Contains a list of checks. Some these checks may have been tested by the AOT.
- `stderr` and `stdout` — Contains the output of `stderr` and `stdout` if they are used in the code. The output is generated only when the AOT is used.

Checks with Read-Only Information

In the Results Manager perspective, the software does not allow the modification of the **Justified**, **Comment**, **Classification**, and **Status** attributes of checks when this information is:

- Entered directly in the code as Polyspace comments. See “Annotate Known Run-Time Errors” on page 6-47.
- Entered in Simulink blocks as Polyspace comments and added to the generated code by Embedded Coder. See “Annotate Blocks with Known Errors or Coding-Rule Violations” on page 13-9.
- Derived from comments generated by Embedded Coder. See “Annotate Code to Justify Polyspace Checks” on page 14-7.

The check information appears dimmed.



Check Review

Non-initialized variable

Classification: Low

Status: No action planned

☑ Justified

Enter comment here...

This behavior of the software helps to preserve check information specified through Polyspace code comments. You can overwrite this information only if you modify source comments *and* then run a new verification that specifies the same results folder.

Import and Export Review Comments

In this section...

"Reusing Review Comments" on page 9-118

"Import Review Comments from Previous Verifications" on page 9-118

"View Checks and Comments Report" on page 9-120

Reusing Review Comments

After you have reviewed verification results on a module, you can reuse your review comments with subsequent verifications of the same module. This allows you to avoid reviewing the same check twice, or to compare results over time.

The Results Manager perspective allows you to either:

- Import review comments from another set of results into the current results.
- Export review comments from the current results to a spreadsheet.

You can also generate a report that compares the source code and verification results from two verifications, and highlights differences in the results.

Note If the code has changed since the previous verification, the imported comments may not be applicable to your current results. For example, the justification for an orange check may no longer be relevant to the current code. Open the Import/Export Report to see changes that affect your review comments.

Import Review Comments from Previous Verifications

If you have previously reviewed verification results for a module and saved your comments, you can import those comments into the current verification, allowing you to avoid reviewing the same check twice.

To import review comments from a previous verification:

1. Open your most recent verification results in the Results Manager perspective.

2. Select **Review > Import > Import Comments**.

3. Navigate to the folder containing your previous results.

4. Select the results file with extension `.pscp`, 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" on page 9-120.

To automatically import comments from the last verification, before running your verification:

1. Select **Options > Preferences**, which opens the Polyspace Preferences dialog box.

2. Select the **Project and result folder** tab.

3. Under **Import Comments**, select the **Automatically import comments from last verification** check box.

4. Click **OK**.

Note To automatically import comments from a specific verification, use the batch option `-import-comments`. For example:

```
polyspace-c -version 1.3 -import-comments C:\PolyspaceResults\1.2
```

Once you import checks and comments, the ⇨ icon skips any justified checks, allowing you to review only checks that you have not justified previously.

Note If the code has changed since the previous verification, the imported comments may not be applicable to your current results. For example, the justification for an orange check may no longer be relevant to the current code.

View Checks and Comments Report

Importing review comments from a previous verification can be extremely useful, since it allows you to avoid reviewing checks twice, and to compare verification results over time.

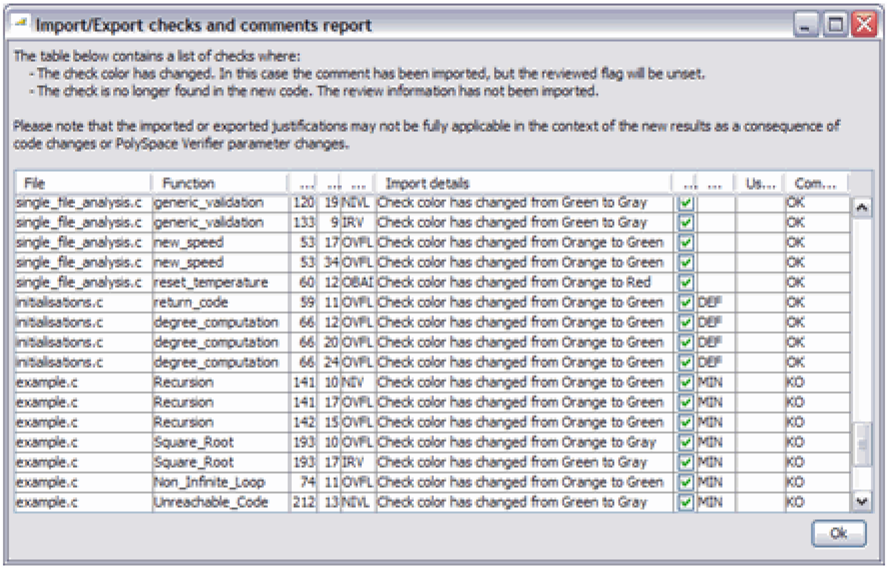
However, if your code has changed since the previous verification, or if you have upgraded to a new version of the software, the imported comments might not be applicable to your current results. For example, the color of a check may have changed, or the justification for an orange check may no longer be relevant to the current code.

The Import/Export checks and comments report allows you to compare the source code and verification results from a previous verification to the current verification, and highlights differences in the results.

To view the Import/Export checks and comments report:

1 Select **Review > Import > Open Import Report**.

The Import/Export checks and comments report opens, highlighting differences in the two results, such as unmatched lines and changes to the color of checks.



The table below contains a list of checks where:

- The check color has changed. In this case the comment has been imported, but the reviewed flag will be unset.
- The check is no longer found in the new code. The review information has not been imported.

Please note that the imported or exported justifications may not be fully applicable in the context of the new results as a consequence of code changes or PolySpace Verifier parameter changes.

File	Function	...	...	...	Import details	...	...	Us...	Com...
single_file_analysis.c	generic_validation	120	19	NIVL	Check color has changed from Green to Gray	☑			OK
single_file_analysis.c	generic_validation	133	9	IRV	Check color has changed from Green to Gray	☑			OK
single_file_analysis.c	new_speed	53	17	OVFL	Check color has changed from Orange to Green	☑			OK
single_file_analysis.c	new_speed	53	34	OVFL	Check color has changed from Orange to Green	☑			OK
single_file_analysis.c	reset_temperature	60	12	OBAI	Check color has changed from Orange to Red	☑			OK
initialisations.c	return_code	59	11	OVFL	Check color has changed from Orange to Green	☑	DEF		OK
initialisations.c	degree_computation	66	12	OVFL	Check color has changed from Orange to Green	☑	DEF		OK
initialisations.c	degree_computation	66	20	OVFL	Check color has changed from Orange to Green	☑	DEF		OK
initialisations.c	degree_computation	66	24	OVFL	Check color has changed from Orange to Green	☑	DEF		OK
example.c	Recursion	141	10	NIV	Check color has changed from Orange to Green	☑	MIN		KO
example.c	Recursion	141	17	OVFL	Check color has changed from Orange to Green	☑	MIN		KO
example.c	Recursion	142	15	OVFL	Check color has changed from Orange to Green	☑	MIN		KO
example.c	Square_Root	193	10	OVFL	Check color has changed from Orange to Gray	☑	MIN		KO
example.c	Square_Root	193	17	IRV	Check color has changed from Green to Gray	☑	MIN		KO
example.c	Non_Infinite_Loop	74	11	OVFL	Check color has changed from Orange to Green	☑	MIN		KO
example.c	Unreachable_Code	212	13	NIVL	Check color has changed from Green to Gray	☑	MIN		KO

If the color of a check changes, the previous review comments are imported, but the check is not marked as reviewed.

If a check no longer appears in the code, the report highlights the change, but the software does not import any comments on the check.

Polyspace Report Generator Overview

The Polyspace Report Generator allows you to generate reports about your verification results, using predefined report templates.

Report Templates

The Polyspace Report Generator provides the following report templates:

- **Coding Rules Report** – Provides information about compliance with MISRA C, MISRA AC AGC, MISRA C++, JSF C++, and custom coding rules, as well as Polyspace configuration settings for the verification.
- **Developer Report** – Provides information useful to developers, including summary results, coding rule violations, detailed lists of red, orange, and gray checks, and Polyspace configuration settings for the verification. Detailed results are sorted by type of check (Proven Run-Time Violations, Proven Unreachable Code Branches, Unreachable Functions, and Unproven Run-Time Checks).
- **Developer Review Report** – Provides the same information as the Developer Report, but reviewed results are sorted by review classification (`High`, `Medium`, `Low`, `Not a defect`) and status, and untagged checks are sorted by file location.
- **Developer with Green Checks Report** – Provides the same content as the Developer Report, but also includes a detailed list of green checks.
- **Quality Report** – Provides information useful to quality engineers, including summary results, statistics about the code, graphs showing distributions of checks per file, and Polyspace configuration settings for the verification.
- **Software Quality Objectives Report** – Provides comprehensive information on software quality objectives (SQO), including code metrics, code analysis (coding-rules checker results), code verification (run-time checks), and the configuration settings for the verification. The code metrics section provides the same information displayed by Polyspace Metrics.

Report Formats

The Polyspace Report Generator allows you to generate verification reports in the following formats:

- HTML
- PDF (version 1.4)
- RTF
- DOC (Microsoft® Word version 2003 or later)
- XML (DocBook 4.2)

Note Microsoft Word format is not available on UNIX platforms. RTF format is used instead.

Note You must have Microsoft Office installed to view .RTF format reports containing graphics, such as the Quality report.

Gray Checks Reported in Summary vs. Check Details

When you generate a report, the number of gray checks reported in the Code Verification Summary section may differ from the number of gray checks listed in the Run-Time Checks Results section. The summary provides the total number of gray checks in your results but the detailed tables in the Run-Time Checks Results section do not list every gray check.

In the details section, only UNR checks are listed, since all gray checks derived from a UNR check do not have to be justified.

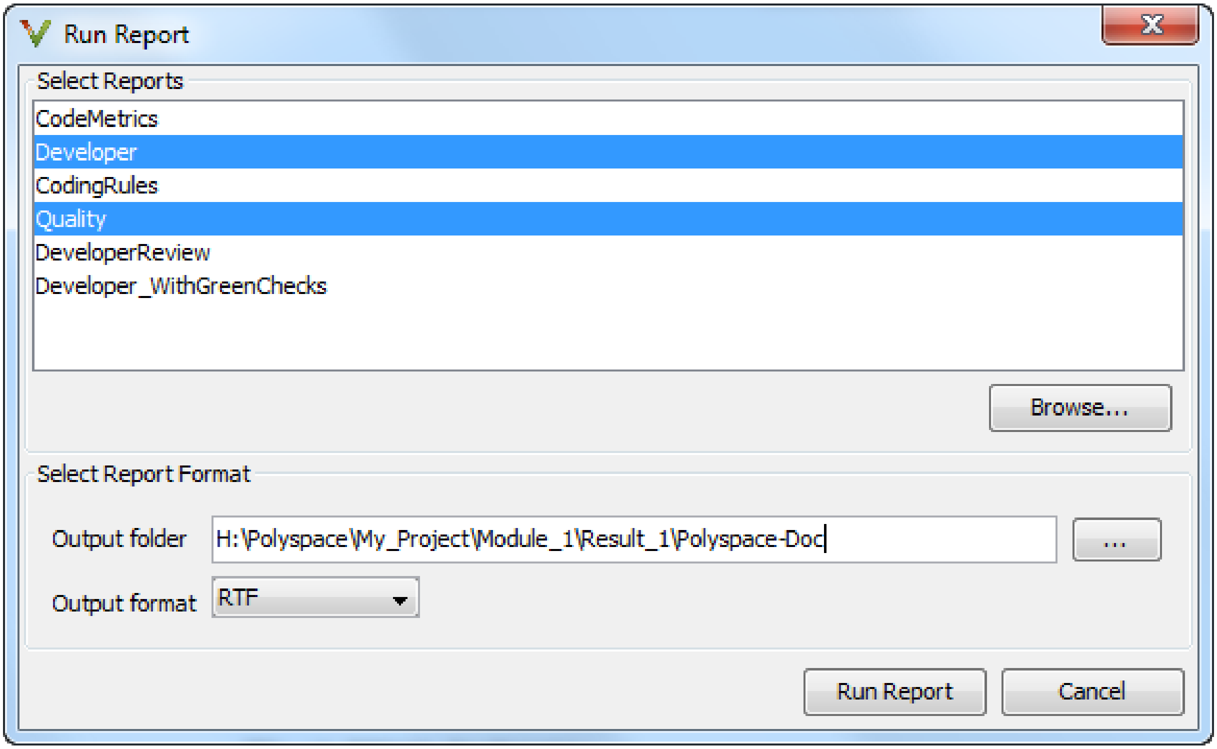
Generate Verification Reports

You can generate reports for any verification results using the Polyspace Report Generator.

To generate a verification report:

1. In the Results Manager perspective, open your verification results.
2. Select **Run > Run Report > Run Report...**.

   The Run Report dialog box opens.
3. In the **Select Reports** section, select the types of reports that you want to generate. For example, you can select **Developer** and **Quality**.



Output folder H:\Polyspace\My_Project\Module_1\Result_1\Polyspace-Doc

Output format RTF

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.

Run the Report Generator from the 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.

Automatically Generate Verification Reports

You can specify that Polyspace software automatically generate reports for each verification using an option in the Project Manager perspective.

Note You cannot generate reports of software quality objectives automatically.

To automatically generate reports for each verification:

1. In the Project Manager perspective, open your project.
2. Select the **Configuration > Reporting** pane.
3. Select the **Generate report** check box.
4. From the **Report template** drop-down list, select a template.
5. From the **Output format** drop-down list, select a format for the report.
6. Save your project.

Customize Verification Reports

If you have MATLAB Report Generator™ software installed on your system, you can customize the Polyspace report templates or create your own reports. You can then generate these custom reports using the Polyspace Report Generator.

Before you can customize Polyspace reports, you must configure the MATLAB Report Generator software to access the following folders:

- **Custom components** – `Matlab_Install/polyspace/toolbox/psrptgen/psrptgen`
- **Report templates** – `Matlab_Install/polyspace/toolbox/psrptgen/templates`

To customize a Polyspace report:

1. Open MATLAB.
2. Add the Polyspace reports custom components folder to the MATLAB search path, using the following command:

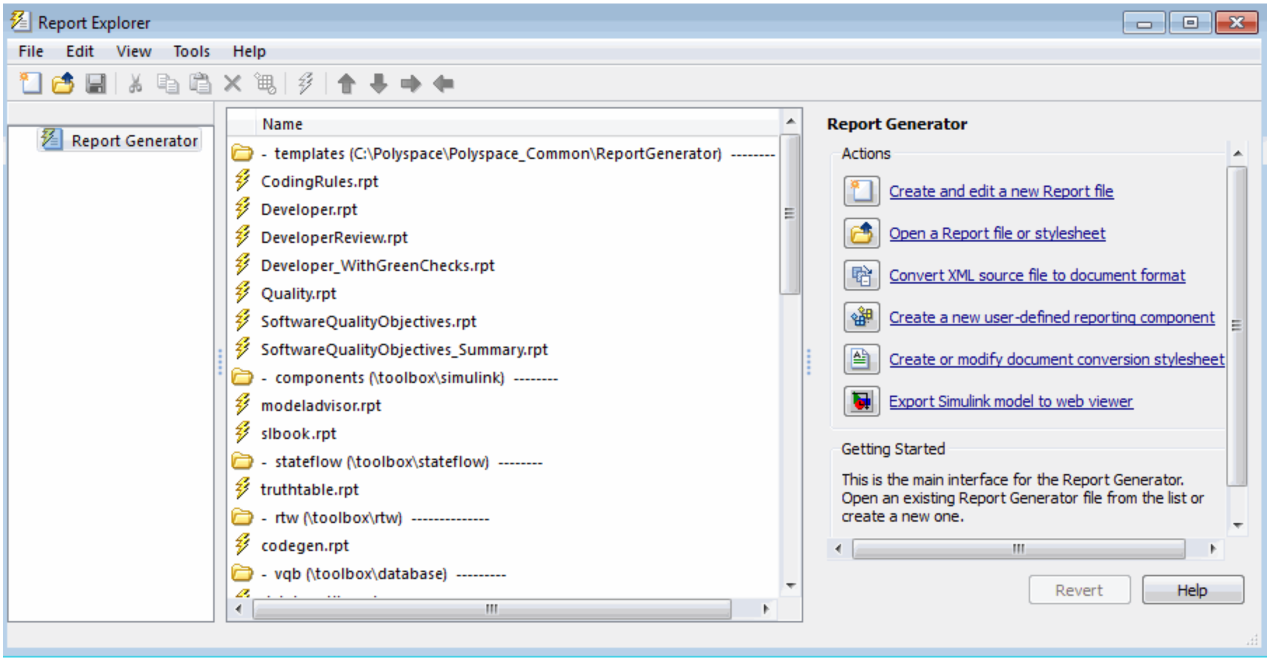
   ```
   addpath('Matlab_Install/polyspace/toolbox/psrptgen/psrptgen')
   ```

3. Set the current folder in MATLAB to the Polyspace reports template folder, using the following command:

   ```
   cd('Matlab_Install/polyspace/toolbox/psrptgen/templates')
   ```

4. Open the Report Explorer using the following command:

   ```
   report
   ```



- templates (C:\Polyspace\Polyspace_Common\ReportGenerator) --------
CodingRules.rpt
Developer.rpt
DeveloperReview.rpt
Developer_WithGreenChecks.rpt
Quality.rpt
SoftwareQualityObjectives.rpt
SoftwareQualityObjectives_Summary.rpt
- components (\toolbox\simulink) --------
modeladvisor.rpt
slbook.rpt
- stateflow (\toolbox\stateflow) --------
truthtable.rpt
- rtw (\toolbox\rtw) --------------
codegen.rpt
- vqb (\toolbox\database) ---------

Create and edit a new Report file
Open a Report file or stylesheet
Convert XML source file to document format
Create a new user-defined reporting component
Create or modify document conversion stylesheet
Export Simulink model to web viewer

This is the main interface for the Report Generator. Open an existing Report Generator file from the list or create a new one.

5 Open the template that you want to customize. For example, double-click `Developer.rpt`. You can add, delete, or alter components of this template.

6 To save the modified template, select **File > Save As**. The Save Report File as dialog box opens. If you are not in the *`Matlab_Install`*`/polyspace/toolbox/psrptgen/templates` folder, navigate to this folder.

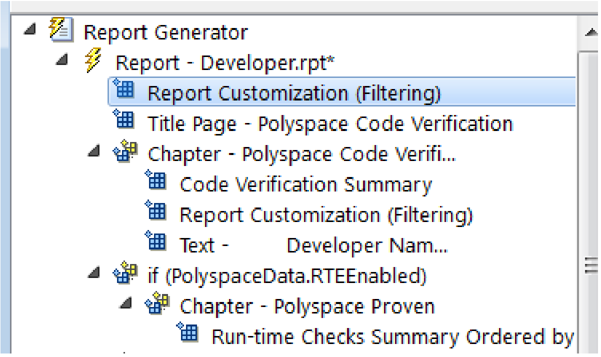
7 In the **File name** field, specify the name of the modified template, for example `Developer_modified.rpt`. Then, click **Save**.

When you next generate a report, `Developer_modified.rpt` will be available as an option in the Run Report dialog box.

Note To produce custom reports with the Polyspace Report Generator, you must save the report template in: *`Polyspace_Install`*`/polyspace/toolbox/psrptgen/templates`.

You can use the **Report Customization (Filtering)** component to apply filters to your report. This component provides a number of filters, for example, for code metrics, coding rules, and run-time checks.

1 From the **Name** list, under **Polyspace**, select the **Report Customization (Filtering)** component. Then drag this component to the required point in the template. For example, if you want to apply global filters to the report, place the component above the **Title Page** component.

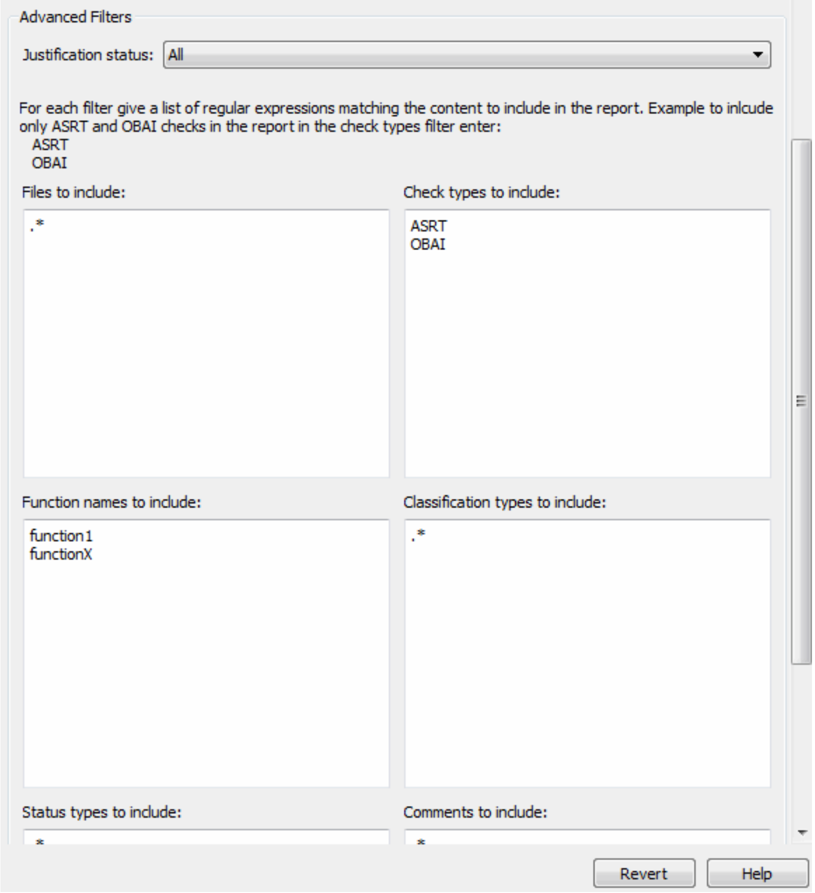


```
Report Generator
  Report - Developer.rpt*
    Report Customization (Filtering)
    Title Page - Polyspace Code Verification
    Chapter - Polyspace Code Verifi...
      Code Verification Summary
      Report Customization (Filtering)
      Text -        Developer Nam...
    if (PolyspaceData.RTEEnabled)
      Chapter - Polyspace Proven
        Run-time Checks Summary Ordered by
```

2 Select the **Report Customization (filtering)** component.

3 On the right of the dialog box, specify your filters. For example, you might want your report to contain only specific run-time checks. In addition, you might want to see these checks for only certain functions. Under **Advanced Filters**:

- In the **Check types to include** field, enter the run-time checks, for example, `ASRT` and `OBAI`.
- In the **Function names to include** field, enter the functions, for example, `function1` and `functionX`.



Advanced Filters

Justification status: All

For each filter give a list of regular expressions matching the content to include in the report. Example to inlcude only ASRT and OBAI checks in the report in the check types filter enter:
ASRT
OBAI

Files to include: .*

Check types to include:
ASRT
OBAI

Function names to include:
function1
functionX

Classification types to include: .*

Status types to include: .*

Comments to include: .*

Note You can also exclude items. For example, to exclude all comments containing the string `GEN`, in the **Comments to include** field, enter the expression `^(?:(?!GEN).)*$` . For more information about regular expressions, refer to *Regular Expressions* in the MATLAB documentation.

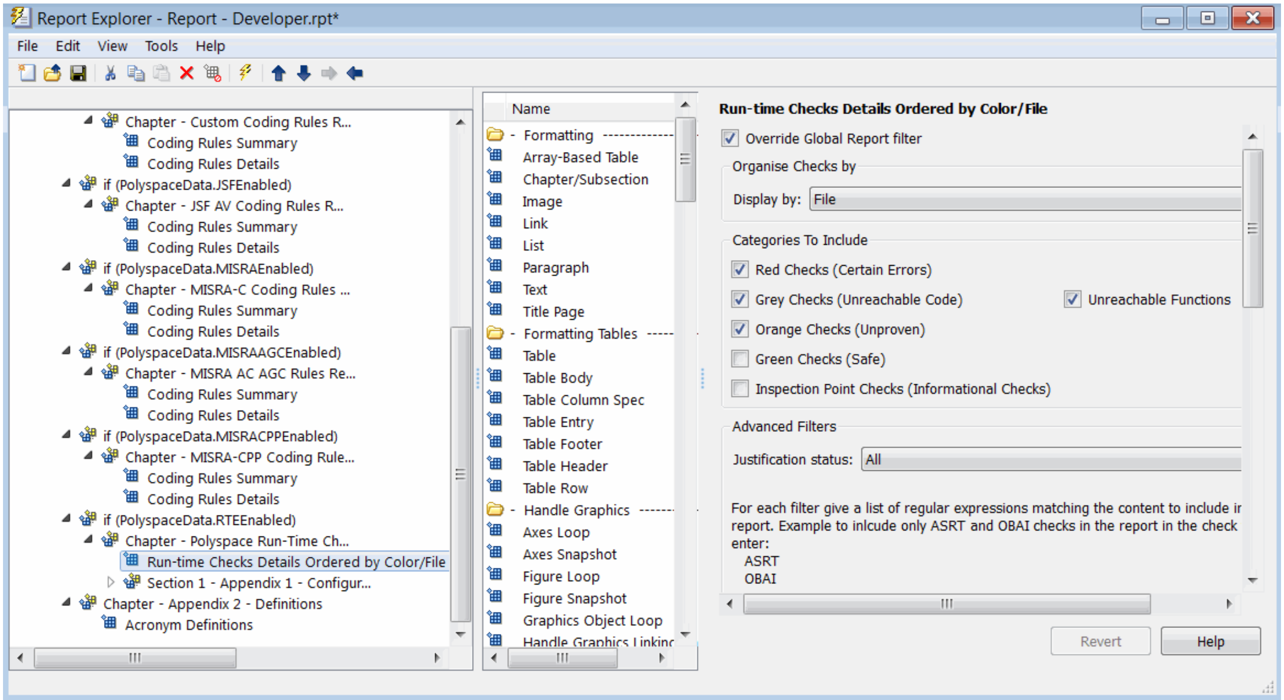
4 Save the modified template.

For the **Run-time Check Details Ordered by Color/File** component, you can override the global filters and specify different filters for this component.

For example, you might want to have a report chapter that contains NIV checks filtered by the global filter.

To override global filters:

1 Select the **Run-time Check Details Ordered by Color/File** component.



Run-time Checks Details Ordered by Color/File

☑ Override Global Report filter

Organise Checks by

Display by: File

Categories To Include

☑ Red Checks (Certain Errors)

☑ Grey Checks (Unreachable Code) ☑ Unreachable Functions

☑ Orange Checks (Unproven)

□ Green Checks (Safe)

□ Inspection Point Checks (Informational Checks)

Advanced Filters

Justification status: All

For each filter give a list of regular expressions matching the content to include ir report. Example to inlcude only ASRT and OBAI checks in the report in the check enter:
ASRT
OBAI

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.

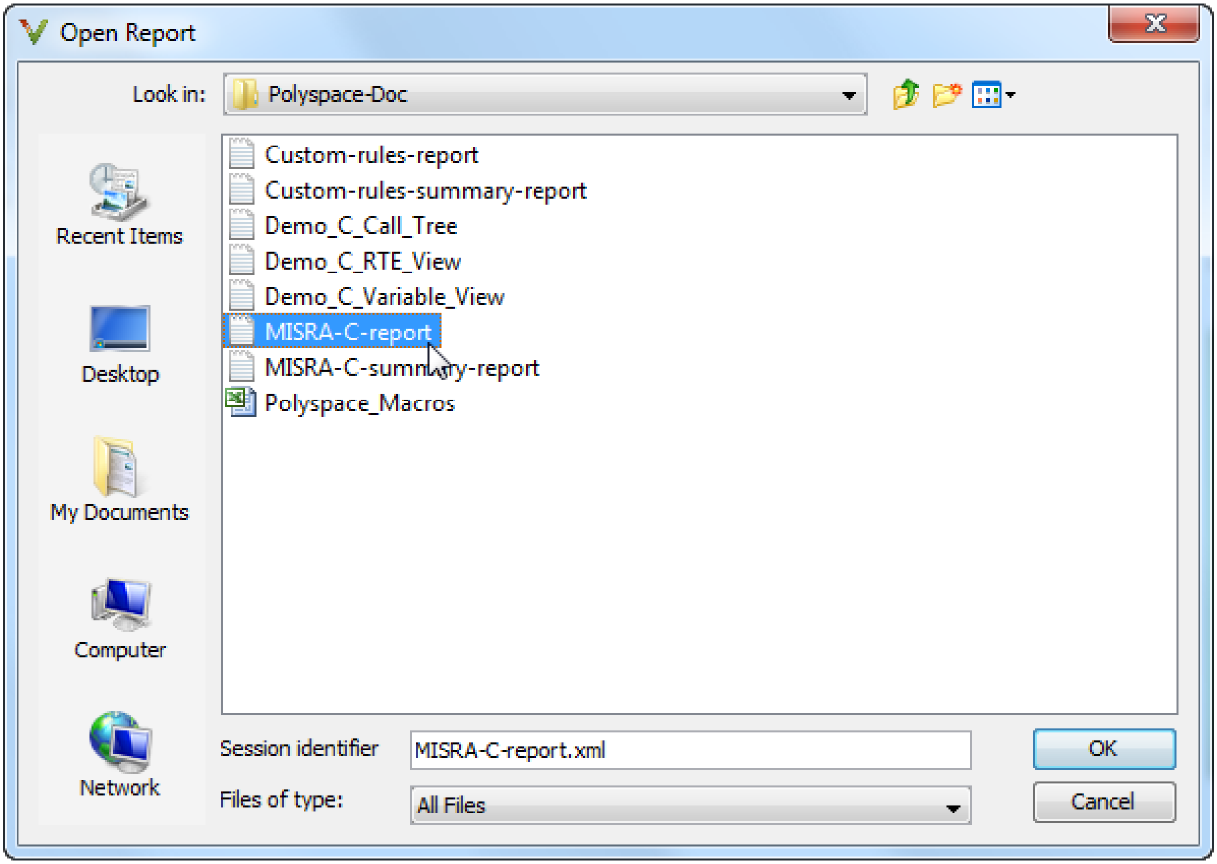
For more information, refer to the MATLAB Report Generator documentation.

Open Verification Report

To view a verification results report:

1 From the Results Manager toolbar, select **Run > Run Report > Open Report**, which opens the Open Report dialog box.

2 Navigate to the folder that contains your report. Then select the report.



Session identifier: MISRA-C-report.xml

Files of type: All Files

3 Click **OK**.

Note Before you can open a verification report, you must specify a text editor. See "Configure Text Editor" on page 3-17.

Managing Orange Checks

- “What is an Orange Check?” on page 10-3
- “Sources of Orange Checks” on page 10-7
- “Do I Have Too Many Orange Checks?” on page 10-12
- “Manage Orange Checks” on page 10-13
- “Overview: Reducing Orange Checks” on page 10-14
- “Apply Coding Rules to Reduce Orange Checks” on page 10-15
- “Use Generated Code” on page 10-16
- “Improve Verification Precision” on page 10-17
- “Specify Multitasking Behavior” on page 10-21
- “Effects of Application Code Size” on page 10-22
- “Overview: Reviewing Orange Checks” on page 10-23
- “Define Your Review Methodology” on page 10-24
- “Perform Selective Review” on page 10-25
- “View Sources of Orange Checks” on page 10-29
- “Prioritize Orange Check Review” on page 10-31
- “Refine Data Range Specifications” on page 10-34
- “Perform Exhaustive Review” on page 10-38
- “Automatic Orange Tester Overview” on page 10-41
- “How the Automatic Orange Tester Works” on page 10-43
- “Select the Automatic Orange Tester” on page 10-45
- “Start the Automatic Orange Tester Manually” on page 10-46

- “Review Test Results After Manual Run” on page 10-50
- “Refine Data Ranges with Automatic Orange Tester” on page 10-54
- “Save and Reuse Your Configuration” on page 10-57
- “Export Data Ranges for Polyspace Verification” on page 10-58
- “Configure Compiler Options” on page 10-59
- “Polyspace-Instrumented Folder” on page 10-61
- “Technical Limitations” on page 10-62

What is an Orange Check?

Orange checks indicate *unproven code*, which means the software cannot prove whether the code leads to a run-time error or not.

Polyspace verification attempts to prove the absence or existence of run-time errors. Therefore, the software considers all code unproven before a verification. During a verification, the software attempts to prove that code is:

- Without run-time errors (green)
- Certain to fail (red)
- Unreachable (gray)

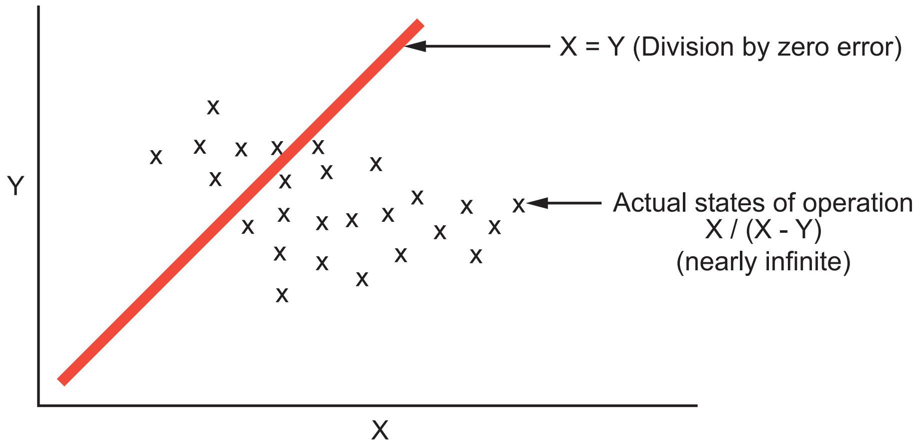
Any code that is not assigned one of these categories (colors) stays unproven (orange).

Code often remains unproven in situations where some execution paths fail while others succeed. For example, in the instruction:

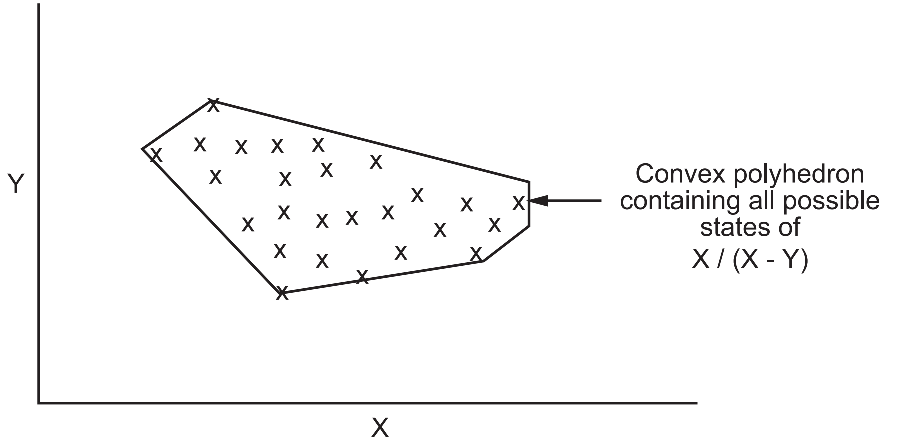
```
X = 1 / (X - Y);
```

the presence or absence of a Division by Zero error depends on the values of *X* and *Y*.

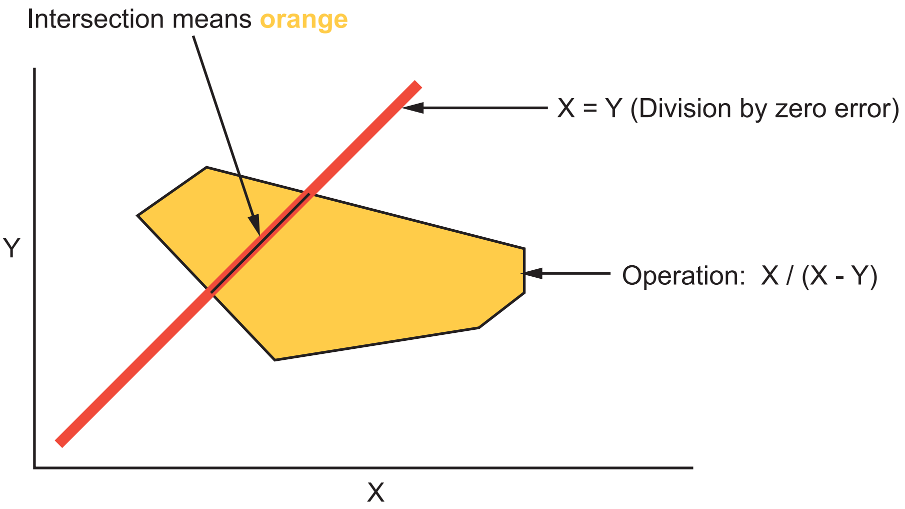
However, there are an almost infinite number of possible values. Creating test cases for all possible values is not practical.



Although it is not possible to test every value for each variable, the target computer and programming language provide limits on the possible values of the variables. Polyspace verification uses these limits to compute a *cloud of points* (upper-bounded convex polyhedron) that contains all possible states for the variables.

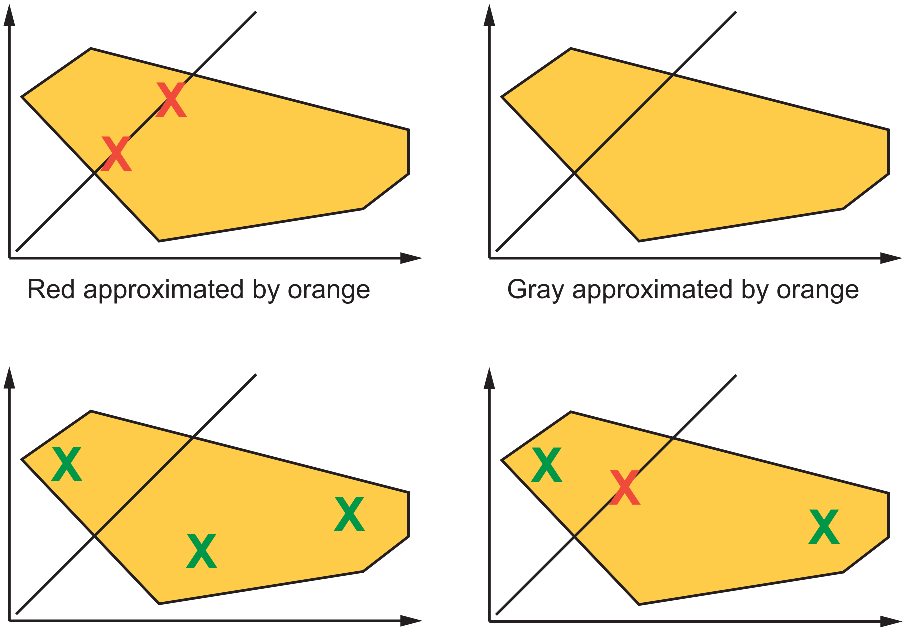


Polyspace verification then compares the data set represented by this polyhedron to possible values leading to an error. If the two data sets intersect, the check is orange.



Graphical Representation of an Orange Check

A true orange check represents a situation where some paths fail while others succeed. However, because the data set used for verification is a superset of actual run-time values, an orange check can represent a check of any other color, as shown below.



Red approximated by orange

Gray approximated by orange

Green approximated by orange

Any other situation (true orange)

Polyspace verification reports an orange check any time the two data sets intersect. Therefore, it is possible that some of the orange checks will lead to errors during run time while others will not.

Sources of Orange Checks

Orange checks can be separated into two categories:

In this section…

"Orange Checks from Code" on page 10-7

"Orange Checks from Verification Limitations" on page 10-9

Orange Checks from Code

Most orange checks are caused by the code. These checks can represent real bugs or execution paths that are not relevant for your application.

An orange check can occur when the verification finds an error for certain:

- "Data Values" on page 10-7
- "Function Sequences" on page 10-8

Data Values

An orange check can reveal code that will fail for certain data values.

For example, consider the function `Recursion()`:

```
int Recursion(int i)
 {
   if (i>10)
       return(1);
   else
       return(i/Recursion(i+1));
   }
```

If the initial value passed to `Recursion()` is negative, then the recursive loop will at some point attempt a division by zero. Therefore, the division operation causes an orange `Division by Zero` check.

When an orange check occurs for certain data values, you can usually identify the cause quickly. The range information provided in the Results Manager perspective can help you identify whether the orange check represents a bug that should be fixed. See "Use Range Information in the Results Manager" on page 9-53.

If the orange check represents a situation that cannot occur (say, if the initial value in the above example cannot be negative), you can do one of the following:

- Annotate the code to justify the check. For more information, see "Annotate Known Run-Time Errors" on page 6-47.
- Modify the code to help Polyspace determine actual run-time values of variables. In the above example, rewrite the code as

```
int Recursion(int i)
 {
   if(i>0)
      {if (i>10)
         return(1);
       else
         return(i/Recursion(i+1));
      }
   else
     return(1);
  }
```

- Constrain the data ranges used in the verification using DRS. For more information, see "Overview of Data Range Specifications (DRS)" on page 5-54.

Function Sequences

An orange check can occur if the verification finds an error for certain function sequences in the automatically generated main.

For example, consider a variable X, and two functions, F1 and F2:

- F1 makes the assignment X = 12.
- F2 divides a local variable by X.
- The automatically generated main (F0) initializes *X* to 0.

- The generated main then randomly calls the functions in the following sequence:

  ```
  If (random)
   Call F1
   Call F2
  Else
   Call F2
   Call F1
  ```

A `Division by Zero` error occurs when `F1` is called after `F2`. Therefore, the division operation in `F2` causes an orange check. The verification cannot determine if an error will occur unless you define the call sequence.

Many inconclusive orange checks take some time to investigate, due to the complexity of the code. When an orange check is caused by function sequence, you have several options:

- Provide manual stubs for some functions. For more information, see "Constrain Data with Stubbing" on page 6-12.
- Use `-main-generator` options to describe the function call sequence, or to specify a function called before the main. For more information, see "Specify Call Sequence" on page 5-35.
- Write defensive code to prevent potential problems.
- Annotate the code to justify the check. For more information, see "Annotate Known Run-Time Errors" on page 6-47.

Orange Checks from Verification Limitations

Some orange checks are caused by limitations of the verification process itself.

In these cases, the orange check is a false positive, because the code does not contain an actual bug. However, these types of orange checks can suggest design issues with the code.

Orange checks from verification limitations can be caused by:

- "Code Complexity" on page 10-10
- "Imprecise Approximation" on page 10-11

Code Complexity

An orange check can occur when the code structure is too complex to be verified by Polyspace software.

When a code is extremely complex, the verification cannot conclude whether a problem exists. The software then reports an orange check in the results.

For example, consider the following sequence of operations on a variable *Computed_Speed*:

- *Computed_Speed* is first copied into a signed integer (between -2^31 and 2^31-1).
- *Computed_Speed* is then copied into an unsigned integer (between 0 and 2^31-1).
- *Computed_Speed* is next copied into a signed integer again.
- Finally, *Computed_Speed* is added to another variable.

Polyspace verification reports an orange `Overflow` on the addition.

Although this type of orange check does not indicate a real bug, it does suggest that the code might be poorly designed.

Orange checks caused by code complexity often take some time to investigate, but generally share certain characteristics:

- Code complexity problems usually result in multiple orange checks in the same module.
- The multiple checks in the same module are often related. Further analysis often reveals that the checks pertain to a single variable or function.

Depending on the criticality of the function and the required speed of execution, you can rewrite the code to remove risk of failure.

To limit the number of orange checks caused by code complexity, you can:

- Enforce coding rules during development. For more information, see "Overview of Polyspace Code Analysis" on page 11-2.

- Perform unit-by-unit verification to verify smaller sections of code. For more information, see “Run unit by unit verification (`-unit-by-unit`)”.

Imprecise Approximation

An orange check can be caused by imprecise approximation of the data set used for verification.

Static verification uses approximations of software operations and data. For certain code constructions, these approximations can lead to a loss of precision. This loss of precision can cause orange checks in the verification results.

For example, consider a variable *X*:

- Before the function call, *X* is defined as having the following values: `-5`, `-3`, `8`, or any value in range `[10...20]`.
  This means that `0` has been excluded from the set of possible values for *X*.
- However, due to optimization (especially at low precision levels), the verification approximates *X* in the range `[-5...20]`, instead of the previous set of values.
- The instruction `y = 1/x` causes an orange `Division by Zero` error.

Polyspace verification is unable to prove the absence of a run-time error in this case.

In cases of imprecise approximations, you can resolve orange checks by increasing the precision level. If this does not remove the orange check, review the code to determine the problem. To limit the number of orange checks caused by basic imprecision, avoid code constructions that cause imprecision. For more information, see “Approximations Made by Polyspace Verification”.

Do I Have Too Many Orange Checks?

If the goal of code verification is to prove the absence of run-time errors, you might be concerned by the number of orange checks in your results.

However, the presence of multiple orange checks need not be a cause for concern. There is no ideal minimum number of orange checks for all applications. The minimum number that you want depends on several factors:

- **Development Stage** – When verifying the first version of a software component, focus exclusively on resolving red checks. As development progresses, start considering the orange checks more and more.
- **Application Requirements** – Sometimes, to write provable code, you can compromise with properties such as code size, speed, and portability. Depending on the requirements of your application, you might optimize one or more of these properties at the expense of more orange checks.
- **Quality Goals** – Using Polyspace software, you can meet your quality goals. Therefore, before you verify code, you must define quality goals for your application. These goals should be based on the criticality of the application, as well as time and cost constraints. Based on your quality goals, you can choose to retain a specific minimum number of orange checks in your application.

Therefore, it is essential to understand how to manage the remaining orange checks. For more information, see “Manage Orange Checks” on page 10-13.

Manage Orange Checks

Polyspace verification by itself cannot produce quality code at the end of the development process. Verification helps you measure the quality of your code, identify issues, and achieve your quality goals. To do this, you must effectively integrate Polyspace verification into your development process.

To manage orange checks effectively, perform each of the following steps:

1. Define your quality goals. See “Analysis and Review Criteria” on page 2-4.
2. Set Polyspace analysis options to match your quality goals. See “Specify Options to Match Your Quality Goals” on page 3-18.
3. Define a process to reduce orange checks. See “Overview: Reducing Orange Checks” on page 10-14.
4. Apply the process to work with remaining orange checks.

Overview: Reducing Orange Checks

Actions that reduce orange checks and improve the quality of your code:

- “Apply Coding Rules to Reduce Orange Checks” on page 10-15.
- “Use Generated Code” on page 10-16.

Actions that reduce orange checks through increased verification precision:

- “Improve Verification Precision” on page 10-17.
- “Constrain Data with Stubbing” on page 6-12.
- “Specify Multitasking Behavior” on page 10-21.

Options that reduce orange checks but do not improve code quality or verification precision:

- “Specify Data Ranges for Variables and Functions (Contextual Verification)” on page 5-54.

Each of these actions have trade-offs, either in development time, verification time, or the risk of errors. Therefore, before taking any of these actions, it is important to define your quality goals. For more information, see “Analysis and Review Criteria” on page 2-4.

Your quality goals determine how many orange checks are acceptable, what actions you should take to reduce orange checks, and what you should do with the remaining orange checks.

Apply Coding Rules to Reduce Orange Checks

The number of orange checks in your verification results depends strongly on the coding style used in the project. Applying coding rules is an efficient way of reducing the number of orange checks and improves the quality of your code.

Polyspace allows you to check your code with reference to coding rules:

- If your code complies with the coding rules subset that has a *direct* impact on selectivity, the total number of orange checks decreases substantially and the percentage of orange checks representing real bugs increases.
- Some forms of code construction are known to produce orange checks. If your design avoids these forms of construction, you see fewer orange checks in your verification results. You can avoid these forms of construction by checking that your code complies with the coding rules subset that has an *indirect* impact on selectivity.

You can check compliance with the following coding rule subsets:

- MISRA C "SQO Subset 1 – Direct Impact on Selectivity" on page 11-44 and "SQO Subset 2 – Indirect Impact on Selectivity" on page 11-46
- MISRA AC AGC "SQO Subset 1 – Direct Impact on Selectivity" on page 11-49 and "SQO Subset 2 – Indirect Impact on Selectivity" on page 11-49
- MISRA C++ "SQO Subset 1 – Direct Impact on Selectivity" on page 11-51 and "SQO Subset 2 – Indirect Impact on Selectivity" on page 11-54

For more information on checking coding rules, see "Activate Coding Rules Checker" on page 11-5.

Use Generated Code

Generated code causes fewer orange checks and improves the overall quality of your software.

Generated code obeys a well-defined set of coding rules, which eliminates certain types of coding errors. You observe a higher ratio of green to orange checks in your verification results.

For information about a generated code workflow, see “Simulink Verification”.

Improve Verification Precision

This example shows how to improve the precision of your verification. Improving the verification precision can reduce the number of orange checks in your results. The trade off for this improved precision is increased verification time. Increasing verification precision does not improve the quality of the code itself.

Set Precision Level

The precision level specifies the mathematical algorithm used to compute the cloud of points (polyhedron) containing all possible states for the variables. Changing the precision level does not affect the quality of your code. However, orange checks caused by low precision can become green when verified with higher precision. The default precision level is 2. To set the precision level:

1. In the Project Manager perspective, on the **Configuration** pane, select **Precision**.
2. From the **Precision level** drop-down list, select the appropriate precision level.

Set Verification Level

The verification level specifies how many times the abstract interpretation algorithm passes through your code. Each pass results in a deeper level of propagation of calling and called context. The deeper the verification goes, the more precise it is. By default, verification proceeds to `Software Safety Analysis Level 4`. To set the verification level:

1. In the Project Manager perspective, on the **Configuration** pane, select **Precision**.
2. From the **Verification level** drop-down list, select the appropriated level.

Software Safety Analysis Level 0	Software Safety Analysis Level 1

#include <stdlib.h>
 	
void ratio (float x, float *y)
{
 *y=(abs(x-*y))/(x+*y);
}
 	
void level1 (float x,
     float y, float *t)
{ float v;
 v = y;
 ratio (x, &y);
 *t = 1.0/(v - 2.0 * x);
}
 	
float level2(float v)
{
 float t;
 t = v;
 level1(0.0, 1.0, &t);
 return t;
}
 	
void main(void)
{
 float r,d;
 d= level2(1.0);
 r = 1.0 / (2.0 - d);
}
	#include <stdlib.h>
	
	void ratio (float x, float *y)
	{
	 *y=(abs(x-*y))/(x+*y);
	}
	
	void level1 (float x,
	     float y, float *t)
	{ float v;
	 v = y;
	 ratio (x, &y);
	 *t = 1.0/(v - 2.0 * x);
	}
	
	float level2(float v)
	{
	 float t;
	 t = v;
	 level1(0.0, 1.0, &t);
	 return t;
	}
	
	void main(void)
	{
	 float r,d;
	 d= level2(1.0);
	 r = 1.0 / (2.0 - d);
	}

In the table, verification produces an orange `Division by Zero` check during level 0 verification, but turns to green during level 1. The verification gains more knowledge of `x` as the value is propagated deeper.

Improve Precision of Interprocedural Analysis

This option causes the verification to propagate information within procedures earlier than usual. The precision within each verification level improves. However, using this option can increase verification time. In some cases, a level 1 verification to take longer than a level 4 verification. To use this option:

1 In the Project Manager perspective, on the **Configuration** pane, select **Precision**.

2 Enter the appropriate value in the field, **Improve Precision of interprocedural analysis**.

Provide Sensitivity Context

This option splits each check within a procedure into sub-checks, depending on the context of a call. This improves precision for discrete calls to the procedure. For example, if a check is red for one call to the procedure and green for another, both colors will be revealed. To use this option:

1 In the Project Manager perspective, on the **Configuration** pane, select **Precision**.

2 From the **Sensitivity context** drop-down list, select `none`, `auto` or `custom`.

3 If you select `custom`, to add procedure names, use the ✚ button on the **Procedure** box. The verification will split each check into sub-checks only for those procedures.

Inline Procedures

This option creates clones of the specified procedure for each call to it. Using this option reduces the number of aliases in a procedure and can improve precision. To use this option:

1 In the Project Manager perspective, on the **Configuration** pane, select **Scaling**.

2 To add procedure names, use the ✚ button on the **Procedure** box. The verification will create clones only for those procedures.

Concepts

- "Precision level (`-O`)"
- "Verification level (`-to`)"
- "Improve precision of interprocedural analysis (-path-sensitivity-delta)"
- "Sensitivity context (`-context-sensitivity`)"
- "Inline (`-inline`)"

Specify Multitasking Behavior

The asynchronous characteristics of your application can have a direct impact on the number of orange checks. Specifying characteristics such as implicit task declarations, mutual exclusion, and critical sections can reduce the number of orange checks in your results.

For example, consider a variable `X`, and two concurrent tasks `T1` and `T2`.

- `X` is initialized to `0`.
- `T1` assigns the value `12` to *X*.
- `T2` divides a local variable by *X*.
- A division by zero error is possible because `T1` can be started before or after `T2`, so the division causes an orange `Division by Zero` error.

The verification cannot determine if an error will occur without knowing the call sequence. Modelling the task differently could turn this orange check green or red.

For more information, see "Model Synchronous Tasks" on page 6-31.

Effects of Application Code Size

Polyspace verification can make approximations when computing the possible values of the variables, at any point in the program. Such an approximation will always use a superset of the actual possible values.

For example, in a relatively small application, Polyspace verification might retain very detailed information about the data at a particular point in the code, so that for example the variable VAR can take the values { -2; 1; 2; 10; 15; 16; 17; 25 }. If VAR is used to divide, the division is green (because 0 is not a possible value).

If the program being analyzed is large, Polyspace verification would simplify 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 verification might further simplify the VAR range to (say) [-2; 20].

This phenomenon leads to the increase or the number of orange warnings when the size of the program becomes large.

Note Polyspace verification adjusts the level of simplification based on the required precision level :

- -O0: shorter computation time. Focus only red and gray.
- -O2: less orange warnings.
- -O3: less orange warnings and bigger computation time.

For more information, see ."Precision level (`-O`)".

Overview: Reviewing Orange Checks

After you define a process that matches your quality goals, you end up with a certain number of orange checks for your quality model.

At this point, the goal is not to eliminate orange checks, but to work efficiently with them.

To work efficiently with orange checks:

- “Define Your Review Methodology” on page 10-24
- “Prioritize Orange Check Review” on page 10-31
- “Perform Selective Review” on page 10-25
- “Perform Exhaustive Review” on page 10-38

Define Your Review Methodology

Before reviewing verification results, configure a methodology for your project. The methodology specifies both the type and number of orange checks you need to review. For more information, see "What Are Review Methodologies?" on page 9-23.

As part of the process for defining quality goals for your project:

- Polyspace Code Prover provides four predefined review methodologies. Choose one of the predefined review methodologies to specify the number and type of orange checks to review. For more information, see "Review Checks Using Predefined Methodologies" on page 9-25.
- To control the number and type of orange checks to review, define a custom methodology. For more information, see "Review Checks Using Custom Methodologies" on page 9-29.

  After you define a methodology, each developer can use the methodology to review verification results. This approach ensures that all users apply the same standards when reviewing orange checks at each stage of the development cycle.

Note For information on setting the quality levels for your project, see "Define Software Quality Levels" on page 2-7.

Perform Selective Review

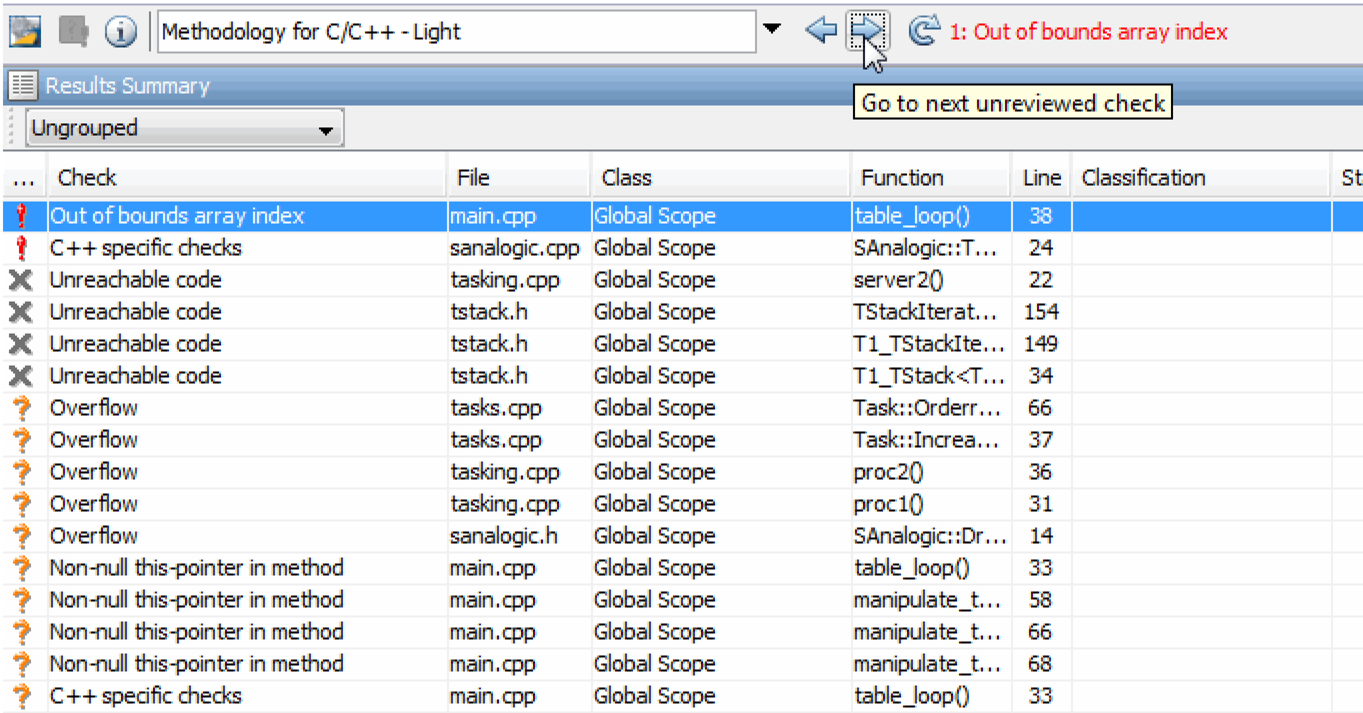
This example shows how to perform a selective orange check review using a predefined methodology. The number and type of orange checks that you review is determined by your review methodology. As a project progresses, change your review methodology to progressively review greater number of orange checks. For example, you can choose the review methodologies, **First checks to review** and **Methodology for C > Light** in the early stages of development. Later, you can choose the methodology, **Methodology for C > Moderate**.

To perform a selective orange review using the methodology **Methodology for C > Light**:

1 In the Results Manager perspective, from the drop-down list above the **Results Summary** pane, select the methodology **Methodology for C > Light**.

2 Select the first check on the **Results Summary** pane.

The **Source** pane displays the source code for this check.


Methodology for C/C++ - Light
1: Out of bounds array index
Go to next unreviewed check
Results Summary
Ungrouped

...	Check	File	Class	Function	Line	Classification	St
!	Out of bounds array index	main.cpp	Global Scope	table_loop()	38		
!	C++ specific checks	sanalogic.cpp	Global Scope	SAnalogic::T...	24		
✗	Unreachable code	tasking.cpp	Global Scope	server2()	22		
✗	Unreachable code	tstack.h	Global Scope	TStackIterat...	154		
✗	Unreachable code	tstack.h	Global Scope	T1_TStackIte...	149		
✗	Unreachable code	tstack.h	Global Scope	T1_TStack<T...	34		
?	Overflow	tasks.cpp	Global Scope	Task::Orderr...	66		
?	Overflow	tasks.cpp	Global Scope	Task::Increa...	37		
?	Overflow	tasking.cpp	Global Scope	proc2()	36		
?	Overflow	tasking.cpp	Global Scope	proc1()	31		
?	Overflow	sanalogic.h	Global Scope	SAnalogic::Dr...	14		
?	Non-null this-pointer in method	main.cpp	Global Scope	table_loop()	33		
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	58		
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	66		
?	Non-null this-pointer in method	main.cpp	Global Scope	manipulate_t...	68		
?	C++ specific checks	main.cpp	Global Scope	table_loop()	33		

3 Perform a quick code review on each orange check. Your goal is to quickly identify whether the orange check is a:

- Potential bug — code that will fail under some circumstances.
- Inconclusive check — check that requires additional information to resolve, such as the call sequence.
- Data set issue — check originating from a set of data that cannot actually occur.

Note If you cannot understand an orange check quickly, it can be caused by complex code structure or approximate data set used for verification. These checks can often take a substantial amount of time to understand.

---

4 If you cannot identify a cause for the check, proceed to the next check.

5. Once you understand the cause of an orange check, record your review on the **Check Review** pane.

   a. Select a **Classification** to describe the severity of the issue:

      - `High`
      - `Medium`
      - `Low`
      - `Not a defect`

   b. 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, which then appear in the user-defined acronym menu.

   c. In the text box, enter a comment for the reviewed check.

6. Click ⇨ to navigate to the next check, and repeat steps 3, 4, 5 and 6.

7. Continue to click ⇨ until you have reviewed all of the checks identified on the **Results Summary** pane.

8. Select **File > Save** to save your review comments.

Tip The goal of a selective orange review is to find the maximum number of bugs in a short period of time. Many orange checks take only a few seconds to understand. To maximize the number of defects you can identify, focus on those checks you can understand quickly. Leave the checks that take longer to understand for later analysis.

Related Examples

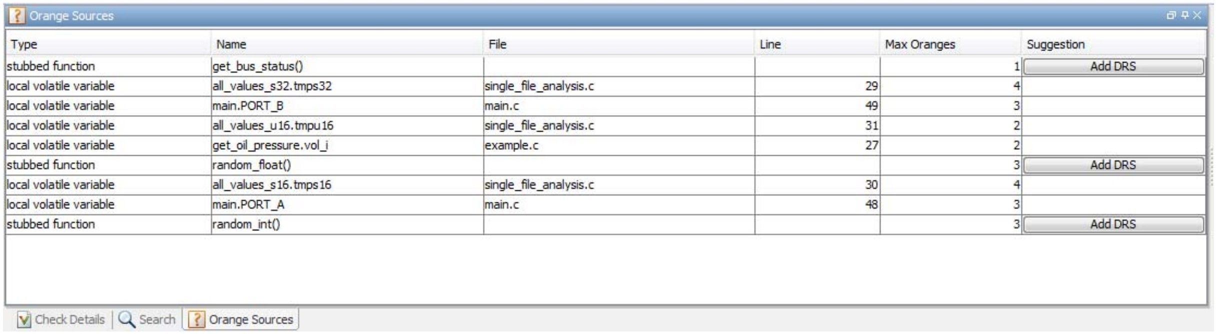
- "Customize Review Status" on page 9-49

Concepts

- "Sources of Orange Checks" on page 10-7

View Sources of Orange Checks

During a verification, the software identifies code that might be the source of orange checks. To view these possible sources of orange checks, in the Results Manager perspective, select **Window > Show/Hide View > Orange Sources**.



Type	Name	File	Line	Max Oranges	Suggestion
stubbed function	get_bus_status()			1	Add DRS
local volatile variable	all_values_s32.tmps32	single_file_analysis.c	29	4	
local volatile variable	main.PORT_B	main.c	49	3	
local volatile variable	all_values_u16.tmpu16	single_file_analysis.c	31	2	
local volatile variable	get_oil_pressure.vol_i	example.c	27	2	
stubbed function	random_float()			3	Add DRS
local volatile variable	all_values_s16.tmps16	single_file_analysis.c	30	4	
local volatile variable	main.PORT_A	main.c	48	3	
stubbed function	random_int()			3	Add DRS

You can see the following information about code that is the source of orange checks:

- **Type** — Type of code element, for example, stubbed function, volatile variable
- **Name** — Name of code element
- **File** — Name of source file
- **Line** — Line number in source file
- **Max Oranges** — Maximum number of orange checks arising from code element
- **Suggestion** — How you can fix the orange check. For example, **Add DRS** suggests that adding a data range specification mighty resolve the orange check.

Note In rare cases, the **Max Oranges** value may be an approximate value of the maximum number of orange checks.

You can sort the information by category. For example, to sort the information by file name, click **File**.

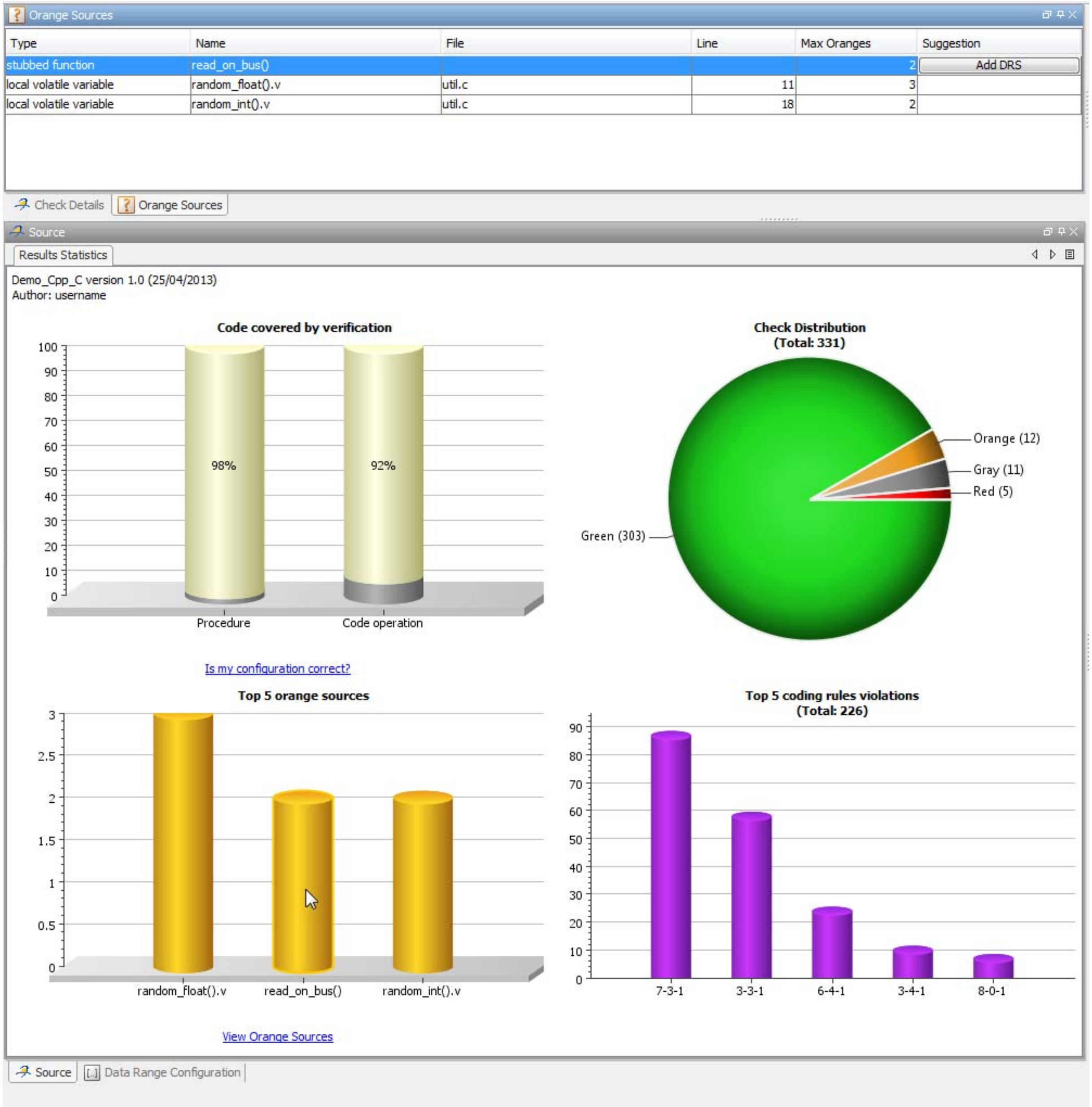
If the orange source is a variable, to see the line of code where the check occurs, on the **Orange Sources** tab, select the source.

Prioritize Orange Check Review

This example shows how to prioritize your review of orange checks using the **Top 5 orange sources** graph in the **Results Statistics** pane. If there are sources (variables or functions) affecting a large number of orange checks, this method can quickly reduce the number of orange checks.

1. Open a verification result file, with extension `.pscp`.
2. On the **Results Statistics** pane, select a column in the **Top 5 orange sources** graph.

   Further information about the orange source represented by the column is displayed in the **Orange Sources** pane.



Orange Sources

Type	Name	File	Line	Max Oranges	Suggestion
stubbed function	read_on_bus()			2	Add DRS
local volatile variable	random_float().v	util.c	11	3	
local volatile variable	random_int().v	util.c	18	2	

Demo_Cpp_C version 1.0 (25/04/2013)
Author: username

Is my configuration correct?

View Orange Sources

3 Click the Add DRS button. to add data range specification to that source from the **Orange Sources** pane. You can add data range specification for:

- Global variables
- Stubbed functions
- User-defined functions

4 Repeat step 3 for all the columns in the **Top 5 orange sources** graph.

Note You cannot specify data ranges for volatile variables. Polyspace Code Prover assumes that such variables can take all allowed values.

5 Rerun the verification. Reopen the verification result file.

If the checks were caused by input values that Polyspace Code Prover assumed for the sources, you might see a reduction in the number of orange checks.

6 Repeat all of these steps in the newly generated **Results Statistics** pane. If the same orange source appears as before, consider narrowing the data range before rerunning verification.

Related Examples

- “Refine Data Range Specifications” on page 10-34

Concepts

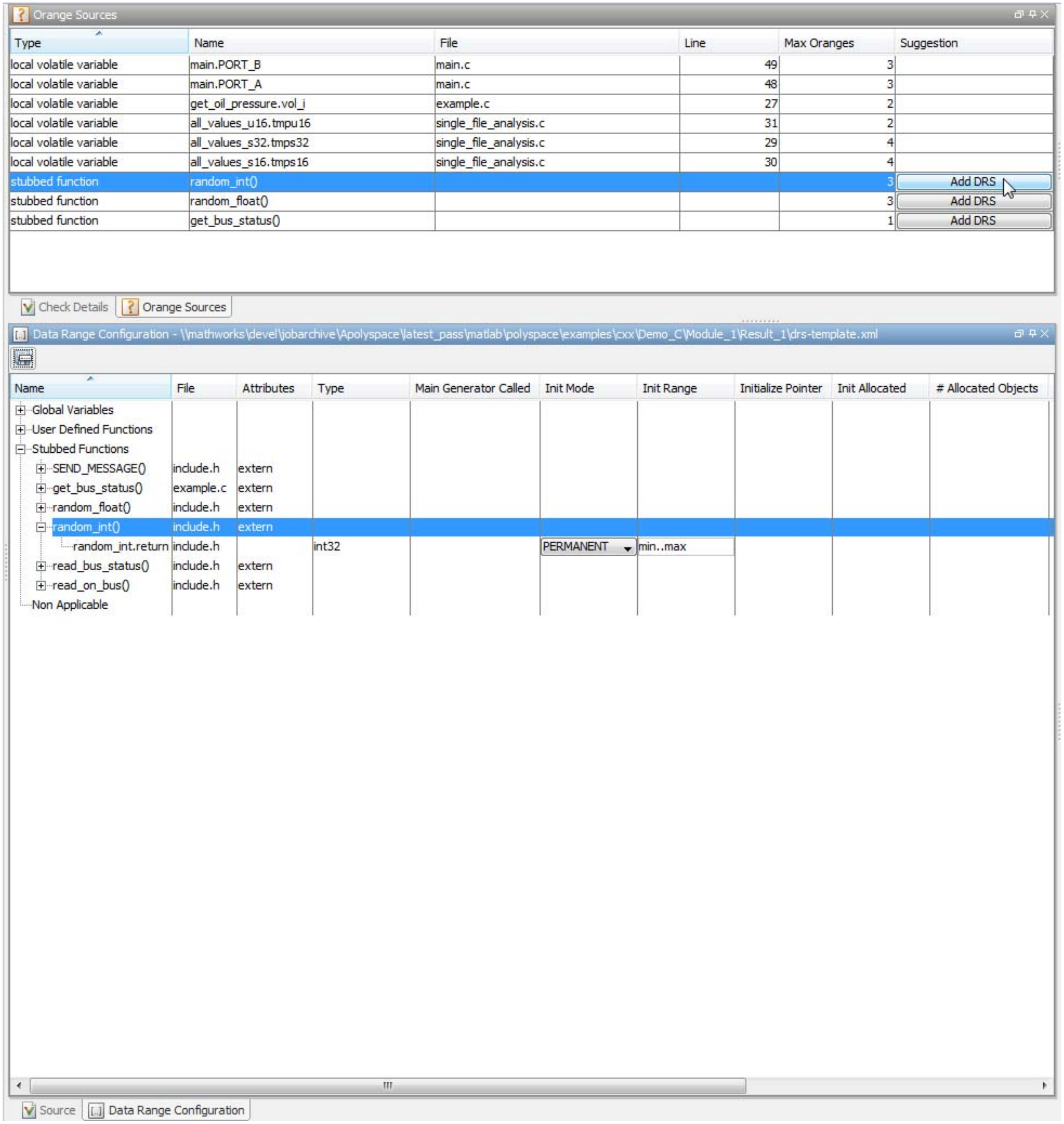
- “Results Statistics” on page 9-66
- “Orange Check Identified as Potential Errors” on page 9-99

Refine Data Range Specifications

This example shows how to refine data range specifications through the **Add DRS** button on the **Orange Sources** 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.



Type	Name	File	Line	Max Oranges	Suggestion
local volatile variable	main.PORT_B	main.c	49	3	
local volatile variable	main.PORT_A	main.c	48	3	
local volatile variable	get_oil_pressure.vol_i	example.c	27	2	
local volatile variable	all_values_u16.tmpu16	single_file_analysis.c	31	2	
local volatile variable	all_values_s32.tmps32	single_file_analysis.c	29	4	
local volatile variable	all_values_s16.tmps16	single_file_analysis.c	30	4	
stubbed function	random_int()			3	Add DRS
stubbed function	random_float()			3	Add DRS
stubbed function	get_bus_status()			1	Add DRS

Data Range Configuration - \\mathworks\devel\jobarchive\Apolyspace\latest_pass\matlab\polyspace\examples\cxx\Demo_C\Module_1\Result_1\drs-template.xml

Name	File	Attributes	Type	Main Generator Called	Init Mode	Init Range	Initialize Pointer	Init Allocated	# Allocated Objects
⊞ Global Variables									
⊞ User Defined Functions									
⊟ Stubbed Functions									
⊞ SEND_MESSAGE()	include.h	extern							
⊞ get_bus_status()	example.c	extern							
⊞ random_float()	include.h	extern							
⊟ random_int()	include.h	extern							
random_int.return	include.h		int32		PERMANENT	min..max			
⊞ read_bus_status()	include.h	extern							
⊞ read_on_bus()	include.h	extern							
Non Applicable									

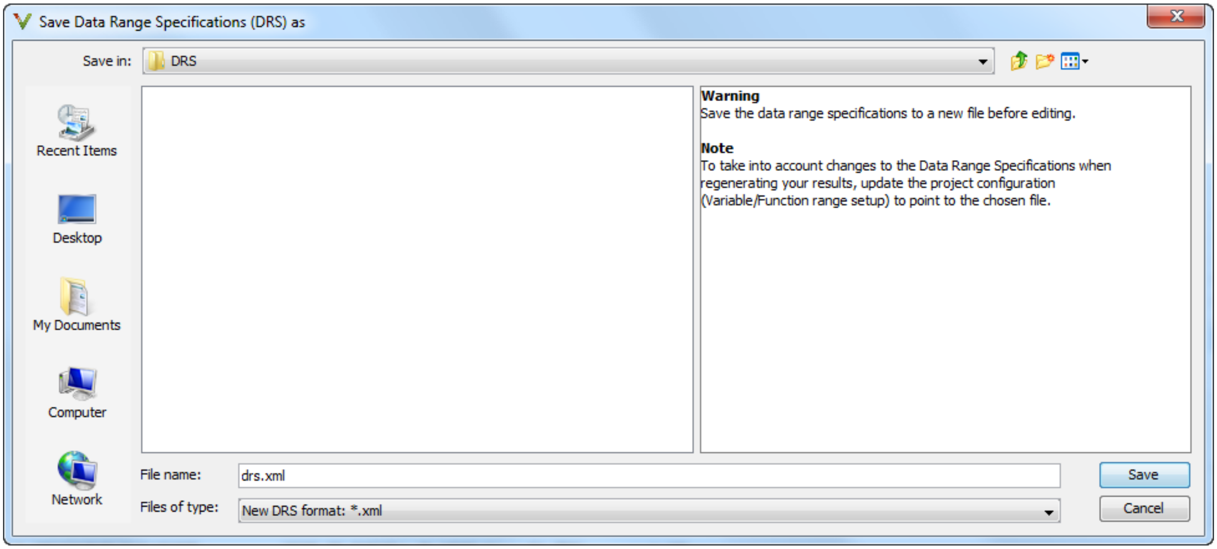
3 You can specify a range for the value returned by the function `random_int`. In the **Init Range** column, replace `min..max` by `-10..10`.

   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.



Save in: DRS

Warning
Save the data range specifications to a new file before editing.

Note
To take into account changes to the Data Range Specifications when regenerating your results, update the project configuration (Variable/Function range setup) to point to the chosen file.

File name: drs.xml

Files of type: New DRS format: *.xml

   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 DRS Configuration” on page 5-63

Perform Exhaustive Review

Most orange checks can be resolved using multiple selective reviews. For more information, see "Perform Selective Review" on page 10-25. However, for extremely critical applications, you might want to resolve all orange checks.

To display all orange checks, in the Results Manager perspective, select **All checks** from the drop-down list above the **Results summary** pane.

An exhaustive orange review is conducted later in the development process, during the unit testing or integration testing phase. The purpose of an exhaustive orange review is to analyze any orange checks that were not resolved during previous selective orange reviews, to identify potential defects in those orange checks.

Before performing an exhaustive orange review, you must balance the time and cost of performing an exhaustive orange review against the potential cost of leaving a defect in the code.

Exhaustive Orange Review Methodology

Performing an exhaustive orange review involves reviewing each orange check individually. As with selective orange review, your goal is to identify whether the orange check is a:

- Potential bug – code which will fail under some circumstances.
- Inconclusive check – a check that requires additional information to resolve, such as the call sequence.
- Data set issue – a theoretical set of data that cannot actually occur.
- Basic imprecision – checks caused by imprecise approximation of the data set used for verification.

Note For more information on each of these causes, see "Sources of Orange Checks" on page 10-7.

Although you must review each check individually, there are some general guidelines to follow.

- Start your review with the files that have the highest selectivity in your application.

  If the verification finds only one or two orange checks in a file or function, these checks are probably not caused by either inconclusive verification or basic imprecision. Therefore, it is more likely that these orange checks contain actual defects. These types of orange checks can also be resolved more quickly.

- Next, examine files that contain a large percentage of orange checks compared to the rest of the application. These files can highlight design issues.

  If the verification is unable to draw a conclusion, it often means the code is very complex, which can mean low robustness and quality. See "Inconclusive Verification and Code Complexity" on page 10-39.

- For all files that you review, first identify checks that you can quickly categorize (such as potential bugs and data set issues).
- Depending on the results of your review, update the code or insert comments to identify the source of the orange check.

Inconclusive Verification and Code Complexity

Sometimes an inconclusive check occurs because the code is too complicated. In these cases, most orange checks in a file are related, and careful analysis identifies a single cause — perhaps a function or a variable modified many times. These situations often focus on functions or variables that have caused problems earlier in the development cycle.

For example, consider a variable `Computed_Speed`.

- `Computed_Speed` is first copied into a signed integer (between -2^31 and 2^31-1).
- `Computed_Speed` is then copied into an unsigned integer (between 0 and 2^31-1).
- `Computed_Speed` is next copied into a signed integer again.

- Finally, `Computed_Speed` is added to another variable.

The verification can report orange `Overflow`—s.

This report does not indicate a real defect, but informs the development team that the variable `Computed_Speed` caused trouble during development and testing phases. The report also suggests that the code is poorly designed.

Resolving Orange Checks Caused by Imprecise Approximation

On rare occasions, a module may contain many orange checks caused by imprecise approximation of the data set used for verification. These checks are usually local to functions, so their impact on the project as a whole is limited.

In cases of imprecise approximation, you can resolve orange checks by increasing the precision level. If this does not resolve the orange check, however, verification cannot help directly.

In these cases, Polyspace software can assist you only through the call tree and dictionary. For more information, see "Dataflow Verification" on page 9-113. The code must be reviewed using alternate means. These alternate means may include:

- Additional unit tests
- Code review with the developer
- Checking an interpolation algorithm in a function
- Checking calibration data

For more information on basic imprecision, see "Sources of Orange Checks" on page 10-7.

Automatic Orange Tester Overview

The Polyspace Automatic Orange Tester performs dynamic stress tests on unproven code (orange checks) to help you identify run-time errors.

Performing an exhaustive orange review manually can be time consuming. The Automatic Orange Tester saves time by automatically creating test cases for all input variables in orange code, and then dynamically testing the code to find actual run-time errors.

Before you run a verification, select the Automatic Orange Tester through the option `-automatic-orange-tester`. See “Select the Automatic Orange Tester” on page 10-45. When the software runs the Automatic Orange Tester at the end of static verification, the software might categorize some orange checks as potential run-time errors. For more information, see “Orange Check Identified as Potential Errors” on page 9-99.

The verification log indicates whether the Automatic Orange Tester has identified potential run-time errors. For example, the following log states that no orange checks have been selected for Review Level 0, which indicates that the Automatic Tester has not identified potential run-time errors.

```
...

Automatic Orange Tester (AOT) statistics:
- Execution status:
  * Number of executions: 50
  ** Successful: 3
  ** Failed: 47
- No orange checks selected for Level 0 review.
- Execution times:
  * Fastest run: 00:00:00.2
  * Slowest run: 00:00:00.19

...
```

The Automatic Orange Tester is only one of a few ways by which the software identifies potential run-time errors.

You can also run the Automatic Orange Tester manually. See “Start the Automatic Orange Tester Manually” on page 10-46.

How the Automatic Orange Tester Works

Polyspace verification mathematically analyzes the operations in the code to derive its dynamic properties without actually executing it (see “What is Static Verification” on page 1-6). Although this verification can identify almost all run-time errors, some operations cannot be proved either true or false because the input values are unknown. The software reports these operations as orange checks in the Results Manager perspective (see “What is an Orange Check?” on page 10-3).

If you select the Automatic Orange Tester , at the end of the verification Polyspace generates an *instrumented* version of the source code. For each orange check that could lead to a run-time error, the software generates instrumented code around the orange check. The software compiles the instrumented code and generates binary code. In addition, the software generates randomized test cases based on the input variables. For each test case, the Automatic Orange Tester executes the binary code and records whether the test is a failure. Consider the following example.

```
int x;

x = f();
x = 1 / x;  // orange ZDV: division by zero
```

During static verification, Polyspace determines that the function `f()` can return values between -10 and 10. Therefore, for each test, the Automatic Orange Tester assigns `x` to be a random number between -10 and 10. If the number is 0, division by zero occurs, and the Automatic Orange Tester records the failure.

Limitations of Dynamic Testing

As the Automatic Orange Tester uses a finite number of test cases to analyze the code, there is no guarantee that it will identify a problem in any particular run. Consider an example where a specific variable value causes an error. If no test case uses this value, then the Automatic Orange Tester does not record a failure.

The Automatic Orange Tester creates new randomized test cases for each run. Therefore, there is no guarantee that the results from two separate runs will be the same.

Running more tests increases the chances of finding run-time errors. However, the tests take more time to complete.

Select the Automatic Orange Tester

You must run a verification with the `-automatic-orange-tester` option selected, if you want:

- The software to run the Automatic Orange Tester at the end of the verification
- To manually run the Automatic Orange Tester after the verification

To enable the Automatic Orange Tester:

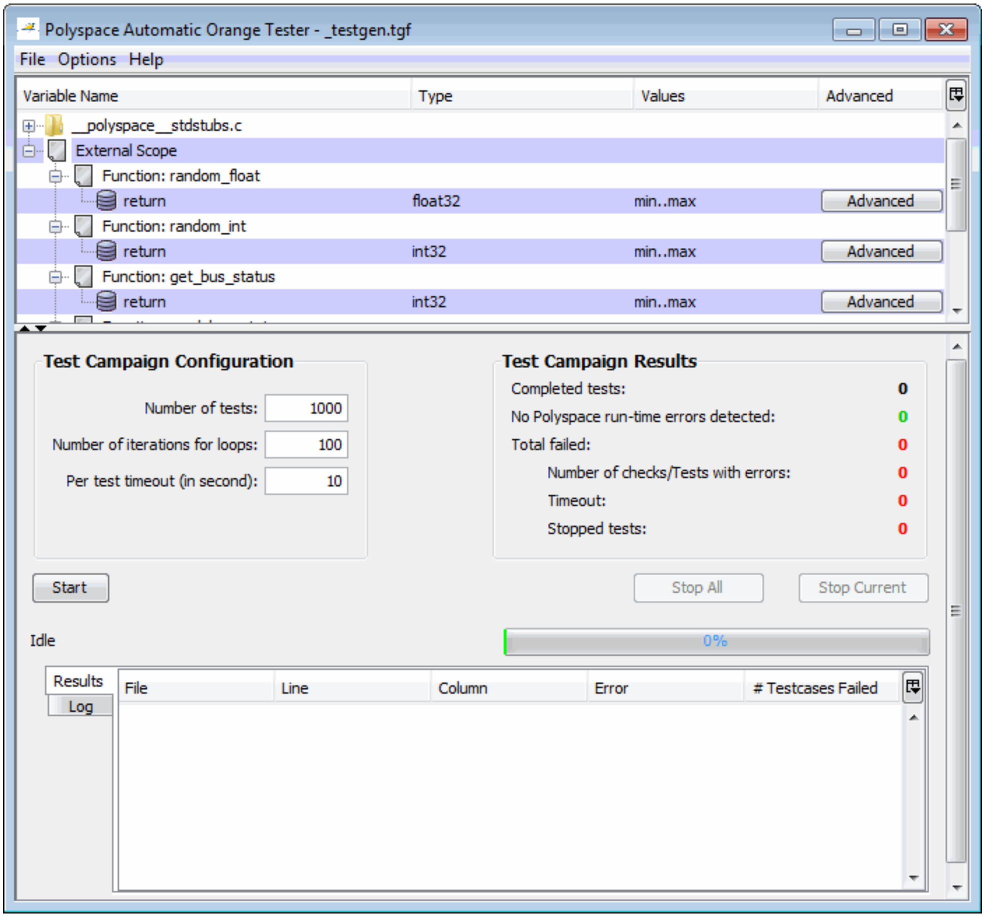
1. In the Project Manager perspective, select the **Configuration > Advanced Settings** pane.
2. Select the **Automatic Orange Tester** check box.
3. Specify values for the following options:
   - **Number of automatic tests** — Total number of test cases that you want to run. Running more tests increases the chances of finding a run-time error, but takes more time to complete. The default is 500. The maximum value that the software supports is 100,000.
   - **Maximum loop iterations** — Maximum number of iterations allowed before a loop is considered to be an infinite loop. A larger number of iterations decreases the chances of incorrectly identifying an infinite loop, but takes more time to complete. The default is 1000, which is also the maximum value that the software supports.
   - **Maximum test time** — Maximum time (in seconds) allowed for a test before Automatic Orange Tester moves on to the next test. Increasing test time reduces the number of tests that time out, but increases total verification time. The default is 5 seconds. The maximum value that the software supports is 60.

Start the Automatic Orange Tester Manually

If you ran a verification with the `-automatic-orange-tester` option selected, you can run the Automatic Orange Tester manually. See “Select the Automatic Orange Tester” on page 10-45.

To start the Automatic Orange Tester:

1. Open your results in the Results Manager perspective.
2. On the Results Manager toolbar, click (**Launch the Polyspace Automatic Orange Tester**) to open the Automatic Orange Tester.



Variable Name	Type	Values	Advanced
__polyspace__stdstubs.c			
External Scope			
Function: random_float			
return	float32	min..max	Advanced
Function: random_int			
return	int32	min..max	Advanced
Function: get_bus_status			
return	int32	min..max	Advanced

Test Campaign Configuration

Number of tests: 1000

Number of iterations for loops: 100

Per test timeout (in second): 10

Test Campaign Results

Completed tests:	0
No Polyspace run-time errors detected:	0
Total failed:	0
Number of checks/Tests with errors:	0
Timeout:	0
Stopped tests:	0

Idle 0%

File	Line	Column	Error	# Testcases Failed

3 In the Test Campaign Configuration window, specify the following parameters:

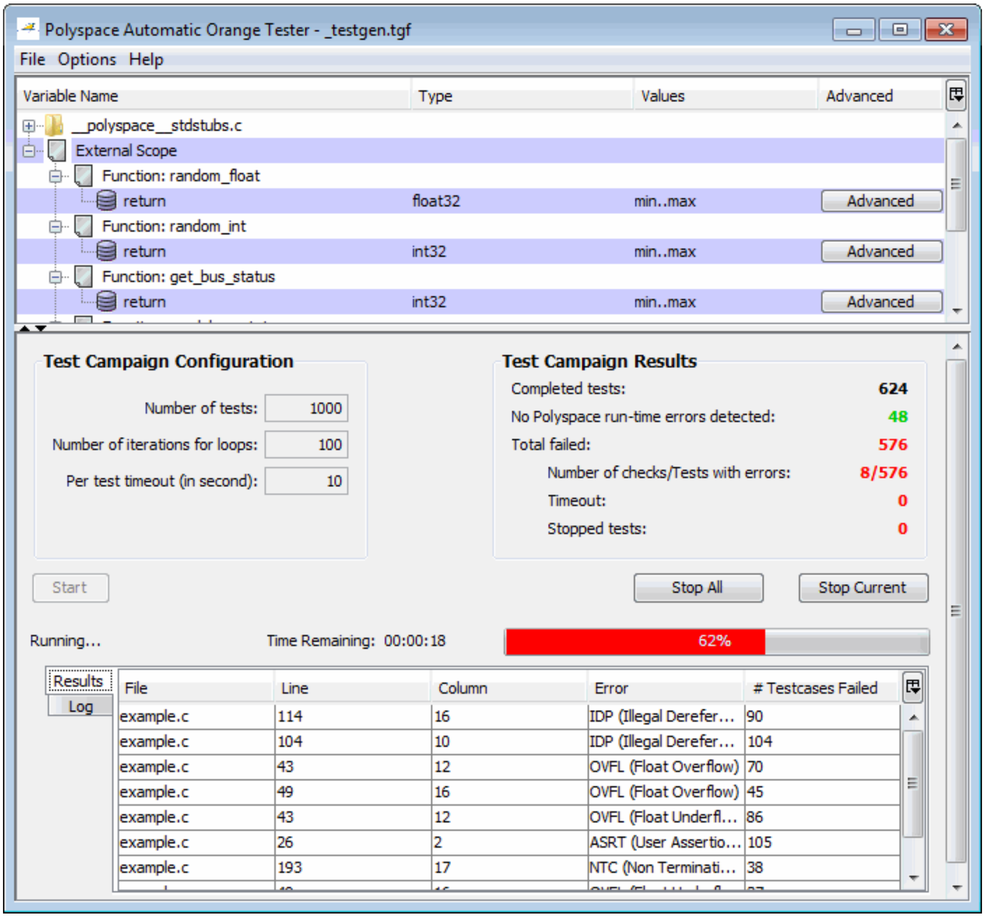
- **Number of tests** – Specifies the total number of test cases that you want to run. Running more tests increases the chances of finding a run-time error, but also takes more time to complete.
- **Number of iterations for infinite loops** – Specifies the maximum number of loop iterations to perform before the Automatic Orange Tester identifies an infinite loop. A larger number of iterations decreases the

chances of incorrectly identifying an infinite loop, but also might take more time to complete.

- **Per test timeout** – Specifies the maximum time that an individual test can run (in seconds) before the Automatic Orange Tester moves on to the next test. Increasing the time limit reduces the number of tests that time out, but can also increase the total verification time.

4 Click **Start** to begin testing.

The Automatic Orange Tester generates test cases and runs the dynamic tests.



Variable Name	Type	Values	Advanced
__polyspace__stdstubs.c			
External Scope			
Function: random_float			
return	float32	min..max	Advanced
Function: random_int			
return	int32	min..max	Advanced
Function: get_bus_status			
return	int32	min..max	Advanced

Test Campaign Configuration

Number of tests: 1000

Number of iterations for loops: 100

Per test timeout (in second): 10

Test Campaign Results

Completed tests: **624**

No Polyspace run-time errors detected: **48**

Total failed: **576**

Number of checks/Tests with errors: **8/576**

Timeout: **0**

Stopped tests: **0**

Running...

Time Remaining: 00:00:18

62%

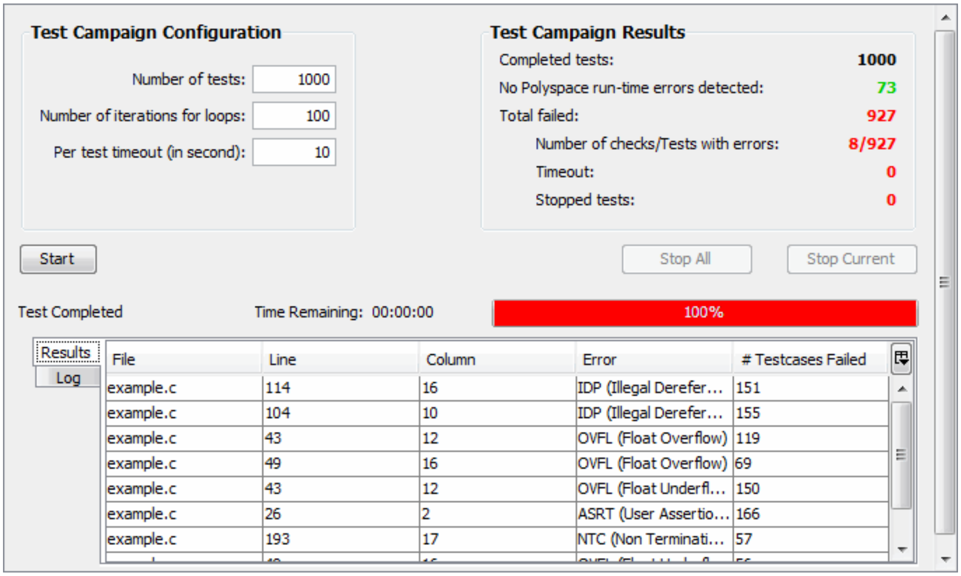
File	Line	Column	Error	# Testcases Failed
example.c	114	16	IDP (Illegal Derefer...	90
example.c	104	10	IDP (Illegal Derefer...	104
example.c	43	12	OVFL (Float Overflow)	70
example.c	49	16	OVFL (Float Overflow)	45
example.c	43	12	OVFL (Float Underfl...	86
example.c	26	2	ASRT (User Assertio...	105
example.c	193	17	NTC (Non Terminati...	38

5 If you want to stop the testing before it is complete:

- Click **Stop Current** to stop the current test and move on to the next one.
- Click **Stop All** to immediately stop all tests.

Review Test Results After Manual Run

When testing is complete, the Automatic Orange Tester displays an overview of the testing results, along with detailed information about each failed test.



Test Campaign Configuration

Number of tests: 1000

Number of iterations for loops: 100

Per test timeout (in second): 10

Test Campaign Results

Completed tests: **1000**

No Polyspace run-time errors detected: **73**

Total failed: **927**

Number of checks/Tests with errors: **8/927**

Timeout: **0**

Stopped tests: **0**

Test Completed Time Remaining: 00:00:00 100%

File	Line	Column	Error	# Testcases Failed
example.c	114	16	IDP (Illegal Derefer...	151
example.c	104	10	IDP (Illegal Derefer...	155
example.c	43	12	OVFL (Float Overflow)	119
example.c	49	16	OVFL (Float Overflow)	69
example.c	43	12	OVFL (Float Underfl...	150
example.c	26	2	ASRT (User Assertio...	166
example.c	193	17	NTC (Non Terminati...	57

Test Campaign Results

The Test Campaign Results window displays overview information about the results of your dynamic tests, including:

- **Completed tests** – The total number of tests completed.
- **No Polyspace runtime errors detected** – The number of tests that did not produce a run-time error.
- **Total failed** – The number of tests that produced a run-time error.
- **Number of checks/Tests with errors** – The number of Polyspace checks that produced at least one failed test, as well as the total number of tests that produced a run-time error.
- **Timeout** – The number of tests that exceeded the specified **Per test timeout** limit.

- **Stopped tests** – The number of tests that were stopped manually.

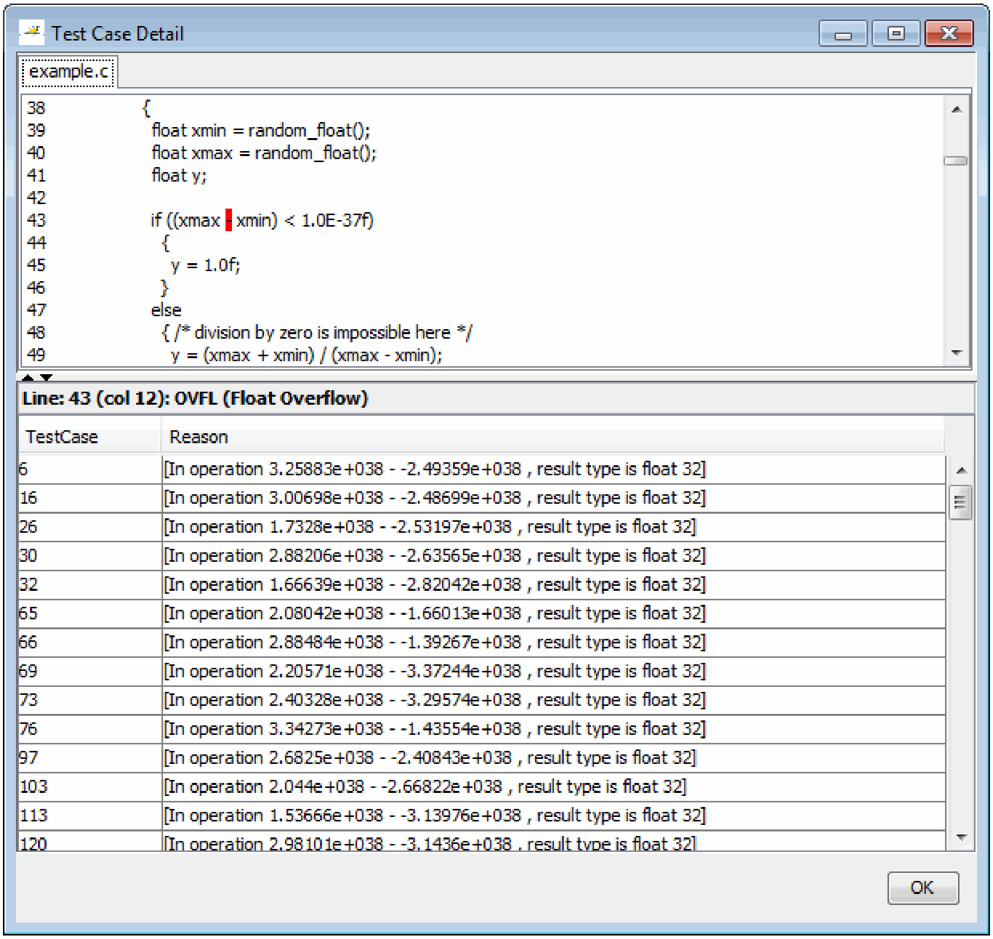
Use the Test Campaign Results Window to see an overall assessment of your test results, as well as to decide if you need to increase the **Per test timeout** value.

Results Table

The Results table displays detailed information about each failed test to help you identify the cause of the run-time error. This information includes:

- The file name, line number, and column in which the error was found.
- The type of error that occurred.
- The number of test cases in which the error occurred.

You can view more details about any failed test by clicking the corresponding row in the Results table. The Test Case Detail dialog box opens.



```
38            {
39              float xmin = random_float();
40              float xmax = random_float();
41              float y;
42
43              if ((xmax - xmin) < 1.0E-37f)
44                {
45                  y = 1.0f;
46                }
47              else
48                { /* division by zero is impossible here */
49                  y = (xmax + xmin) / (xmax - xmin);
```

Line: 43 (col 12): OVFL (Float Overflow)

TestCase	Reason
6	[In operation 3.25883e+038 - -2.49359e+038 , result type is float 32]
16	[In operation 3.00698e+038 - -2.48699e+038 , result type is float 32]
26	[In operation 1.7328e+038 - -2.53197e+038 , result type is float 32]
30	[In operation 2.88206e+038 - -2.63565e+038 , result type is float 32]
32	[In operation 1.66639e+038 - -2.82042e+038 , result type is float 32]
65	[In operation 2.08042e+038 - -1.66013e+038 , result type is float 32]
66	[In operation 2.88484e+038 - -1.39267e+038 , result type is float 32]
69	[In operation 2.20571e+038 - -3.37244e+038 , result type is float 32]
73	[In operation 2.40328e+038 - -3.29574e+038 , result type is float 32]
76	[In operation 3.34273e+038 - -1.43554e+038 , result type is float 32]
97	[In operation 2.6825e+038 - -2.40843e+038 , result type is float 32]
103	[In operation 2.044e+038 - -2.66822e+038 , result type is float 32]
113	[In operation 1.53666e+038 - -3.13976e+038 , result type is float 32]
120	[In operation 2.98101e+038 - -3.1436e+038 , result type is float 32]

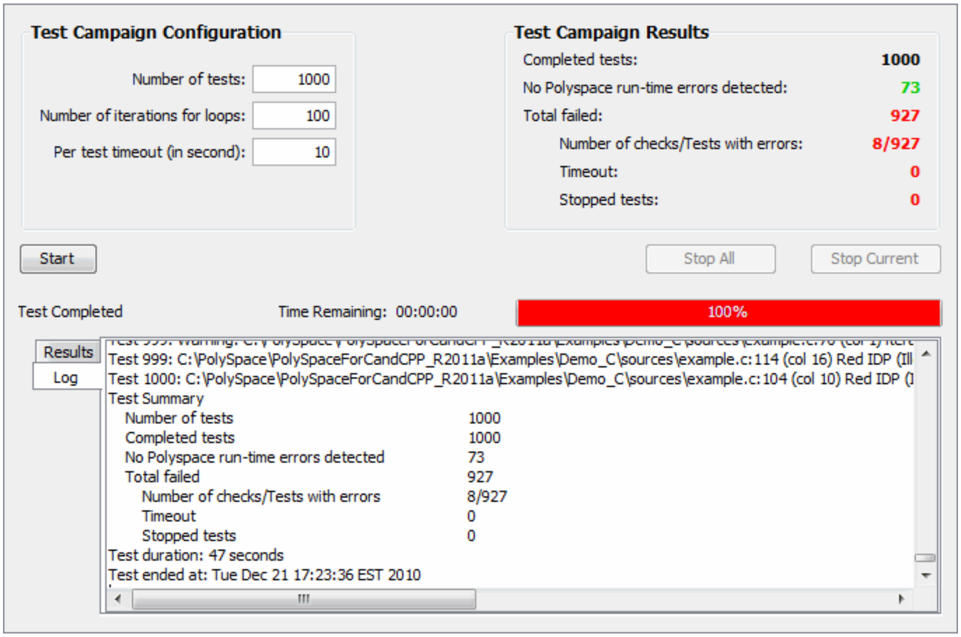
The Test Case Detail dialog box displays the portion of the code in which the error occurred, and gives detailed information about why each test case failed. Because the Automatic Orange Tester performs run-time tests, this information includes the actual values that caused the error.

You can use this information to quickly identify the cause of the error, and determine whether the code contains a bug.

Log

The Log window displays a complete list of all the tests which failed, as well as summary information.

You can copy information from the log window to paste into other applications, such as Microsoft Excel®.



Test Campaign Configuration

Number of tests: 1000

Number of iterations for loops: 100

Per test timeout (in second): 10

Test Campaign Results

Completed tests: **1000**

No Polyspace run-time errors detected: **73**

Total failed: **927**

Number of checks/Tests with errors: **8/927**

Timeout: **0**

Stopped tests: **0**

Test Completed

Time Remaining: 00:00:00

100%

```
Test 999: Warning: C:\PolySpace\PolySpaceForCandCPP_R2011a\Examples\Demo_C\sources\example.c:70 (col 1) Itera
Test 999: C:\PolySpace\PolySpaceForCandCPP_R2011a\Examples\Demo_C\sources\example.c:114 (col 16) Red IDP (Ill
Test 1000: C:\PolySpace\PolySpaceForCandCPP_R2011a\Examples\Demo_C\sources\example.c:104 (col 10) Red IDP (I
Test Summary
   Number of tests                               1000
   Completed tests                               1000
   No Polyspace run-time errors detected         73
   Total failed                                  927
      Number of checks/Tests with errors         8/927
      Timeout                                    0
      Stopped tests                              0
Test duration: 47 seconds
Test ended at: Tue Dec 21 17:23:36 EST 2010
```

The log file is also saved in the `Polyspace-Instrumented` folder with the following file name:
`TestGenerator_`*`day`*`_`*`month`*`_`*`year`*`-`*`time`*`.out`

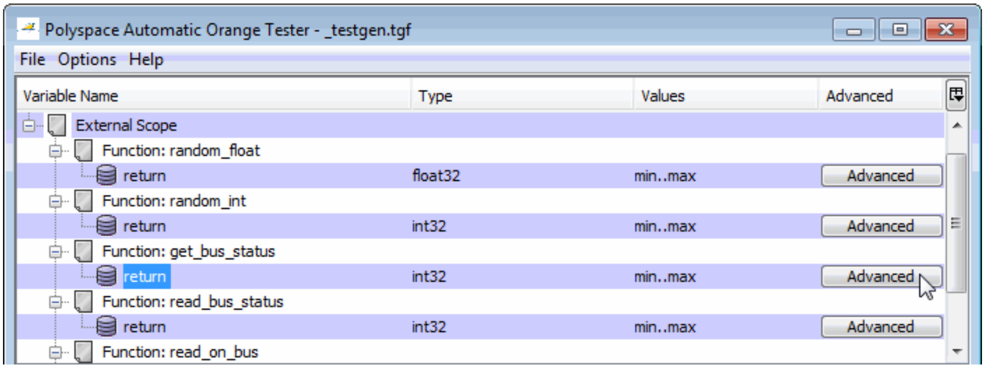
Refine Data Ranges with Automatic Orange Tester

The Automatic Orange Tester allows you to specify ranges for external variables. You can perform run-time tests using real-world values for your variables, rather than randomly selected values.

Setting ranges for your variables reduces the number of tests that fail due to unrealistic data values, allowing you to focus on actual problems, rather than purely theoretical problems. Once you set data ranges, you can export them to a DRS file for use in future verifications, reducing the number of orange checks in your results (see "Export Data Ranges for Polyspace Verification" on page 10-58).

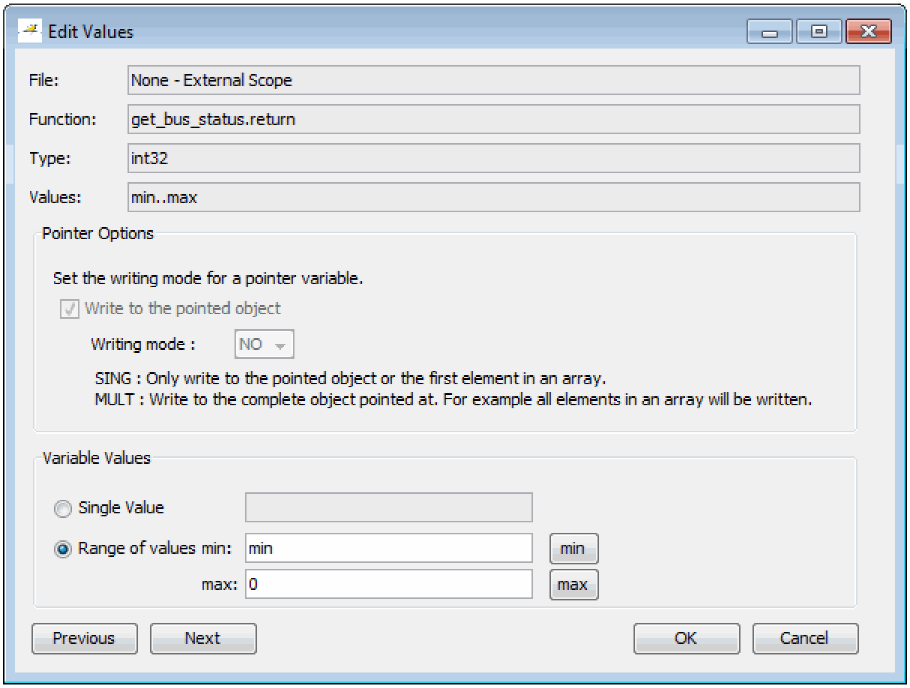
To refine your data ranges:

1 In the Variables section at the top of the Automatic Orange Tester, identify the variable for which you want to set a data range.



Variable Name	Type	Values	Advanced
External Scope			
Function: random_float			
return	float32	min..max	Advanced
Function: random_int			
return	int32	min..max	Advanced
Function: get_bus_status			
return	int32	min..max	Advanced
Function: read_bus_status			
return	int32	min..max	Advanced
Function: read_on_bus			

2 Select **Advanced**.



File: None - External Scope

Function: get_bus_status.return

Type: int32

Values: min..max

Pointer Options

Set the writing mode for a pointer variable.

☑ Write to the pointed object

Writing mode : NO

SING : Only write to the pointed object or the first element in an array.
MULT : Write to the complete object pointed at. For example all elements in an array will be written.

Variable Values

○ Single Value

● Range of values min: min

max: 0

3 In the Edit Values dialog box, set the values for the variable:

- **Single Value** — A constant value for the variable.
- **Range of values** — A minimum and maximum value for the variable.

Note For pointers, you can also specify the writing mode:

- **SING** — The tests write only the object or first element in the array.
- **MULT** — The tests write the complete object, or all elements in the array.

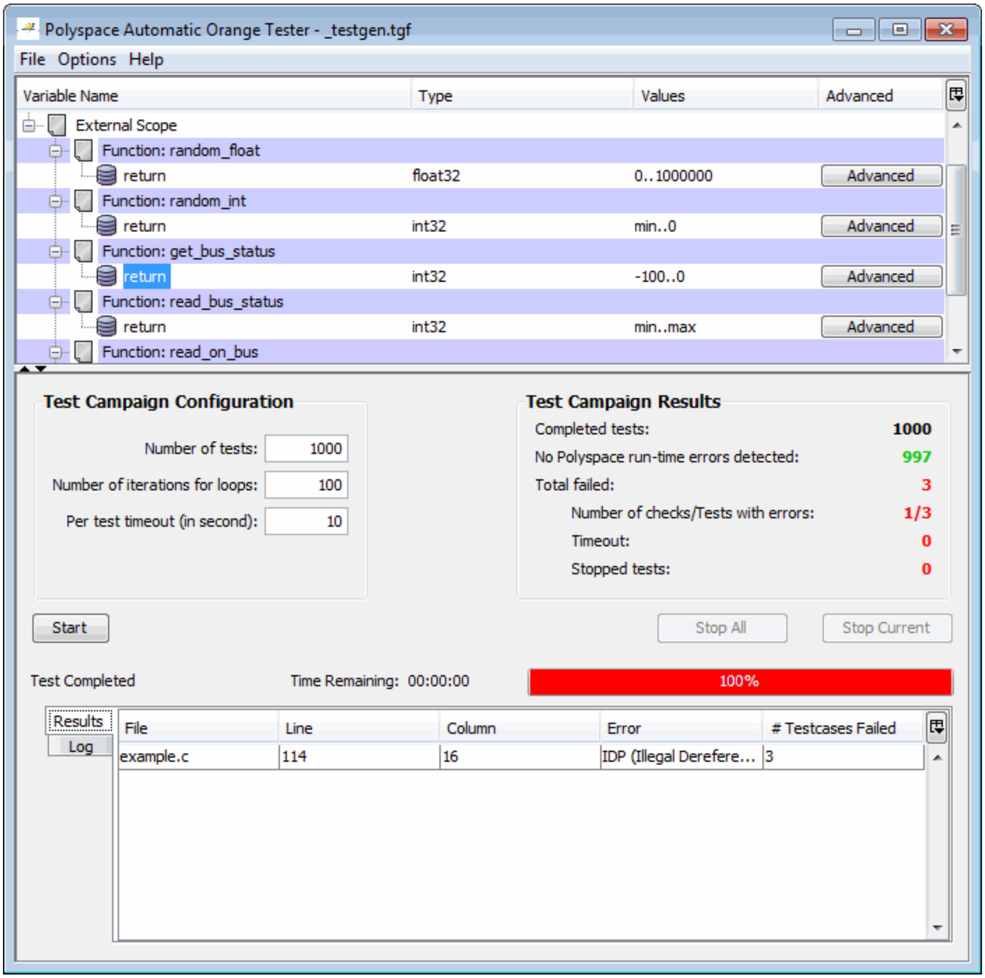
---

4 Click **Next** to edit the values for the next variable.

5 When you have finished setting values, click **OK** to save your changes and close the Edit Values dialog box.

6 Click **Start** to retest the code.

The Automatic Orange Tester generates test cases, runs the tests, and displays the updated results.



Variable Name	Type	Values	Advanced
External Scope			
Function: random_float			
return	float32	0..1000000	Advanced
Function: random_int			
return	int32	min..0	Advanced
Function: get_bus_status			
return	int32	-100..0	Advanced
Function: read_bus_status			
return	int32	min..max	Advanced
Function: read_on_bus			

Test Campaign Configuration

Number of tests: 1000

Number of iterations for loops: 100

Per test timeout (in second): 10

Test Campaign Results

Completed tests:	1000
No Polyspace run-time errors detected:	997
Total failed:	3
Number of checks/Tests with errors:	1/3
Timeout:	0
Stopped tests:	0

Test Completed   Time Remaining: 00:00:00   100%

File	Line	Column	Error	# Testcases Failed
example.c	114	16	IDP (Illegal Derefere…	3

The updated results show fewer failed tests, allowing you to focus on any actual code problems.

Save and Reuse Your Configuration

You can save your Automatic Orange Tester preferences and variable ranges for use in future dynamic testing.

To save your configuration:

1. Select **File > Save**.
2. Enter a name and click **Save**.

   Your configuration is saved in a `.tgf` file.

To open a configuration from a previous verification:

1. Select **File > Open**.
2. Select the required`.tgf` file. Then click **Open**.

When you open a previously saved configuration, the **Log** window displays any differences in the configuration files. For example:

- If a variable does not exist in the new configuration, a warning is displayed.
- If the ranges for a variable are no longer valid (if the variable type changes, for example), a warning is displayed and the range is changed to the largest valid range for the new data type (if possible).

Export Data Ranges for Polyspace Verification

Once you have set the data ranges for your variables, you can export them to a Data Range Specifications (DRS) file for use in future Polyspace verifications. Using these data ranges allows you to reduce the number of orange checks identified in the Results Manager perspective.

To export your data ranges:

1. Set the values for each variable that you want to specify.
2. Select **File > Export DRS**.
3. Enter a name. Then click **Save**.

   The DRS file is saved.

For information on using a DRS file for Polyspace verifications, see “Specify Data Ranges for Variables and Functions (Contextual Verification)” on page 5-54.

Configure Compiler Options

Before using the Automatic Orange Tester, on UNIX®, Solaris, or Linux systems, you must configure your compiler and linker options .

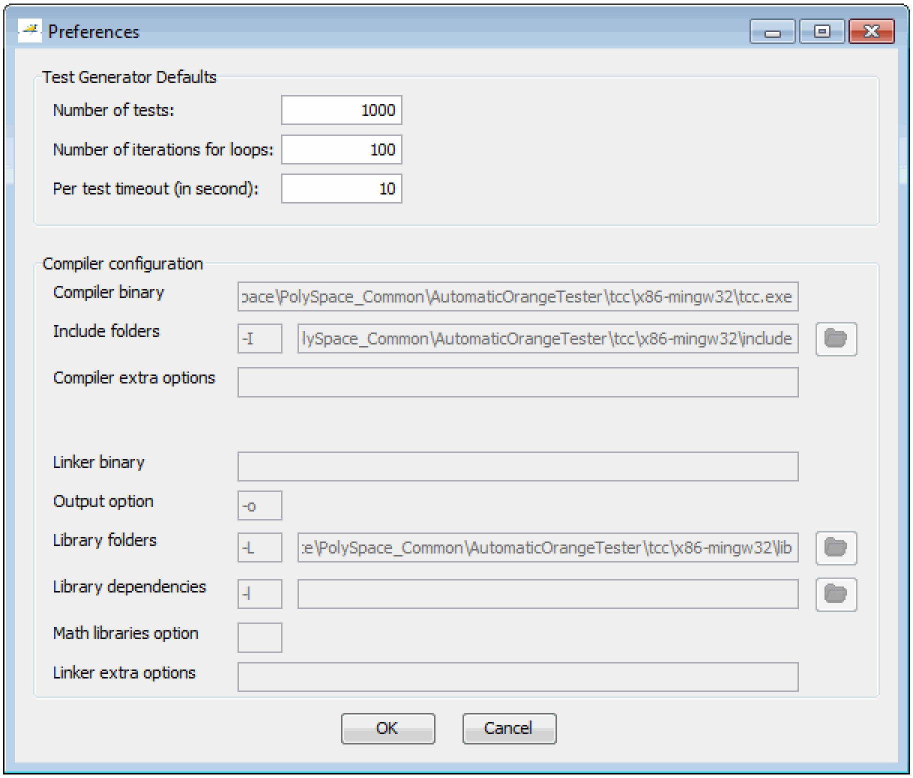
Note On Windows systems, the compiler options cannot be modified. You can configure only the library dependencies.

To set compiler and linker options:

1 Open the Automatic Orange Tester.

2 Select **Options > Configure**.

3



Test Generator Defaults

Number of tests: 1000

Number of iterations for loops: 100

Per test timeout (in second): 10

Compiler configuration

Compiler binary: pace\PolySpace_Common\AutomaticOrangeTester\tcc\x86-mingw32\tcc.exe

Include folders: -I lySpace_Common\AutomaticOrangeTester\tcc\x86-mingw32\include

Compiler extra options:

Linker binary:

Output option: -o

Library folders: -L e\PolySpace_Common\AutomaticOrangeTester\tcc\x86-mingw32\lib

Library dependencies: -l

Math libraries option:

Linker extra options:

4 In the Preferences dialog box, set the parameters for your compiler.

Polyspace-Instrumented Folder

When the software runs the Automatic Orange Tester (AOT) at the end of a static verification, the software creates the `Polyspace-Instrumented` folder within the verification results folder, for example, `\Demo_C_Single-File\Module_1\Result_2\Polyspace-Instrumented`. 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.

Technical Limitations

The Automatic Orange Tester has the following limitations:

In this section...

"Unsupported Polyspace Options" on page 10-62

"Options with Restrictions" on page 10-62

"Unsupported C Routines" on page 10-62

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`

Checking Coding Rules

- "Overview of Polyspace Code Analysis" on page 11-2
- "Activate Coding Rules Checker" on page 11-5
- "Create Coding Rules File" on page 11-11
- "Exclude from Rules Checking" on page 11-29
- "Run Verification with Coding Rules Checking" on page 11-32
- "Examine Coding Rule Violations" on page 11-33
- "Apply Coding Rule Violation Filters" on page 11-36
- "Review Coding Rule Violations" on page 11-40
- "Open Coding Rules Report" on page 11-42
- "Software Quality Objective Subsets of Coding Rules (C)" on page 11-44
- "Software Quality Objective Subsets of Coding Rules (AC AGC)" on page 11-49
- "Software Quality Objective Subsets of Coding Rules (C++)" on page 11-51
- "Supported Coding Rules" on page 11-60

Overview of Polyspace Code Analysis

In this section...

"Code Analysis Overview" on page 11-2

"Polyspace MISRA C and MISRA AC AGC Checkers Overview" on page 11-3

"Polyspace MISRA C++ Checker Overview" on page 11-3

"Polyspace JSF C++ Checker Overview" on page 11-4

Code Analysis Overview

Polyspace software allows you to analyze code to demonstrate compliance with established C and C++ coding standards (MISRA C 2004, MISRA C++:2008 or JSF++:2005).

Applying coding rules can reduce the number of orange checks in your verification results and improve the quality of your code. Coding rules are the most efficient way to reduce orange checks.

While creating a project, you specify both the coding standard, and individual rules to enforce. Polyspace software then performs code analysis before starting verification, and reports any errors or warnings in the Results Manager perspective.

If any source files in the verification 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

Note When you enable the Compiler Assistant *and* coding rules checking, the software does not report coding rule violations if there are compilation errors.

Polyspace MISRA C and MISRA AC AGC Checkers Overview

The Polyspace MISRA C checker helps you comply with the MISRA C 2004 coding standard.[10]

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 a verification.

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 verification results. When you set up rule checking, you can select these subsets directly. These subsets are defined in:

- "Software Quality Objective Subsets of Coding Rules (C)" on page 11-44
- "Software Quality Objective Subsets of Coding Rules (AC AGC)" on page 11-49

Note The Polyspace MISRA checker is based on MISRA C:2004, which also incorporates MISRA-C Technical Corrigendum (http://www.misra-c.com).

Polyspace MISRA C++ Checker Overview

The Polyspace MISRA C++ checker helps you comply with the MISRA C++:2008 coding standard.[11]

[10] MISRA and MISRA C are registered trademarks of MISRA Ltd., held on behalf of the MISRA Consortium.

[11] MISRA is a registered trademark of MISRA Ltd., held on behalf of the MISRA Consortium.

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 a verification. 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 verification results. When you set up rule checking, you can select these subsets directly. These subsets are defined in "Software Quality Objective Subsets of Coding Rules (C++)" on page 11-51.

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.

Polyspace JSF C++ Checker Overview

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 JSF program. They are designed to improve the robustness of C++ code, and improve maintainability.

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 a verification.

Note The Polyspace JSF C++ checker is based on JSF++:2005. For more information on these coding standards, see http://www.jsf.mil/downloads/documents/JSF_AV_C++_Coding_Standards_Rev_C.doc.

Activate Coding Rules Checker

In this section...

"Activate the MISRA C Checker" on page 11-5

"Activate the MISRA AC AGC Checker" on page 11-6

"Activate the MISRA C++ Checker" on page 11-7

"Activate the JSF C++ Checker" on page 11-9

"Activate Custom Rules Checker" on page 11-9

Activate the MISRA C Checker

To check MISRA C compliance, before running a verification, you must set an option in your project. Polyspace software finds the violations during the compile phase of a verification. When you have addressed all MISRA C violations, you must run the verification again.

To set the MISRA C rule checking option:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2. Select the **Check MISRA C rules** check box.

3. From the corresponding drop-down list, select the MISRA C rules to check:

   - `required-rules` — All *required* MISRA C coding rules. All violations are reported as warnings.

   - `all-rules` — All *required* and *advisory* coding rules. All violations are reported as warnings.

   - `SQO-subset1` — A subset of MISRA C rules that have a direct impact on the selectivity of verification. All violations are reported as warnings. For more information, see "SQO Subset 1 – Direct Impact on Selectivity" on page 11-44.

   - `SQO-subset2` — A second subset of MISRA C rules that have an indirect impact on the selectivity of verification, as well as the rules contained in `SQO-subset1`. All violations are reported as warnings. For more information, see “SQO Subset 2 – Indirect Impact on Selectivity” on page 11-46.

- `custom` — A specified set of coding rules. When you select this option, you must provide a rules file that specifies the rules to check and whether to report an error or warning for violations of each rule. For more information, see “Create a MISRA C or MISRA AC AGC Rules File” on page 11-11.

4 Specify custom rules that you define. See “Activate Custom Rules Checker” on page 11-9.

5 Specify files to exclude from MISRA C checking. For more information, see “Exclude Specific Files and Folders from Rules Checking” on page 11-29.

6 Specify data types that you want Polyspace to consider as Boolean. For more information, see “Redefine Data Types as Boolean” on page 11-31.

7 Specify undocumented pragma directives for which rule MISRA C 3.4 must not be applied. For more information, see “Allow Undocumented Pragma Directives” on page 11-30 .

Activate the MISRA AC AGC Checker

To check MISRA AC AGC compliance, before running a verification, you must set an option in your project. Polyspace software finds the violations during the compile phase of a verification. When you have addressed all MISRA AC AGC violations, you must run the verification again.

To set the MISRA AC AGC rule checking option:

1 In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2 Select the **Check AC AGC rules** check box.

3 From the corresponding drop-down list, select the MISRA AC AGC rules to check:

- `OBL-rules` — All *obligatory* MISRA AC AGC coding rules. All violations are reported as warnings.

- `OBL-REC-rules` — All *obligatory* and *recommended* MISRA AC AGC coding rules. All violations are reported as warnings.
- `all-rules` — All *obligatory*, *recommended*, and *readability* coding rules. All violations are reported as warnings.
- `SQO-subset1` — A subset of MISRA AC AGC rules that have a direct impact on the selectivity of verification. All violations are reported as warnings. For more information, see "SQO Subset 1 – Direct Impact on Selectivity" on page 11-49.
- `SQO-subset2` — A second subset of MISRA AC AGC rules that have an indirect impact on the selectivity of verification, as well as the rules contained in `SQO-subset1`. All violations are reported as warnings. For more information, see "SQO Subset 2 – Indirect Impact on Selectivity" on page 11-49.
- `custom` — A specified set of coding rules. When you select this option, you must provide a rules file that specifies the rules to check and whether to report an error or warning for violations of each rule. For more information, see "Create a MISRA C or MISRA AC AGC Rules File" on page 11-11.

4. Specify custom rules that you define. See "Activate Custom Rules Checker" on page 11-9.

5. Specify files to exclude from MISRA AC AGC checking. For more information, see "Exclude Specific Files and Folders from Rules Checking" on page 11-29.

6. Specify data types that you want Polyspace to consider as Boolean. For more information, see "Redefine Data Types as Boolean" on page 11-31.

7. Specify undocumented pragma directives for which rule MISRA 3.4 must not be applied. For more information, see "Allow Undocumented Pragma Directives" on page 11-30.

Activate the MISRA C++ Checker

Activate the MISRA C++ rule checker using the option `-misra-cpp`. You can set this option through the command line or through the Project Manager perspective.

To activate the MISRA C++ rule checker:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2. Select the **Check MISRA C++ rules** check box.

3. From the corresponding drop-down list, select the MISRA C++ coding rules to check:

   - `required-rules` — All *required* MISRA C++ coding rules. All violations are reported as warnings.
   - `all-rules` — All *required* and *advisory* coding rules. All violations are reported as warnings.
   - `SQO-subset1` — A subset of MISRA C++ rules that have a direct impact on the selectivity of verification. All violations are reported as warnings. For more information, see "SQO Subset 1 – Direct Impact on Selectivity" on page 11-51.
   - `SQO-subset2` — A second subset of MISRA C++ rules that have an indirect impact on the selectivity of verification, as well as the rules contained in `SQO-subset1`. All violations are reported as warnings. For more information, see "SQO Subset 2 – Indirect Impact on Selectivity" on page 11-54.
   - `custom` — A specified set of MISRA C++ coding rules. When you select this option, you must provide a rules file that specifies the MISRA C++ rules to check and whether to report an error or warning for violations of each rule. For more information, see "Create a MISRA or JSF C++ Coding Rules File" on page 11-13.

4. Specify custom rules that you define. See "Activate Custom Rules Checker" on page 11-9.

5. Specify files to exclude from the checking process. See "Exclude Specific Files and Folders from Rules Checking" on page 11-29.

   You can also exclude all include folders from the checking process. See "Exclude Include Folders from Rules Checking" on page 11-30.

Activate the JSF C++ Checker

Activate the JSF C++ rule checker using the option `-jsf-coding-rules`. You can set this option through the command line or through the Project Manager perspective.

To activate the JSF C++ rule checker:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2. Select the **Check JSF C++ rules** check box.

3. From the corresponding drop-down list, select the JSF C++ coding rules to check:

   - `shall-rules` — All **Shall** rules, which are mandatory rules that require verification.

   - `shall-will-rules` — All **Shall** and **Will** rules. **Will** rules are mandatory rules that do not require verification.

   - `all-rules` — All **Shall**, **Will**, and **Should** rules. **Should** rules are advisory rules.

   - `custom` — A specified set of JSF C++ coding rules. When you select this option, you must provide a rules file that specifies the JSF C++ rules to check and whether to report an error or warning for violations of each rule. For more information, see "Create a MISRA or JSF C++ Coding Rules File" on page 11-13.

4. Specify custom rules that you define. See "Activate Custom Rules Checker" on page 11-9.

5. Specify files to exclude from the checking process. See "Exclude Specific Files and Folders from Rules Checking" on page 11-29.

   You can also exclude all include folders from the checking process. See "Exclude Include Folders from Rules Checking" on page 11-30.

Activate Custom Rules Checker

You can check names or text patterns in your source code with reference to custom rules that you specify in a text file.

Use the `-custom-rules` option to activate the custom rules checker. You can set this option through the command line or through the Project Manager perspective.

To activate the custom rules checker:

1. From the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2. Select the **Check custom rules** check box.

3. In the `-custom-rules` field, specify the path to your custom rules file. Alternatively, Click **Edit**, which opens the New File dialog box:

   - To use an existing custom rules file, on the toolbar, click 📂. The Select a Custom rules C/C++ configuration dialog box opens. Use this dialog box to load a custom rules file.

   - To create a new custom coding rules file, see “Create a Custom Coding Rules File” on page 11-16.

Create Coding Rules File

In this section...

“Create a MISRA C or MISRA AC AGC Rules File” on page 11-11

“Create a MISRA or JSF C++ Coding Rules File” on page 11-13

“Create a Custom Coding Rules File” on page 11-16

“Custom Rules You Can Define” on page 11-19

Create a MISRA C or MISRA AC AGC Rules File

If you select `custom` from the **Check MISRA C rules** or **Check AC AGC rules** drop-down list, you must provide a file that specifies the rules to check.

To create a custom rules file:

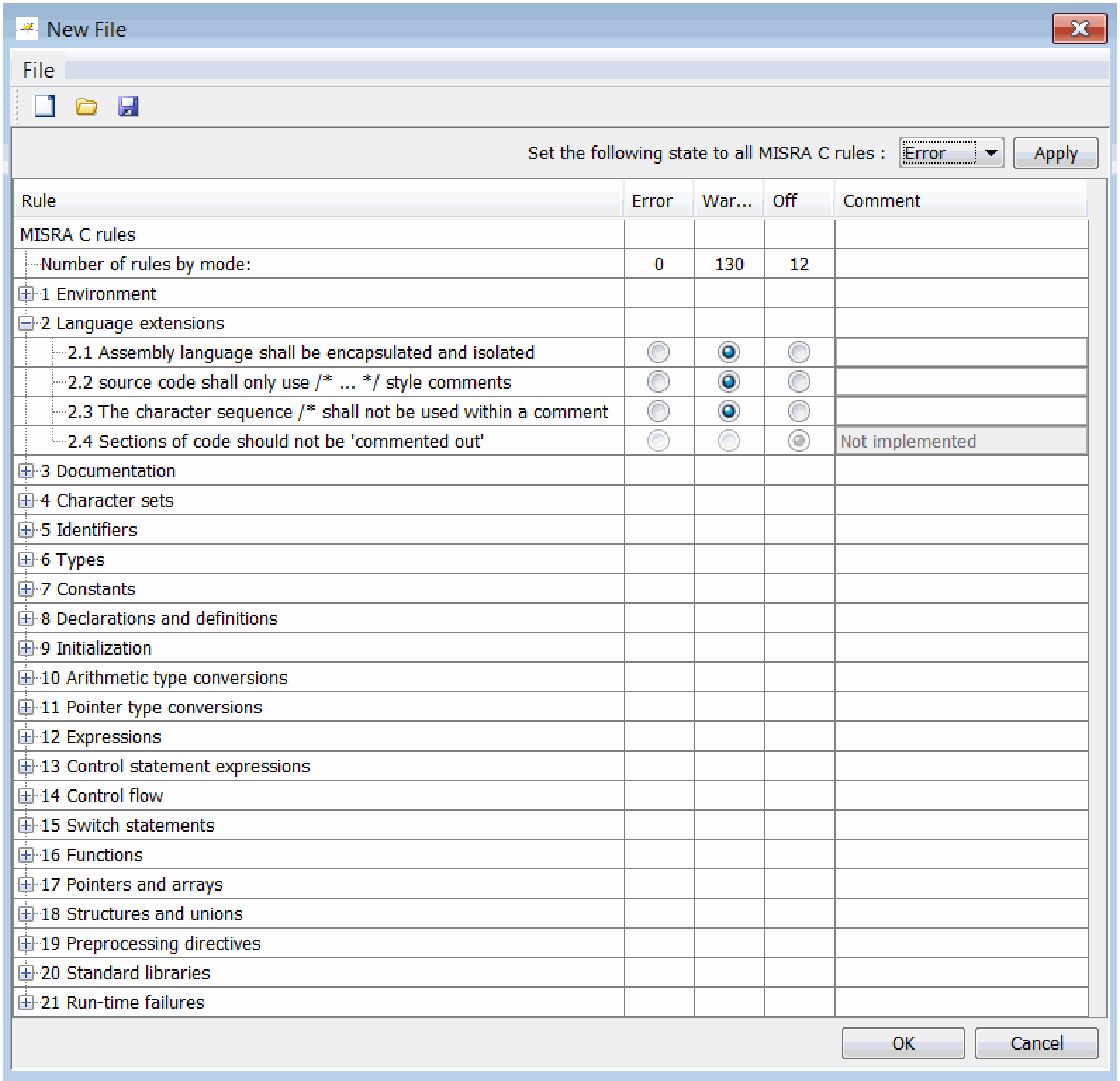
1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2. Select the **Check MISRA C rules** or **Check AC AGC rules** check box.

3. From the corresponding drop-down list, select `custom`. The software displays a new field for your custom file.

4. To the right of this field, click **Edit**.

   The New File window opens, displaying a table of rules.



Set the following state to all MISRA C rules : Error

Rule	Error	War...	Off	Comment
MISRA C rules				
Number of rules by mode:	0	130	12	
⊞ 1 Environment				
⊟ 2 Language extensions				
2.1 Assembly language shall be encapsulated and isolated	○	●	○	
2.2 source code shall only use /* ... */ style comments	○	●	○	
2.3 The character sequence /* shall not be used within a comment	○	●	○	
2.4 Sections of code should not be 'commented out'	○	○	●	Not implemented
⊞ 3 Documentation				
⊞ 4 Character sets				
⊞ 5 Identifiers				
⊞ 6 Types				
⊞ 7 Constants				
⊞ 8 Declarations and definitions				
⊞ 9 Initialization				
⊞ 10 Arithmetic type conversions				
⊞ 11 Pointer type conversions				
⊞ 12 Expressions				
⊞ 13 Control statement expressions				
⊞ 14 Control flow				
⊞ 15 Switch statements				
⊞ 16 Functions				
⊞ 17 Pointers and arrays				
⊞ 18 Structures and unions				
⊞ 19 Preprocessing directives				
⊞ 20 Standard libraries				
⊞ 21 Run-time failures				

5 For each rule, specify one of the following states.

State	Causes the verification to...
Error	End after the compile phase when this rule is violated.
Warning	Display warning message and continue verification when this rule is violated.
Off	Skip checking of this rule.

Note The default state for all rules is `Warning`. The state for rules that have not yet been implemented is `Off`.

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.

Create a MISRA or JSF C++ Coding Rules File

You must have a rules file to run a verification with MISRA C++ or JSF C++ checking. You can use an existing file or create a new one.

To create a new rules file:

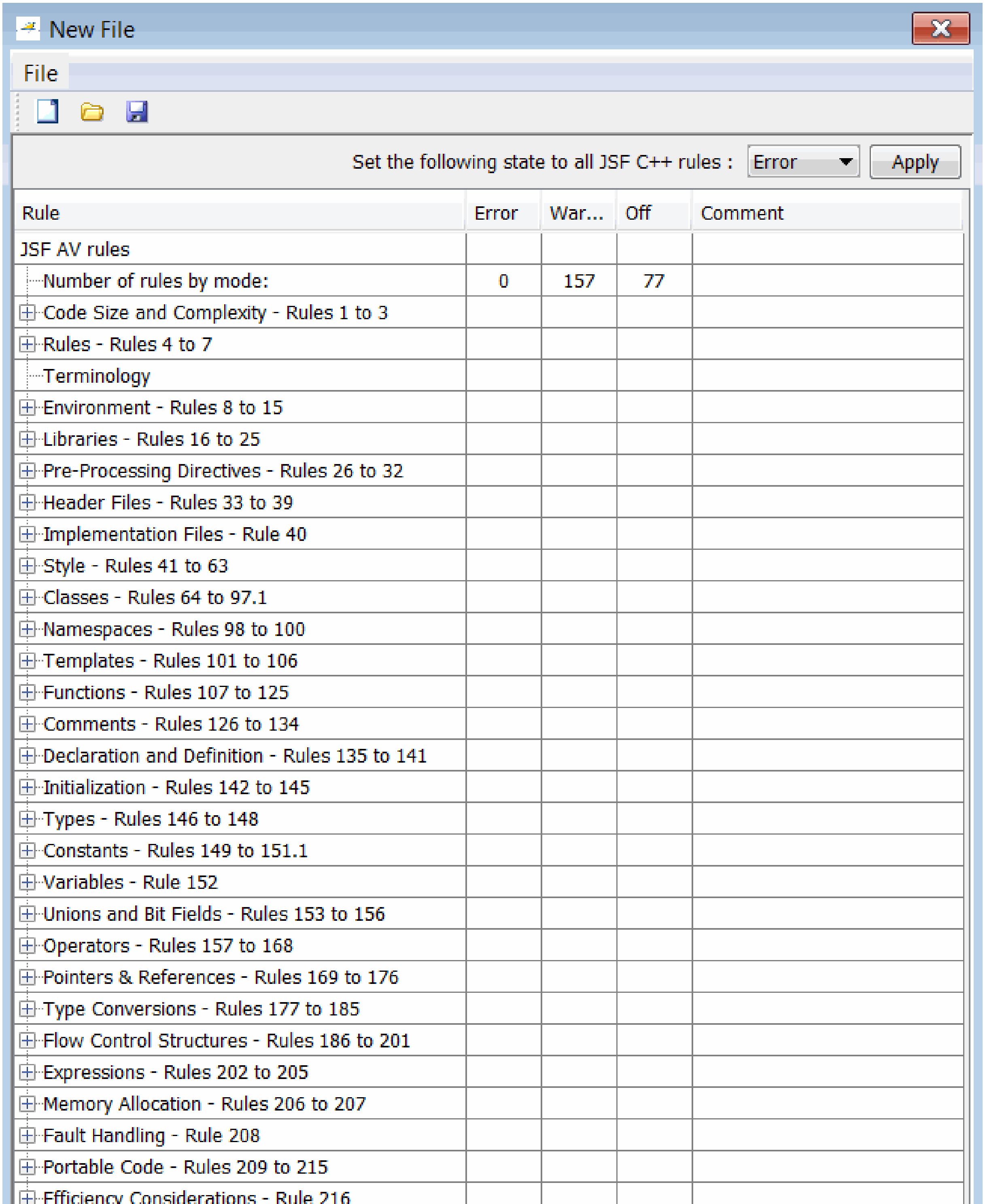
1 In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2 Select the **Check MISRA C++ rules** or **Check JSF C++ rules** check box.

3 From the corresponding drop-down list, select `custom`. The software displays a new field for your custom file.

4 To the right of this field, click **Edit**.

The New File window opens, which allows you to create a new rules file, or open an existing file.



Set the following state to all JSF C++ rules : Error Apply

Rule	Error	War...	Off	Comment
JSF AV rules				
Number of rules by mode:	0	157	77	
Code Size and Complexity - Rules 1 to 3				
Rules - Rules 4 to 7				
Terminology				
Environment - Rules 8 to 15				
Libraries - Rules 16 to 25				
Pre-Processing Directives - Rules 26 to 32				
Header Files - Rules 33 to 39				
Implementation Files - Rule 40				
Style - Rules 41 to 63				
Classes - Rules 64 to 97.1				
Namespaces - Rules 98 to 100				
Templates - Rules 101 to 106				
Functions - Rules 107 to 125				
Comments - Rules 126 to 134				
Declaration and Definition - Rules 135 to 141				
Initialization - Rules 142 to 145				
Types - Rules 146 to 148				
Constants - Rules 149 to 151.1				
Variables - Rule 152				
Unions and Bit Fields - Rules 153 to 156				
Operators - Rules 157 to 168				
Pointers & References - Rules 169 to 176				
Type Conversions - Rules 177 to 185				
Flow Control Structures - Rules 186 to 201				
Expressions - Rules 202 to 205				
Memory Allocation - Rules 206 to 207				
Fault Handling - Rule 208				
Portable Code - Rules 209 to 215				
Efficiency Considerations - Rule 216				

State	Causes the verification to...
Error	End after the compile phase when this rule is violated.
Warning	Display warning message and continue verification when this rule is violated.
Off	Skip checking of this rule.

Note The default state for all rules is `Warning`. The state for rules that have not yet been implemented is `Off`.

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 your rules file.

8 Click **OK** to save the file and close the dialog box.

Note If your project uses a dialect other than ISO, some JSF C++ coding rules might not be completely checked. For example, AV Rule 8: "All code shall conform to ISO/IEC 14882:2002(E) standard C++."

Create a Custom Coding Rules File

You can check names or text patterns in your source code with reference to custom rules that you specify in a text file. 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. A violation generates a warning or error message in the report file, for example, `*Results*/Polyspace-Doc/Custom-rules-report.xml`. You can specify the content of the message through the text file.

You can create your coding rules file:

- Using Polyspace Code Prover.

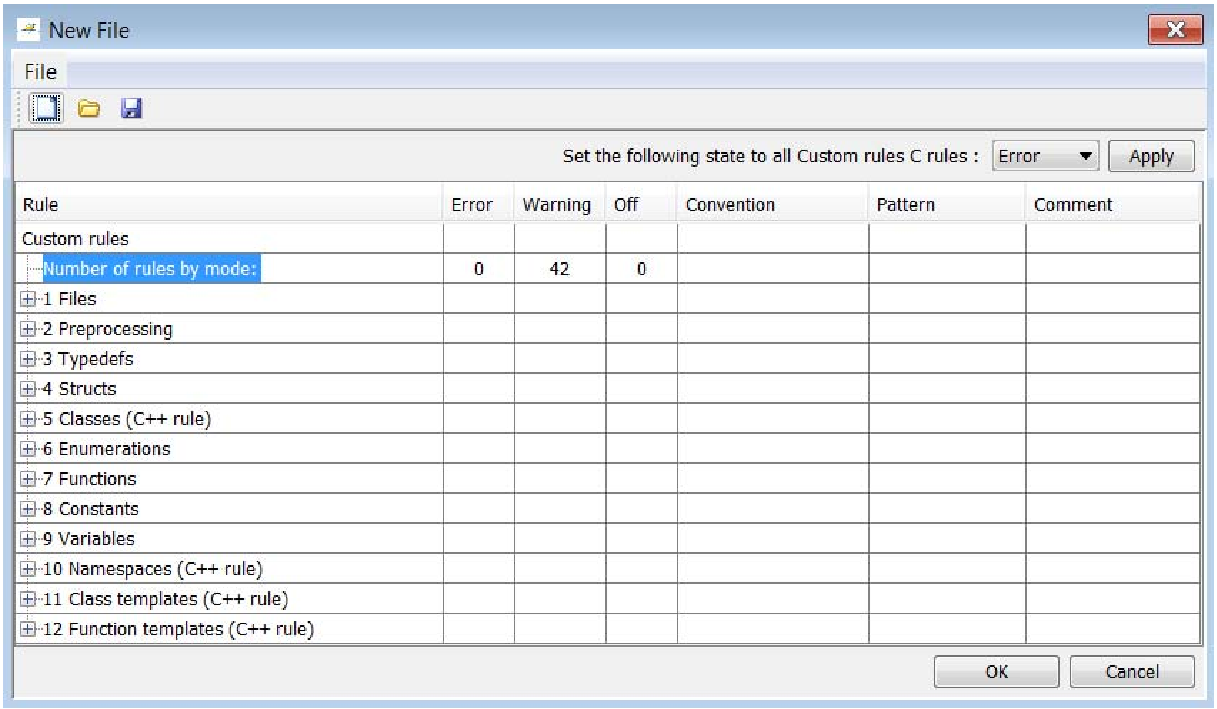
- Manually.

To create your coding rules file using Polyspace Code Prover:

1 In the Project Manager perspective, select the **Configuration > Coding Rules** pane.

2 Select the **Check custom rules** check box.

3 To the right of the **Check custom rules** field, click **Edit**. The New File dialog box opens, displaying a table of rule groups.



Set the following state to all Custom rules C rules : Error

Rule	Error	Warning	Off	Convention	Pattern	Comment
Custom rules						
Number of rules by mode:	0	42	0			
1 Files						
2 Preprocessing						
3 Typedefs						
4 Structs						
5 Classes (C++ rule)						
6 Enumerations						
7 Functions						
8 Constants						
9 Variables						
10 Namespaces (C++ rule)						
11 Class templates (C++ rule)						
12 Function templates (C++ rule)						

For more information about these rule groups, see “Custom Rules You Can Define” on page 11-19.

4 To view all rules within a group, for example **Files**, click the corresponding node.

5 For each rule, configure the following fields:

- **Error**, **Warning** (default), or **Off** — Response you require when rule is violated. If you select **Off**, the software does not perform checking for the rule.

  Tip To set the same response for all rules, from the **Set the following state to all Custom rules** drop-down list, select the required response. Then click **Apply**.

- **Convention** — Optional. Text message that software generates in the report file.
- **Pattern** — Regular expression that software compares against (rule-specific) source code identifier. Default value is `.*`.
- **Comment** — Optional. Text that appears only in the coding rule file.

6 Click **OK**. The Save as dialog box opens.

7 In the **File** field, enter a name for the rules file. Then click **OK**.

You can also create the rules file using a text editor. Each rule in the text file must have the following format:

```
N.n off|error|warning
convention=violation_message
pattern=regular_expression
```

- *`N.n`* — Custom rule number, for example, 1.2.
- `off` — Rule is not considered.
- `error` — Software generates an error if code violates custom rule.
- `warning` — Software generates a warning if code violates custom rule.
- *`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 Rules You Can Define" on page 11-19.

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. No comments are 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  error        # Violation of custom rule 8.1 produces an error
convention=Global constants must begin by G_ and must be in capital letters.
pattern=G_[A-ZO-9_]*
9.1  warning    # Non-adherence to custom rule 9.1 produces only a warning
convention=Global variables should begin by g_.
pattern=g_.*
```

Custom Rules You Can Define

The following table provides information about the custom rules that you can define.

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
Files	1.1	C/C++	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	C/C++	All source folder names	The source dir name	Only the folder name is checked.

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
			must follow the specified pattern.	"dir_name" does not match the specified pattern.	A source file is a file that is not included.
	1.3	C/C++	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	C/C++	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	2.1	C/C++	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	C/C++	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.

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
Type definitions	3.1	C/C++	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;`
	3.2	C/C++	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	C/C++	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	C/C++	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;`

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
	3.5	C/C++	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	4.1	C/C++	All `struct` tags must follow the specified pattern.	The struct tag "tag_name" does not match the specified pattern.	
	4.2	C/C++	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	C/C++	All `struct` fields must follow the specified pattern.	The struct field "field_name" does not match the specified pattern.	
	4.4	C/C++	All `struct` bit fields must follow the specified pattern.	The struct bit field "field_name" does not match the specified pattern.	

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
Classes	5.1	C++	All class names must follow the specified pattern.	The class tag “tag_name” does not match the specified pattern.	
	5.2	C++	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	C++	All data members must follow the specified pattern.	The data member “member_name” does not match the specified pattern.	
	5.4	C++	All function members must follow the specified pattern.	The function member “member_name” does not match the specified pattern.	
	5.5	C++	All static data members must follow the specified pattern.	The static data member “member_name” does not match the specified pattern.	
	5.6	C++	All static function members must follow	The static function member “member_name”	

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
			the specified pattern.	does not match the specified pattern.	
	5.7	C++	All bitfield members must follow the specified pattern.	The bitfield “member_name” does not match the specified pattern.	
Enumerations	6.1	C/C++	All enumeration tags must follow the specified pattern.	The enumeration tag “tag_name” does not match the specified pattern.	
	6.2	C/C++	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	C/C++	All enumeration constants must follow the specified pattern.	The enumeration constant “constant_name” does not match the specified pattern.	

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
Functions	7.1	C/C++	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	C/C++	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	C/C++	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	8.1	C/C++	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	C/C++	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	Language Supported	Rule Applied	Message generated if rule is violated	Other details
	8.3	C/C++	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	C/C++	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	9.1	C/C++	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	C/C++	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	C/C++	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	C/C++	All static local variables must follow	The static local variable "var_name"	A static local variable is a variable

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
			the specified pattern.	does not match the specified pattern.	declared static in a function.
Name spaces	10.1	C++	All namespaces must follow the specified pattern.	The namespace “namespace_name” does not match the specified pattern.	
Class templates	11.1	C++	All class templates must follow the specified pattern.	The class template “template_name” does not match the specified pattern.	
	11.2	C++	All class template parameters must follow the specified pattern.	The class template parameter “param_name” does not match the specified pattern.	
Function templates	12.1	C++	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	C++	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.

Rule group	Number	Language Supported	Rule Applied	Message generated if rule is violated	Other details
	12.3	C++	All function template members must follow the specified pattern.	The function template member “member_name” does not match the specified pattern.	

Exclude from Rules Checking

In this section…

"Exclude Specific Files and Folders from Rules Checking" on page 11-29

"Exclude Include Folders from Rules Checking" on page 11-30

"Allow Undocumented Pragma Directives" on page 11-30

"Redefine Data Types as Boolean" on page 11-31

Exclude Specific Files and Folders from Rules Checking

You can exclude individual files and folders from coding rules checking:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.
2. Select the **Files and folders to ignore** check box.
3. From the corresponding drop-down list, select `custom`. The software displays the **File/Folder** view
4. Click the folder icon 📂. The Open File dialog box opens.
5. Navigate to the folder that contain the files you want to exclude. Then select the files or folder.
6. Click **Open**. The software displays the selected files in the **File/Folder** view.

Note To remove a file or folder from the list of excluded files and folders, in the **File/Folder** view, select the file or folder. Then click ✖.

Exclude Include Folders from Rules Checking

You can use the `-I` option multiple times to specify folders with header and source files that should be included in the compilation process. The `-includes-to-ignores` option allows you to exclude some or all of these folders from coding rules checking.

To exclude include folders from coding rules checking:

1. In the Project Manager perspective, open your project.
2. Select the **Configuration > Coding Rules** pane.
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) — Rule checker excludes folders that contain only header files, that is, folders with no source files.
   - `all` — Rule checker excludes all include folders. For example, if you are checking a large code base with standard or Visual headers, excluding all include folders can significantly improve the speed of code analysis.

   .

Allow Undocumented Pragma Directives

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.

To allow undocumented pragma directives:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.
2. To the right of **Allowed pragmas**, click ➕.

   In the **Pragma** view, the software displays an active text field.
3. In the text field, enter a pragma directive.

Note To remove a directive from the **Pragma** list, select the directive. Then click ✖.

Redefine Data Types as Boolean

You can specify data types that you want Polyspace to consider as Boolean during MISRA C rule checking. The software applies this redefinition only to data types defined by `typedef` statements.

Note The use of this option may affect the checking of MISRA C rules 12.6, 13.2, and 15.4.

To redefine a data type as Boolean:

1. In the Project Manager perspective, select the **Configuration > Coding Rules** pane.
2. To the right of **Effective boolean types**, click ✚.

   In the **Type** view, the software displays an active text field.
3. In the text field, specify the data type that you want Polyspace to treat as Boolean.

Note To remove a data type from the **Type** list, select the data type. Then click ✖.

Run Verification with Coding Rules Checking

When you run a verification with the **Check MISRA C rules**, **Check MISRA AC AGC rules**, **Check MISRA C++ rules**, **Check JSF C++ rules**, or **Check custom rules** option selected, the verification checks most of the rules during the compile phase. If a rule with state `Error` is violated, the verification stops.

Note Some rules address run-time errors.

To start the verification:

1. On the Project Manager toolbar, click .
2. Code analysis begins.
   - If the coding rules checker detects violations of coding rules set to `Error`, the verification stops, and the **Output Summary** view shows that the verification has detected coding rules violations.
   - If there are no violations of rules set to `Error`, code verification continues after the completion of rules checking.
3. When rules checking is complete, the software displays the file **MISRA-C-report.xml**, **MISRA-AC-AGC-report.xml**, **MISRA-CPP-report.xml**, or **JSF-report.xml** in the Project Browser **Result** folder. This file contains the results from the coding rules checker.

Note If any source files in the verification 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, and may not contain full results for the files that did compile since some rules are checked only after compilation is complete.

Examine Coding Rule Violations

When code analysis is complete, you can view results in the Results Manager perspective.

To examine coding rule violations:

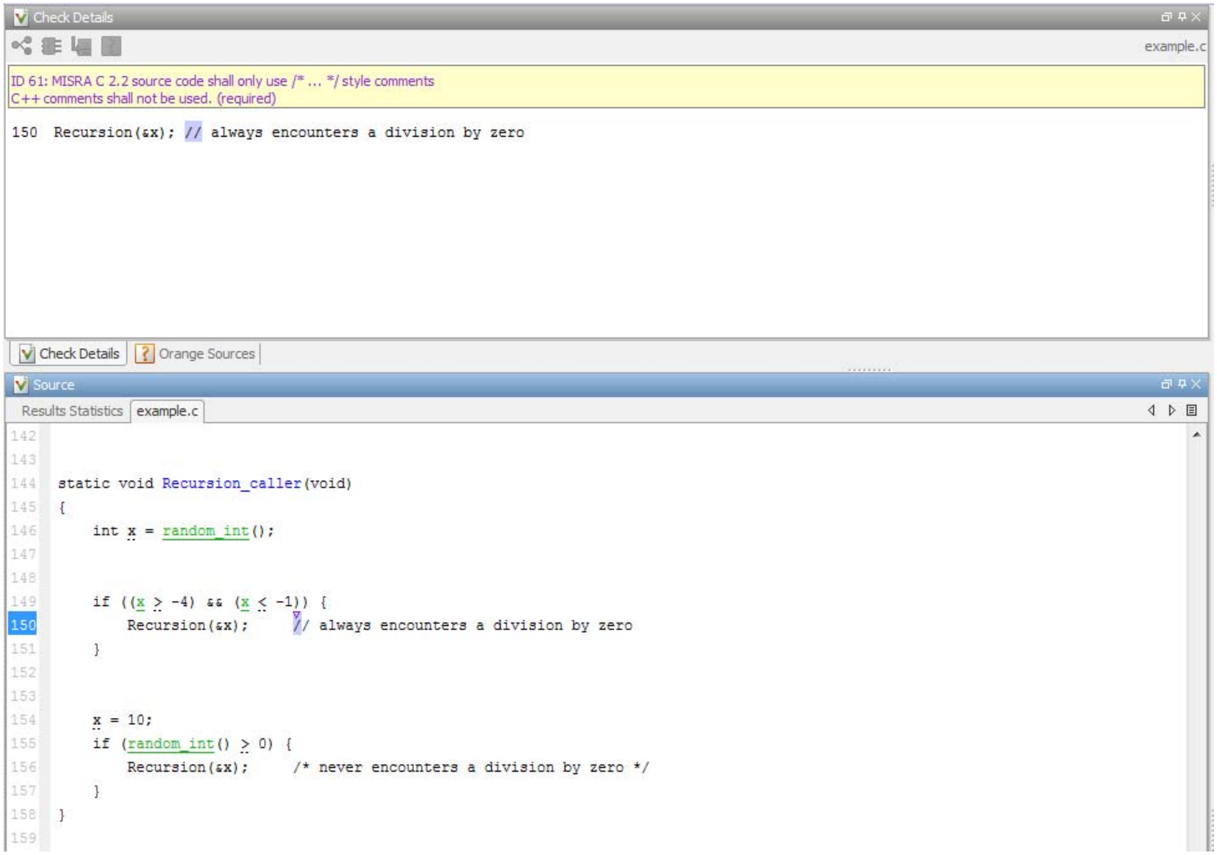
1. Double-click **MISRA-C-report.xml**, **MISRA-CPP-report.xml** or **JSF-report.xml** in the Project Browser **Result** folder.

   The Results Manager perspective opens, displaying the coding-rule violations as purple checks on the **Results Summary** pane.

   Note If you select the review methodology, **First checks to review**, the **Results Summary** view displays only violations of coding rules with state `Error`. For more information, see "What Are Review Methodologies?" on page 9-23.

   You can use filters to focus on specific types of coding rule violations. For more information, see "Apply Coding Rule Violation Filters" on page 11-36.

2. Select a purple check. On the **Check Details** pane, you see the location and description of the violated rule. On the **Source** pane, you see the line of code containing the violation.



ID 61: MISRA C 2.2 source code shall only use /* ... */ style comments
C++ comments shall not be used. (required)

```
150  Recursion(&x); // always encounters a division by zero
```

```
static void Recursion_caller(void)
{
    int x = random_int();


    if ((x > -4) && (x < -1)) {
        Recursion(&x);      // always encounters a division by zero
    }


    x = 10;
    if (random_int() > 0) {
        Recursion(&x);      /* never encounters a division by zero */
    }
}
```

3 Classify, apply comments, or justify the coding rule violation using the **Check Review** tab. For more information, see "Review Coding Rule Violations" on page 11-40.

4 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 your text editor.

Note Before you can open source files, you must configure a text editor. See "Configure Text Editor" on page 3-17.

5 Fix the coding rule violation.

When you have corrected all coding rule violations, run the verification again.

Apply Coding Rule Violation Filters

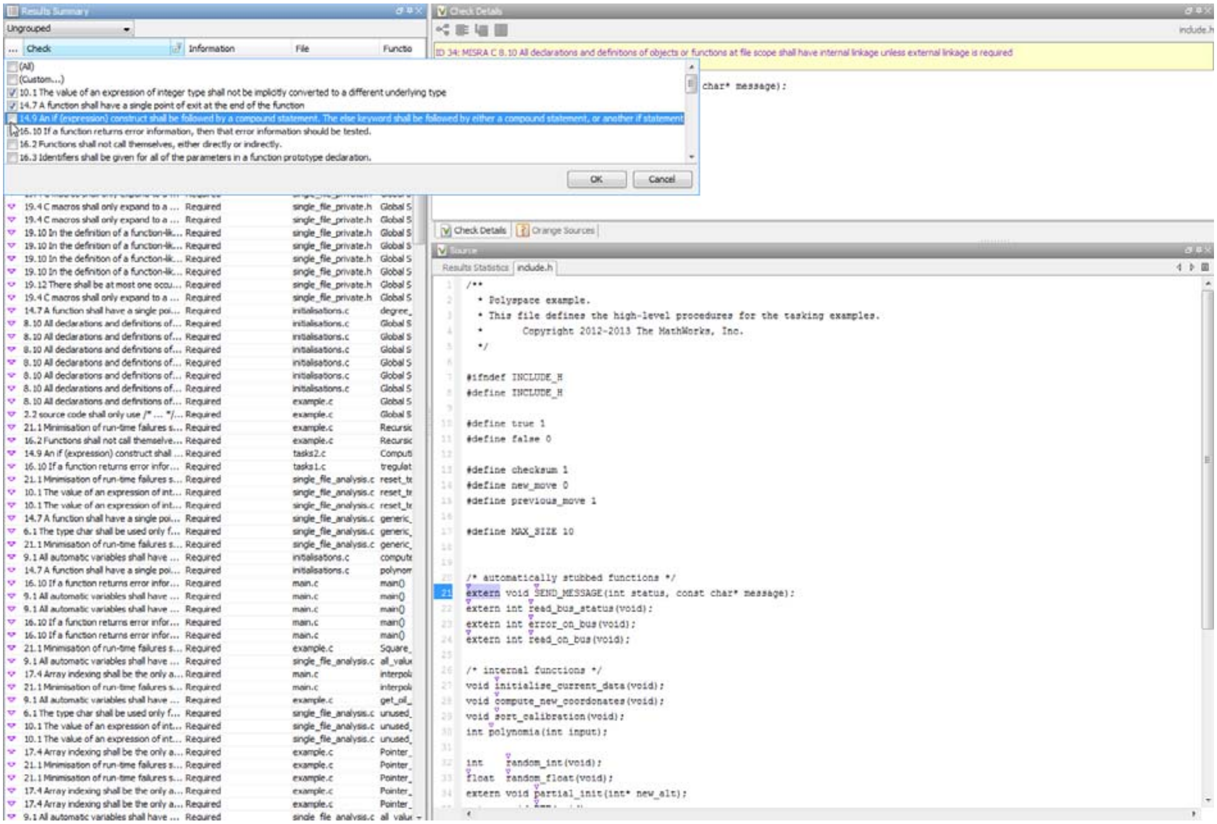
This example shows how to use filters in the **Results Summary** pane to focus on specific kinds of coding rule violations. By default, the software displays all coding rule violations and run-time checks.

Filter Individual Coding Rule Violations

To view filters, on the **Results Summary** pane, place your cursor on the **Check** column header. Click the filter icon that appears. In the context menu, you see items that allow you to filter coding rule violations by rule number.

To display violations by rule number:

1. From the context menu, clear the **All** check box.
2. Select the violated rule numbers that you want to focus on.



□ (All)
□ (Custom...)
☑ 10.1 The value of an expression of integer type shall not be implicitly converted to a different underlying type
☑ 14.7 A function shall have a single point of exit at the end of the function
□ 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
□ 16.10 If a function returns error information, then that error information should be tested.
□ 16.2 Functions shall not call themselves, either directly or indirectly.
□ 16.3 Identifiers shall be given for all of the parameters in a function prototype declaration.

OK   Cancel

...	Check	Information	File	Functio
▽	19.4 C macros shall only expand to a ...	Required	single_file_private.h	Global S
▽	19.4 C macros shall only expand to a ...	Required	single_file_private.h	Global S
▽	19.10 In the definition of a function-lik...	Required	single_file_private.h	Global S
▽	19.10 In the definition of a function-lik...	Required	single_file_private.h	Global S
▽	19.10 In the definition of a function-lik...	Required	single_file_private.h	Global S
▽	19.10 In the definition of a function-lik...	Required	single_file_private.h	Global S
▽	19.12 There shall be at most one occu...	Required	single_file_private.h	Global S
▽	19.4 C macros shall only expand to a ...	Required	single_file_private.h	Global S
▽	14.7 A function shall have a single poi...	Required	initialisations.c	degree_
▽	8.10 All declarations and definitions of...	Required	initialisations.c	Global S
▽	8.10 All declarations and definitions of...	Required	initialisations.c	Global S
▽	8.10 All declarations and definitions of...	Required	initialisations.c	Global S
▽	8.10 All declarations and definitions of...	Required	initialisations.c	Global S
▽	8.10 All declarations and definitions of...	Required	initialisations.c	Global S
▽	8.10 All declarations and definitions of...	Required	initialisations.c	Global S
▽	8.10 All declarations and definitions of...	Required	example.c	Global S
▽	2.2 source code shall only use /* ... */...	Required	example.c	Global S
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Recursic
▽	16.2 Functions shall not call themselve...	Required	example.c	Recursic
▽	14.9 An if (expression) construct shall ...	Required	tasks2.c	Computi
▽	16.10 If a function returns error infor...	Required	tasks1.c	tregulat
▽	21.1 Minimisation of run-time failures s...	Required	single_file_analysis.c	reset_tr
▽	10.1 The value of an expression of int...	Required	single_file_analysis.c	reset_tr
▽	10.1 The value of an expression of int...	Required	single_file_analysis.c	reset_tr
▽	14.7 A function shall have a single poi...	Required	single_file_analysis.c	generic_
▽	6.1 The type char shall be used only f...	Required	single_file_analysis.c	generic_
▽	21.1 Minimisation of run-time failures s...	Required	single_file_analysis.c	generic_
▽	9.1 All automatic variables shall have ...	Required	initialisations.c	compute
▽	14.7 A function shall have a single poi...	Required	initialisations.c	polynom
▽	16.10 If a function returns error infor...	Required	main.c	main()
▽	9.1 All automatic variables shall have ...	Required	main.c	main()
▽	9.1 All automatic variables shall have ...	Required	main.c	main()
▽	16.10 If a function returns error infor...	Required	main.c	main()
▽	16.10 If a function returns error infor...	Required	main.c	main()
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Square_
▽	9.1 All automatic variables shall have ...	Required	single_file_analysis.c	all_valu
▽	17.4 Array indexing shall be the only a...	Required	main.c	interpola
▽	21.1 Minimisation of run-time failures s...	Required	main.c	interpola
▽	9.1 All automatic variables shall have ...	Required	example.c	get_oil_
▽	6.1 The type char shall be used only f...	Required	single_file_analysis.c	unused_
▽	10.1 The value of an expression of int...	Required	single_file_analysis.c	unused_
▽	10.1 The value of an expression of int...	Required	single_file_analysis.c	unused_
▽	17.4 Array indexing shall be the only a...	Required	example.c	Pointer_
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Pointer_
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Pointer_
▽	17.4 Array indexing shall be the only a...	Required	example.c	Pointer_
▽	17.4 Array indexing shall be the only a...	Required	example.c	Pointer_
▽	9.1 All automatic variables shall have ...	Required	single_file_analysis.c	all_valu

include.h

ID 34: MISRA C 8.10 All declarations and definitons of objects or functions at file scope shall have internal linkage unless external linkage is required

```
/**
  * Polyspace example.
  * This file defines the high-level procedures for the tasking examples.
  *       Copyright 2012-2013 The MathWorks, Inc.
  */

#ifndef INCLUDE_H
#define INCLUDE_H

#define true 1
#define false 0

#define checksum 1
#define new_move 0
#define previous_move 1

#define MAX_SIZE 10


/* automatically stubbed functions */
extern void SEND_MESSAGE(int status, const char* message);
extern int read_bus_status(void);
extern int error_on_bus(void);
extern int read_on_bus(void);

/* internal functions */
void initialise_current_data(void);
void compute_new_coordonates(void);
void sort_calibration(void);
int polynomia(int input);

int    random_int(void);
float  random_float(void);
extern void partial_init(int* new_alt);
```

3 Click **OK**.

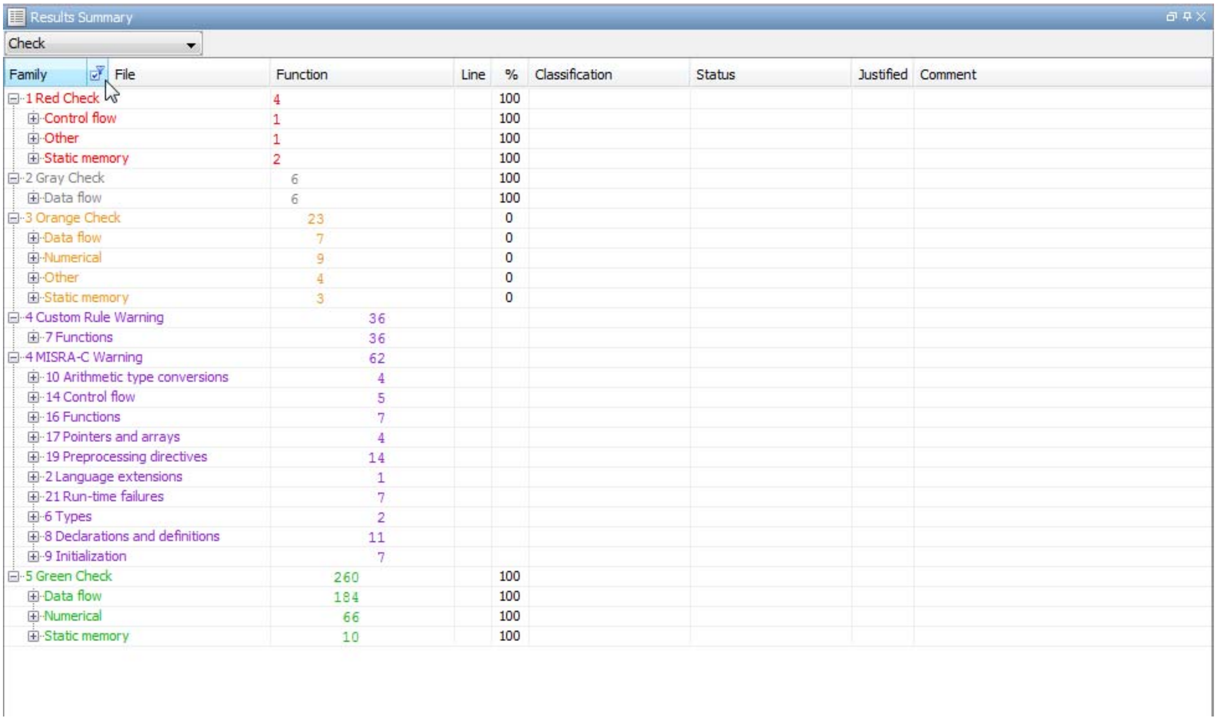
Filter Coding Rule Errors

To display violations of rules that generate, for example, `MISRA-C` errors during the compilation phase:

1 On the **Results Summary** pane, from the drop-down menu, select `Check`.

The checks are grouped by color. Within each color, the checks are grouped by categories.

2 Click the filter-icon on the **Family** column header.



Results Summary

Check

Family	File	Function	Line	%	Classification	Status	Justified	Comment
⊟ 1 Red Check		4		100				
⊞ Control flow		1		100				
⊞ Other		1		100				
⊞ Static memory		2		100				
⊟ 2 Gray Check		6		100				
⊞ Data flow		6		100				
⊟ 3 Orange Check		23		0				
⊞ Data flow		7		0				
⊞ Numerical		9		0				
⊞ Other		4		0				
⊞ Static memory		3		0				
⊟ 4 Custom Rule Warning		36						
⊞ 7 Functions		36						
⊟ 4 MISRA-C Warning		62						
⊞ 10 Arithmetic type conversions		4						
⊞ 14 Control flow		5						
⊞ 16 Functions		7						
⊞ 17 Pointers and arrays		4						
⊞ 19 Preprocessing directives		14						
⊞ 2 Language extensions		1						
⊞ 21 Run-time failures		7						
⊞ 6 Types		2						
⊞ 8 Declarations and definitions		11						
⊞ 9 Initialization		7						
⊟ 5 Green Check		260		100				
⊞ Data flow		184		100				
⊞ Numerical		66		100				
⊞ Static memory		10		100				

3 From the context menu, clear the **All** check box. Select the **4 MISRA-C Error** check box.

   Only the coding rule violations that generate `MISRA-C` errors remain on the **Results Summary** pane.

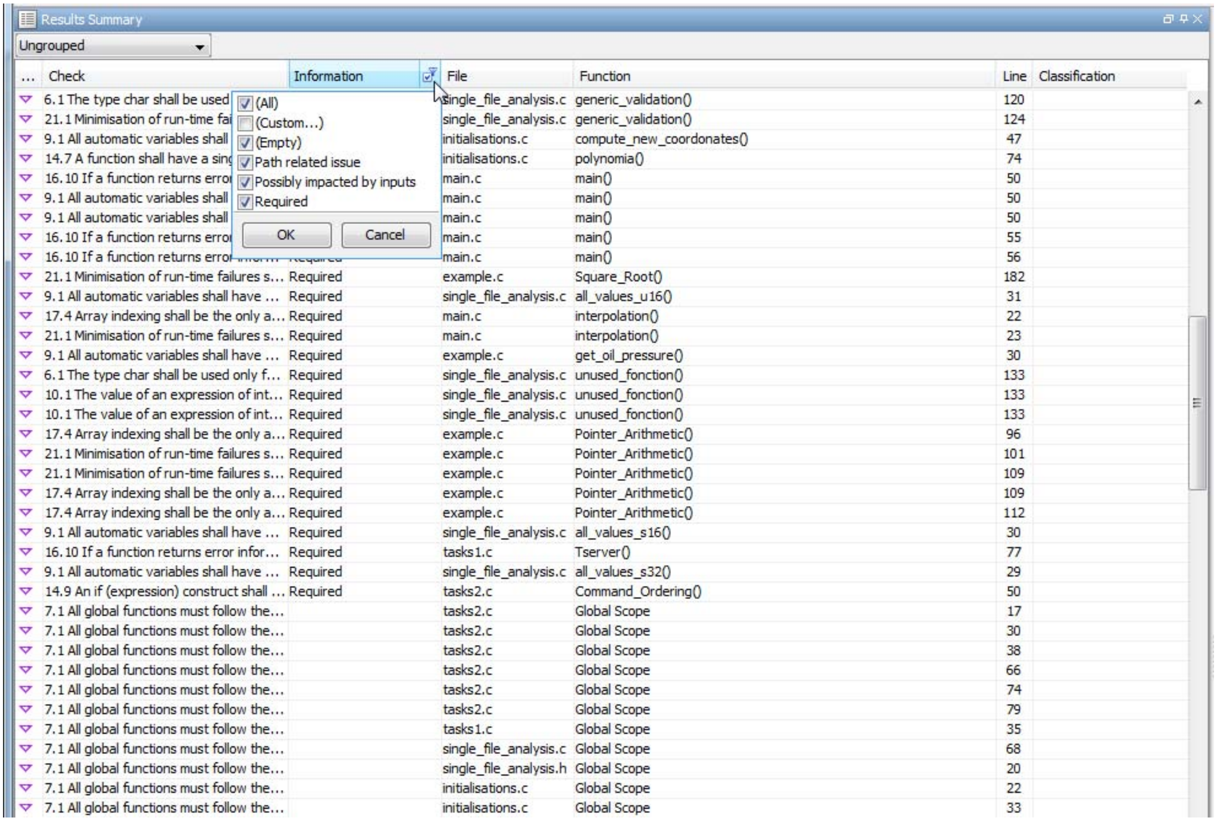
Filter Required Rules

To display violations of rules deemed, for example, mandatory by MISRA C:

1 On the **Results Summary** pane, right-click on any column header. From the context menu, select **Information**.

   The **Information** column appears on the **Results Summary** pane. For a coding-rule violation, this column states whether the rule is **Required**.

2 Click the filter-icon on the **Information** column header.



...	Check	Information	File	Function	Line	Classification
▽	6.1 The type char shall be used		single_file_analysis.c	generic_validation()	120	
▽	21.1 Minimisation of run-time fai		single_file_analysis.c	generic_validation()	124	
▽	9.1 All automatic variables shall		initialisations.c	compute_new_coordonates()	47	
▽	14.7 A function shall have a sing		initialisations.c	polynomia()	74	
▽	16.10 If a function returns erro		main.c	main()	50	
▽	9.1 All automatic variables shall		main.c	main()	50	
▽	9.1 All automatic variables shall		main.c	main()	50	
▽	16.10 If a function returns erro		main.c	main()	55	
▽	16.10 If a function returns error inform...	Required	main.c	main()	56	
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Square_Root()	182	
▽	9.1 All automatic variables shall have ...	Required	single_file_analysis.c	all_values_u16()	31	
▽	17.4 Array indexing shall be the only a...	Required	main.c	interpolation()	22	
▽	21.1 Minimisation of run-time failures s...	Required	main.c	interpolation()	23	
▽	9.1 All automatic variables shall have ...	Required	example.c	get_oil_pressure()	30	
▽	6.1 The type char shall be used only f...	Required	single_file_analysis.c	unused_fonction()	133	
▽	10.1 The value of an expression of int...	Required	single_file_analysis.c	unused_fonction()	133	
▽	10.1 The value of an expression of int...	Required	single_file_analysis.c	unused_fonction()	133	
▽	17.4 Array indexing shall be the only a...	Required	example.c	Pointer_Arithmetic()	96	
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Pointer_Arithmetic()	101	
▽	21.1 Minimisation of run-time failures s...	Required	example.c	Pointer_Arithmetic()	109	
▽	17.4 Array indexing shall be the only a...	Required	example.c	Pointer_Arithmetic()	109	
▽	17.4 Array indexing shall be the only a...	Required	example.c	Pointer_Arithmetic()	112	
▽	9.1 All automatic variables shall have ...	Required	single_file_analysis.c	all_values_s16()	30	
▽	16.10 If a function returns error infor...	Required	tasks1.c	Tserver()	77	
▽	9.1 All automatic variables shall have ...	Required	single_file_analysis.c	all_values_s32()	29	
▽	14.9 An if (expression) construct shall ...	Required	tasks2.c	Command_Ordering()	50	
▽	7.1 All global functions must follow the...		tasks2.c	Global Scope	17	
▽	7.1 All global functions must follow the...		tasks2.c	Global Scope	30	
▽	7.1 All global functions must follow the...		tasks2.c	Global Scope	38	
▽	7.1 All global functions must follow the...		tasks2.c	Global Scope	66	
▽	7.1 All global functions must follow the...		tasks2.c	Global Scope	74	
▽	7.1 All global functions must follow the...		tasks2.c	Global Scope	79	
▽	7.1 All global functions must follow the...		tasks1.c	Global Scope	35	
▽	7.1 All global functions must follow the...		single_file_analysis.c	Global Scope	68	
▽	7.1 All global functions must follow the...		single_file_analysis.h	Global Scope	20	
▽	7.1 All global functions must follow the...		initialisations.c	Global Scope	22	
▽	7.1 All global functions must follow the...		initialisations.c	Global Scope	33	

☑ (All)
□ (Custom...)
☑ (Empty)
☑ Path related issue
☑ Possibly impacted by inputs
☑ Required

3 From the context menu, clear the **All** check box. Select the **Required** check box.

Only the coding rule violations that are deemed mandatory by `MISRA-C` remain on the **Results Summary** pane.

Related Examples

- "Activate Coding Rules Checker" on page 11-5

Review Coding Rule Violations

This example shows how to review coding rule violations in the Results Manager perspective. When reviewing coding rules violations in the Results Manager perspective, you can classify the severity of each violation, mark violations as **Justified**, and enter comments to describe the results of your review. After you mark violations as Justified, you can hide them. This helps you track the progress of your review and avoid reviewing the same violation twice.

1 On the **Results Summary** pane, select the violation you want to review. On the **Check Details** pane, you see the location and description of the violated rule. On the **Source** pane, you see the code containing the violation.

2 Review the violation. Then, on the **Check Review** tab, select a **Classification** to describe the severity of the issue:

- `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`

You can also define your own statuses.

4 In the comment box, enter additional information about the violation.

Related Examples

- “Apply Coding Rule Violation Filters” on page 11-36
- “Review and Comment Checks” on page 9-17
- “Track Review Progress” on page 9-22
- “Customize Review Status” on page 9-49

Open Coding Rules Report

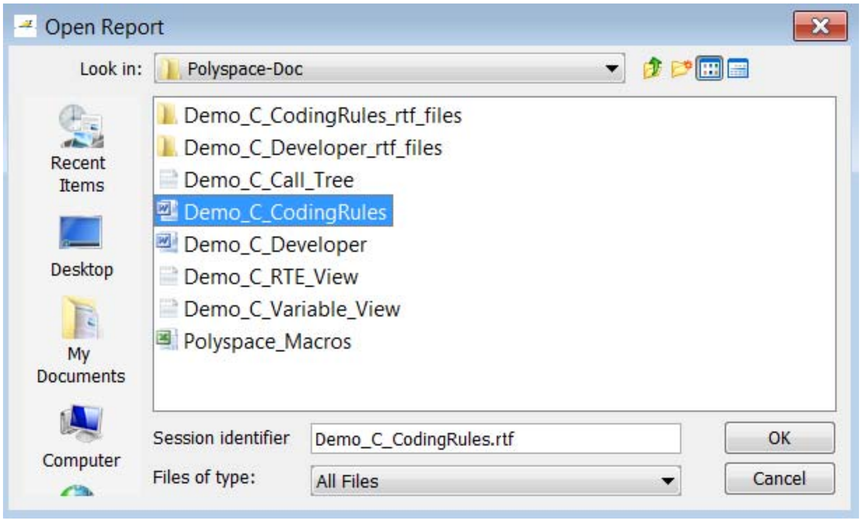
You can use the Polyspace Report Generator to generate reports about compliance with coding rules, as well as other reports. For information on using the Polyspace Report Generator, see “Report Generation”.

The coding rules report contains all the errors and warnings reported by the coding rules checker. You see the following information in tables:

- Summary of violations by file — Number of errors and warning in each file
- Summary of rules broken — Rule number, rule description, severity, and total number of rule violations
- Warnings generated from each file — Rule number, warning message, function name, location of code (line and column number), review information (justification, classification, status, and comment)
- Errors generated from each file — Rule number, warning message, function name, location of code (line and column number), review information (justification, classification, status, and comment)
- Configuration settings — Verification options
- Coding rules configuration — Whether violation of a rule is set to be an error or a warning

To view the coding rules report:

1. From the Results Manager toolbar, select **Run > Run Report > Open Report**, which opens the Open Report dialog box.
2. Navigate to the folder that contains the coding rules report. Then select the report.



Session identifier: Demo_C_CodingRules.rtf

3 Click **OK**.

Note If any source files in the verification do not compile, the verification fails with compilation errors, and coding rules checking is incomplete. If this happens, the coding rules report is not exhaustive. The report may not contain full results for files that did not compile, and may not contain full results for the files that did compile since some rules are checked after compilation.

Software Quality Objective Subsets of Coding Rules (C)

In this section...

“SQO Subset 1 – Direct Impact on Selectivity” on page 11-44

“SQO Subset 2 – Indirect Impact on Selectivity” on page 11-46

SQO Subset 1 – Direct Impact on Selectivity

The following set of coding rules will typically improve the selectivity of your verification results.

Rule number	Description
MISRA 8.11	The *static* storage class specifier shall be used in definitions and declarations of objects and functions that have internal linkage
MISRA 8.12	When an array is declared with external linkage, its size shall be stated explicitly or defined implicitly by initialization
MISRA 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
MISRA 11.3	A cast should not be performed between a pointer type and an integral type
MISRA 12.12	The underlying bit representations of floating-point values shall not be used
MISRA 13.3	Floating-point expressions shall not be tested for equality or inequality
MISRA 13.4	The controlling expression of a *for* statement shall not contain any objects of floating type

Rule number	Description
MISRA 13.5	The three expressions of a *for* statement shall be concerned only with loop control
MISRA 14.4	The *goto* statement shall not be used.
MISRA 14.7	A function shall have a single point of exit at the end of the function
MISRA 16.1	Functions shall not be defined with variable numbers of arguments
MISRA 16.2	Functions shall not call themselves, either directly or indirectly
MISRA 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
MISRA 17.3	>, >=, <, <= shall not be applied to pointer types except where they point to the same array
MISRA 17.4	Array indexing shall be the only allowed form of pointer arithmetic
MISRA 17.5	The declaration of objects should contain no more than 2 levels of pointer indirection
MISRA 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.
MISRA 18.3	An area of memory shall not be reused for unrelated purposes.
MISRA 18.4	Unions shall not be used
MISRA 20.4	Dynamic heap memory allocation shall not be used.

Note Polyspace software does not check MISRA rule **18.3**.

SQO Subset 2 – Indirect Impact on Selectivity

Good design practices generally lead to less code complexity, which can improve the selectivity of your verification results. The following set of coding rules help address design issues that can impact selectivity.

Note Specifying `SQO-subset2` in your **MISRA C rules configuration** checks both the rules listed in SQO Subset 1 and SQO Subset 2.

Rule number	Description
MISRA 6.3	*typedefs* that indicate size and signedness should be used in place of the basic types
MISRA 8.7	Objects shall be defined at block scope if they are only accessed from within a single function
MISRA 9.2	Braces shall be used to indicate and match the structure in the nonzero initialization of arrays and structures
MISRA 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
MISRA 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
MISRA 10.5	Bitwise operations shall not be performed on signed integer types
MISRA 11.1	Conversion shall not be performed between a pointer to a function and any type other than an integral type
MISRA 11.5	Type casting from any type to or from pointers shall not be used
MISRA 12.1	Limited dependence should be placed on C's operator precedence rules in expressions
MISRA 12.2	The value of an expression shall be the same under any order of evaluation that the standard permits

Rule number	Description
MISRA 12.5	The operands of a logical && or || shall be primary-expressions
MISRA 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 !)
MISRA 12.9	The unary minus operator shall not be applied to an expression whose underlying type is unsigned
MISRA 12.10	The comma operator shall not be used
MISRA 13.1	Assignment operators shall not be used in expressions that yield Boolean values
MISRA 13.2	Tests of a value against zero should be made explicit, unless the operand is effectively Boolean
MISRA 13.6	Numeric variables being used within a "*for*" loop for iteration counting should not be modified in the body of the loop
MISRA 14.8	The statement forming the body of a *switch, while, do while* or *for* statement shall be a compound statement
MISRA 14.10	All *if else if* constructs should contain a final *else* clause
MISRA 15.3	The final clause of a *switch* statement shall be the *default* clause
MISRA 16.3	Identifiers shall be given for all of the parameters in a function prototype declaration
MISRA 16.8	All exit paths from a function with non-void return type shall have an explicit return statement with an expression
MISRA 16.9	A function identifier shall only be used with either a preceding &, or with a parenthesized parameter list, which may be empty
MISRA 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

Rule number	Description
MISRA 19.9	Arguments to a function-like macro shall not contain tokens that look like preprocessing directives
MISRA 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 ##
MISRA 19.11	All macro identifiers in preprocessor directives shall be defined before use, except in #ifdef and #ifndef preprocessor directives and the defined() operator
MISRA 19.12	There shall be at most one occurrence of the # or ## preprocessor operators in a single macro definition.
MISRA 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 of Coding Rules (AC AGC)

In this section...

"SQO Subset 1 – Direct Impact on Selectivity" on page 11-49

"SQO Subset 2 – Indirect Impact on Selectivity" on page 11-49

SQO Subset 1 – Direct Impact on Selectivity

The following set of MISRA AC AGC coding rules typically improves the selectivity of your verification 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*.

SQO Subset 2 – Indirect Impact on Selectivity

Good design practices lead to less code complexity, which can improve the selectivity of your verification results. The following set of MISRA AC AGC coding rules might help to address design issues that affect selectivity.

- 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

Note When you specify SQO-subset2 for your MISRA AC AGC rules configuration, the software checks the rules listed in SQO Subset 1 and SQO Subset 2.

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*.

Software Quality Objective Subsets of Coding Rules (C++)

In this section...

"SQO Subset 1 – Direct Impact on Selectivity" on page 11-51

"SQO Subset 2 – Indirect Impact on Selectivity" on page 11-54

SQO Subset 1 – Direct Impact on Selectivity

The following set of coding rules will typically improve the selectivity of your verification 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.

MISRA C++ Rule	Description
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.
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 non-virtual 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.

MISRA C++ Rule	Description
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.
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 verification results. The following set of coding rules may help to address design issues that affect selectivity.

Note When you specify `SQO-subset2` for your MISRA C++ rules configuration, the software checks the rules listed in SQO Subset 1 *and* SQO Subset 2.

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 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.

MISRA C++ Rule	Description
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.
5-2-11	The comma operator, && operator and the || operator shall not be overloaded.

MISRA C++ Rule	Description
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.

MISRA C++ Rule	Description
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.
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 non-virtual 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.

MISRA C++ Rule	Description
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.
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.

MISRA C++ Rule	Description
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.

Supported Coding Rules

In this section...

“Supported MISRA C Rules” on page 11-60

“MISRA C Rules Not Checked” on page 11-99

“Supported MISRA C++ Coding Rules” on page 11-102

“MISRA C++ Rules Not Checked” on page 11-122

“Supported JSF C++ Coding Rules” on page 11-128

“JSF++ Rules Not Checked” on page 11-153

Supported MISRA C Rules

The following tables list MISRA C 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 “Detailed 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 a verification. However, the software detects violations of rules 9.1 (`NIV` checks), 12.11 (`OVFL` check using `-scalar-overflows-checks signed-and-unsigned`), 13.7 (gray checks), 14.1 (gray checks), 16.2 (Call graph) and 21.1 during code verification, 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 verification.

Environment

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
1.1	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.	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 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'	All the supported extensions lead to a violation of this MISRA rule. Standard compilation error messages do not lead to a violation of this MISRA rule and remain unchanged. Can be turned to Off (see -misra2 option).

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
		• text following ‘#else’ violates ANSI standard. • text following ‘#endif’ violates ANSI standard. • text following ‘#else’ or ‘#endif’ violates ANSI standard. • 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.	

Language Extensions

N.	MISRA Definition	Messages in report file	Detailed 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	Detailed 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	Detailed 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	Detailed 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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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
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 a 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	Detailed 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. • Value of type signed char is implicitly converted to plain char. • Value of type unsigned char is implicitly converted to plain char.	Warning if value of type plain char is implicitly converted to value of type signed char or unsigned 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	Detailed 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	Detailed 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

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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.
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. • Fragment of function should not be defined in a header file.	Tentative of definitions are considered as definitions.
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).

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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.
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.	Not checked if `-main-generator` option is set. Assumes that 8.1 is not violated. No warning if 0 uses.
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	Array XX has unknown size.	

Initialization

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
9.1	All automatic variables shall have been assigned a value before being used.		Checked during code verification. Violations displayed as NIV checks in the verification 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	Detailed 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	• Implicit conversion of the expression of underlying type ?? to the type ?? that is not a wider integer type of the same signedness. • Implicit conversion of one of the binary operands	1 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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
	• the expression is not constant and is a function argument, or • the expression is not constant and is a return expression	whose underlying types are ?? and ?? • Implicit conversion of the binary right hand operand of underlying type ?? to ?? that is not an integer type. • Implicit conversion of the binary left hand operand of underlying type ?? to ?? that is not an integer type. • Implicit conversion of the binary right hand operand of underlying type ?? to ?? that is not a wider integer type of the same signedness or Implicit conversion of the binary ? left hand operand of underlying type ?? to ??, but it is a complex expression.	**2** An expression of bool or enum types has int as underlying type. **3** Plain char may have signed or unsigned underlying type (depending on Polyspace target configuration or option setting). **4** 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). **5** 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 **6** No violation reported when the following are all true:

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
			• 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	Detailed Polyspace Specification
10.1 (cont.)		• Implicit conversion of complex integer expression of underlying type ?? to ??. • Implicit conversion of non-constant integer expression of underlying type ?? in function return whose expected type is ??. • Implicit conversion of non-constant integer expression of underlying type ?? as argument of function whose corresponding parameter type is ??.	
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 ?? to ?? that is not a wider floating type. • Implicit conversion of the binary ? right hand operand from ?? to ??, but it is a complex expression. • Implicit conversion of the binary ? right hand operand from ?? to ?? that is not a wider floating type or Implicit conversion of the binary ? left hand operand from ??	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	Detailed Polyspace Specification
		to ??, but it is a complex expression. • Implicit conversion of complex floating expression from ?? to ??. • Implicit conversion of floating expression of ?? type in function return whose expected type is ??. • Implicit conversion of floating expression of ?? type as argument of function whose corresponding parameter type is ??.	
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 ?? may only be cast to narrower integer type of same signedness, however the destination type is ??.	• 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

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
			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 ?? type may only be cast to narrower floating type, however the destination type is ??.	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.
10.5	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	Bitwise [<<|~] is applied to the operand of underlying type [unsigned char|unsigned short], the result shall be immediately cast to the underlying type.	
10.6	The “U” suffix shall be applied to all constants of *unsigned* types	No explicit ‘U suffix on constants of 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 will

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
			report a violation of rule 10.6 for the following line: `int a = 2147483648;` There is a difference between decimal and hexadecimal constants when `int` and `long int` are not the same size.

Pointer Type Conversion

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
11.1	Conversion shall not be performed between a pointer to a function and any type other than an integral type	Conversion shall not be performed between a pointer to a function and any type other than an integral type.	Casts and implicit conversions involving a function pointer. Casts or implicit conversions from `NULL` or `(void*)0` do not give any warning.
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

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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	Detailed 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).
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

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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).

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 !).	• 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 '?:'.
			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, `(var == 0)`.
			Consider the following code:
			`unsigned char flag;`
			`if (!flag)`
			The rule checker reports a violation of rule 12.6:
			`Operand  of '!' logical`

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification

			`operator should be effectively Boolean.`
			The operand `flag` is not a Boolean but an `unsigned char`.
			To be compliant with rule 12.6, the code must be rewritten either as
			`if (!( flag != 0))`
			or
			`if (flag == 0)`
			The use of the option `-boolean-types` may increase or decrease the 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 ??. • Bitwise [<<|>>] on left hand operand of signed underlying type ??. • Bitwise [& | ^] on two operands of s	The underlying type for an integer used in a re-processor expression is signed when : • it does not have a u or U suffix • it is small enough to fit into a 64 bits signed number

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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 ?? 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 ??. • Minus operator applied to an expression whose underlying type is unsigned	The underlying type for an integer used in a re-processor expression 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.	
12.11	Evaluation of constant unsigned expression should not lead to wraparound.	Evaluation of constant unsigned integer expressions should not lead to wrap-around.	

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification

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	Detailed 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)

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
			The use of the option `-boolean-types` may 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.
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;	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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
		(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.	
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.
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	Detailed Polyspace Specification
14.1	There shall be no unreachable code.	There shall be no unreachable code.	
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: • 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.	

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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	
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	Detailed 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`
			`4  case 1: ...`
			The code between switch statement and first case is checked as gray by Polyspace verification. It follows ANSI standard behavior.

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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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	Detailed 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 verification 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.
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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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.	
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`,

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
			`memset`, `strcpy`, `strncpy`, `strcat`, or `strncat`.

Pointers and Arrays

N.	MISRA Definition	Messages in report file	Detailed 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 be assigned to an object that may persist after the object has ceased to exist.	Pointer to a parameter is an illegal return value. Pointer to a local is an illegal return value.	Warning when assigning address to a global variable, returning a local variable address, or returning a parameter address.

Structures and Unions

N.	MISRA Definition	Messages in report file	Detailed 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.
18.4	Unions shall not be used	Unions shall not be used.	

Preprocessing Directives

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
19.1	#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	Detailed 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

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
19.5	Macros shall not be #defined and #undefd within a block.	• Macros shall not be #defined within a block. • Macros shall not be #undef'd within a block.	
19.6	#undef shall not be used.	#undef shall not be used.	
19.7	A function should be used in preference to a function like-macro.	Message on all function-like macros expansions	
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)

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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,`.
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	

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
19.14	The defined preprocessor operator shall only be used in one of the two standard forms.	'defined' without an identifier.	

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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
19.16	Preprocessing directives shall be syntactically meaningful even when excluded by the preprocessor.	directive is not syntactically meaningful.	
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	Detailed 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: • 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.

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
			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
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

N.	MISRA Definition	Messages in report file	Detailed Polyspace Specification
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	Detailed 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 verification (runtime error checks).

MISRA C Rules Not Checked

The Polyspace coding rules checker does not check the following MISRA C coding rules. These rules cannot be enforced because they are outside the scope of Polyspace verification. They may concern documentation, dynamic aspects, or functional aspects of MISRA rules. The "**Comments**" column describes the reason each rule is not checked.

Environment

Rule	Description	Comments
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	It is a process rule method.

Rule	Description	Comments
	language/compilers/assemblers conform.	
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 significance and case sensitivity are supported for external identifiers.	The documentation of compiler must be checked.
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	Comments
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	Comments
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	Comments
18.2 (Required)	An object shall not be assigned to an overlapping object.	Not statically checkable unless the data dynamic properties is taken into account
18.3 (Required)	An area of memory shall not be reused for unrelated purposes.	"purpose" is functional design issue.

Supported MISRA C++ Coding Rules

- “Language Independent Issues” on page 11-103
- “General” on page 11-103
- “Lexical Conventions” on page 11-103
- “Basic Concepts” on page 11-105
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Language Independent Issues

N.	MISRA Definition	Comments
0-1-1	A project shall not contain unreachable code.	
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.	
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 Verifier.

General

N.	MISRA Definition	Comments
1-0-1	All code shall conform to ISO/IEC 14882:2003 "The C++ Standard Incorporating Technical Corrigendum 1".	

Lexical Conventions

N.	MISRA Definition	Comments
2-3-1	Trigraphs shall not be used.	
2-5-1	Digraphs should not be used.	

N.	MISRA Definition	Comments
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.	
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.
2-10-3	A typedef name (including qualification, if any) shall be a unique identifier.	No detection accross namespaces.
2-10-4	A class, union or enum name (including qualification, if any) shall be a unique identifier.	No detection accross namespaces.
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.
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.
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.	
2-13-5	Narrow and wide string literals shall not be concatenated.	

Basic Concepts

N.	MISRA Definition	Comments
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 shall be token-for-token identical in all declarations and re-declarations.	Comparison is done between current declaration and last seen declaration.

N.	MISRA Definition	Comments
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	Comments
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	Comments
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.	
5-0-3	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 integerIf the conversion is to a narrower integer with a different sign then Misra Cpp 5-0-4 takes precedence over Misra Cpp 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 Cpp 5-0-4 takes precedence over Misra Cpp 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.	

N.	MISRA Definition	Comments
5-0-14	The first operand of a conditional-operator shall have type bool.	
5-0-15	Array indexing shall be the only 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, p[i] accepted).
5-0-18	>, >=, <, <= shall not be applied to objects of pointer type, except where they point to the same array.	Report when relational operator are used on pointers types (casts ignored).
5-0-19	The declaration of objects shall contain no more than two levels of pointer indirection.	
5-0-20	Non-constant operands to a binary bitwise operator shall have the same underlying type.	
5-0-21	Bitwise operators shall only be applied to operands of unsigned underlying type.	
5-2-1	Each operand of a logical && or || shall be a postfix - expression.	During preprocessing, violations of this rule are detected on the expressions in #if directives. Allowed exception on associativity (a && b && c), (a || b || c).
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.	
5-2-3	Casts from a base class to a derived class should not be performed on polymorphic types.	
5-2-4	C-style casts (other than void casts) and functional notation casts (other than explicit constructor calls) shall not be used.	

N.	MISRA Definition	Comments
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.	No violation if pointer types of operand and target are identical.
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.	

N.	MISRA Definition	Comments
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.	
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	Comments
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.	

N.	MISRA Definition	Comments
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.	Detects also 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
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).

N.	MISRA Definition	Comments
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.	
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	Comments
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.	

N.	MISRA Definition	Comments
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.	
7-4-2	Assembler instructions shall only be introduced using the asm declaration.	
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	Comments
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.	
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 &.	
8-5-1	All variables shall have a defined value before they are used.	NIV given by verifier 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	Comments
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	Comments
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 non-virtual 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.

N.	MISRA Definition	Comments
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	Comments
11-0-1	Member data in non- POD class types shall be private.	

Special Member Functions

N.	MISRA Definition	Comments
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.	
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	Comments
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.
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	Comments
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. No detection if no "main" (desktop mode?).
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 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.	

N.	MISRA Definition	Comments
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	Comments
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 enclosed in parentheses, unless it is used as the operand of # or ##.	

N.	MISRA Definition	Comments
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 pre-processor 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	Comments
17-0-1	Reserved identifiers, macros and functions in the standard library shall not be defined, redefined or undefined.	
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	Comments
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 (e.g.: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	Comments
19-3-1	The error indicator errno shall not be used.	

Input/output Library

N.	MISRA Definition	Comments
27-0-1	The stream input/output library <cstdio> shall not be used.	

MISRA C++ Rules Not Checked

- "Language Independent Issues" on page 11-123
- "General" on page 11-124
- "Lexical Conventions" on page 11-124
- "Standard Conversions" on page 11-125
- "Expressions" on page 11-125
- "Declarations" on page 11-126
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- "Exception Handling" on page 11-127
- "Preprocessing Directives" on page 11-128
- "Library Introduction" on page 11-128

Language Independent Issues

N.	MISRA Definition	Comments
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.	
0-1-8	All functions with void return type shall have external side effect(s).	
0-1-9	There shall be no dead code.	Not checked by the coding rules checker. Can be enforced through detection of gray code during verification.
0-1-11	There shall be no unused parameters (named or unnamed) in non- virtual 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.	

N.	MISRA Definition	Comments
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	Comments
1-0-2	Multiple compilers shall only be used if they have a common, defined interface.	
1-0-3	The implementation of integer division in the chosen compiler shall be determined and documented.	

Lexical Conventions

N.	MISRA Definition	Comments
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	Comments
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	Comments
5-0-11	The plain char type shall only be used for the storage and use of character values.	
5-0-12	signed char and unsigned char type shall only be used for the storage and use of numeric values.	
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.	
5-17-1	The semantic equivalence between a binary operator and its assignment operator form shall be preserved.	

Declarations

N.	MISRA Definition	Comments
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	Comments
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	Comments
14-5-1	A non-member generic function shall only be declared in a namespace that is not an associated namespace.	
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	Comments
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	Comments
16-6-1	All uses of the #pragma directive shall be documented.	

Library Introduction

N.	MISRA Definition	Comments
17-0-3	The names of standard library functions shall not be overridden.	
17-0-4	All library code shall conform to MISRA C++.	

Supported JSF C++ Coding Rules

- "Code Size and Complexity" on page 11-129
- "Environment" on page 11-129
- "Libraries" on page 11-130
- "Pre-Processing Directives" on page 11-131
- "Header Files" on page 11-132
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Code Size and Complexity

N.	JSF++ Definition	Comments
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	Comments
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.	

N.	JSF++ Definition	Comments
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 RTE checks in the Verifier.

Libraries

N.	JSF++ Definition	Comments
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.

N.	JSF++ Definition	Comments
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	Comments
26	Only the following pre-processor directives **shall** be used: `#ifndef`, `#define`, `#endif`, `#include`.	
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` pre-processor 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`.

N.	JSF++ Definition	Comments
29	The `#define` pre-processor 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 pre-processor directive shall not be used to create inline macros.` • `29.2 : Inline functions shall be used intead of inline macros`
30	The `#define` pre-processor 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` pre-processor 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` pre-processor directive **will** only be used to include header (*.h) files.	

Header Files

N.	JSF++ Definition	Comments
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	Comments
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.
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.	
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'	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.`

N.	JSF++ Definition	Comments
	• 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’	• `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.`
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 `"`.	

N.	JSF++ Definition	Comments
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.
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.`

N.	JSF++ Definition	Comments
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.
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	Comments
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.

N.	JSF++ Definition	Comments
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 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`
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.	

N.	JSF++ Definition	Comments
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".
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.

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:

N.	JSF++ Definition	Comments
		- `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.
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 non-virtual 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.`

N.	JSF++ Definition	Comments
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
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	Comments
98	Every nonlocal name, except `main()`, **should** be placed in some namespace.	
99	Namespaces **will not** be nested more than two levels deep.	

Templates

N.	JSF++ Definition	Comments
104	A template specialization **shall** be declared before its use.	Reports the actual compilation error message.

Functions

N.	JSF++ Definition	Comments
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 there is no "inline" 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.
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 Verifier. 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	Comments
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	Comments
135	Identifiers in an inner scope **shall not** use the same name as an identifier in an outer scope, and therefore hide that identifier.	
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)

N.	JSF++ Definition	Comments
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
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	Comments
142	All variables **shall** be initialized before use.	Done with **NIV** and **LOCAL_NIV** checks in the Verifier.
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	Comments
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	Comments
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.
151.1	A string literal shall not be modified.	Report when a `char*`, `char[]`, or `string` type is used not as `const`.A violation is raised if a string literal (for example, " ") is cast as a non `const`.

Variables

N.	JSF++ Definition	Comments
152	Multiple variable declarations **shall not** be allowed on the same line.	

Unions and Bit Fields

N.	JSF++ Definition	Comments
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	Comments
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.` • `The operands of a logical || shall be parenthesized if the operands contain binary operators.`

N.	JSF++ Definition	Comments
		Exception for: `X || Y || Z , Z&&Y &&Z`
159	Operators `||`, `&&`, and unary `&` **shall not** be overloaded.	Messages in report file: • `Unary operator & shall not be overloaded.` • `Operator || shall not be overloaded.` • `Operator && shall not be overloaded.`
160	An assignment expression **shall** be used only as the expression in an expression statement.	Only simple assignment, not +=, ++, etc.
162	Signed and unsigned values **shall not** be mixed in arithmetic or comparison operations.	
163	Unsigned arithmetic **shall not** be used.	
164	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).	
164.1	The left-hand operand of a right-shift operator **shall not** have a negative value.	Detects constant case +. Verifier used for dynamic cases.
165	The unary minus operator **shall not** be applied to an unsigned expression.	
166	The `sizeof` operator **will not** be used on expressions that contain side effects.	
168	The comma operator **shall not** be used.	

Pointers and References

N.	JSF++ Definition	
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 **IDP** checks in Verifier.
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	Comments
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. 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. (No special case for visitor pattern.)
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`

N.	JSF++ Definition	Comments
		.
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.
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	Comments
186	There **shall** be no unreachable code.	Done with gray checks in the Verifier.
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).	

N.	JSF++ Definition	Comments
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.	
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 Comments
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 the **SCAL-OVFL** and **FLOAT-OVFL** checks in the Verifier.
204	A single operation with side-effects shall only be used in the following contexts: • by itself • 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	Reports when: • A side effect is found in a return statement • 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	Comments
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	Comments
208	C++ exceptions **shall not** be used.	Reports `try`, `catch`, `throw spec`, and `throw`.

Portable Code

N.	JSF++ Definition	Comments
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

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- “Rules” on page 11-154
- “Environment” on page 11-154
- “Libraries” on page 11-154
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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.

N.	JSF++ Definition
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.
91	Public inheritance will be used to implement “is-a” relationships.

N.	JSF++ Definition
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.

N.	JSF++ Definition
103	Constraint checks should be applied to template arguments.
105	A template definition's dependence on its instantiation contexts should be minimized.
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
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.
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.
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.

Software Quality with Polyspace Metrics

- "Software Quality with Polyspace Metrics" on page 12-2
- "Set Up Verification to Generate Metrics" on page 12-4
- "Access Polyspace Metrics" on page 12-11
- "What You Can Do with Polyspace Metrics" on page 12-17
- "Customize Software Quality Objectives" on page 12-31
- "Descriptions of Code Metrics" on page 12-47
- "Number of Lines of Code Calculation" on page 12-54
- "Administer Results Repository" on page 12-55

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 12-11.
- Observe trends over time, by project or module. See "Review Overall Progress" on page 12-17.
- Compare metrics of one project version with those of another. See "Compare Project Versions" on page 12-23.

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 Coding Rule Violations and Run-Time Checks" on page 12-24.

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 12-28.

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” on page 12-31.

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. Select the **Configuration > Distributed Computing** pane.
2. Select the **Batch** check box.
3. Select the **Add to results repository** check box.

To set up scheduled, automatic verification runs, see “Specify Automatic Verification” on page 12-4.

The software saves generated metrics in the following XML file:

```
Results_Folder/Polyspace-Doc/Code_Metrics.xml
```

See “Results Folder Contents” on page 9-114.

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 12-5.

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 12-6
- “LaunchingPeriod” on page 12-6
- “Commands” on page 12-7
- “Users” on page 12-8

Options. Specify a list of all 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 12-8.

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>
```

Access Polyspace Metrics

In this section...

"Open Polyspace Metrics" on page 12-11

"Organize Polyspace Metrics Projects" on page 12-12

"Protect Access to Project Metrics" on page 12-14

"Web Browser Support" on page 12-16

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 Refresh.

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.

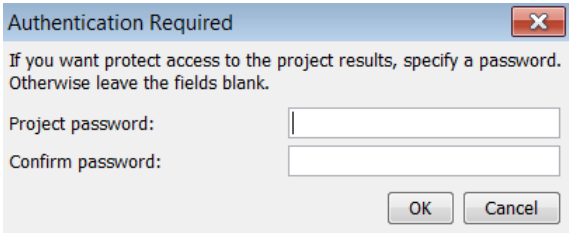
You can move projects back to the root level from project categories without removing the project categories:

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.



Authentication Required

If you want protect access to the project results, specify a password. Otherwise leave the fields blank.

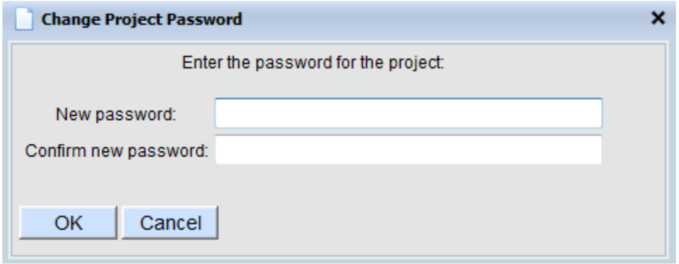
Project password:

Confirm password:

  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.



Change Project Password

Enter the password for the project:

  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 Refresh 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

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
   ```

What You Can Do with Polyspace Metrics

In this section...

"Review Overall Progress" on page 12-17

"Display Metrics for Single Project Version" on page 12-21

"Create File Module and Specify Quality Level" on page 12-22

"Compare Project Versions" on page 12-23

"Review New Findings" on page 12-23

"Review Coding Rule Violations and Run-Time Checks" on page 12-24

"Save Review Comments and Justifications" on page 12-28

"Fix Defects" on page 12-28

"Review Code Complexity" on page 12-29

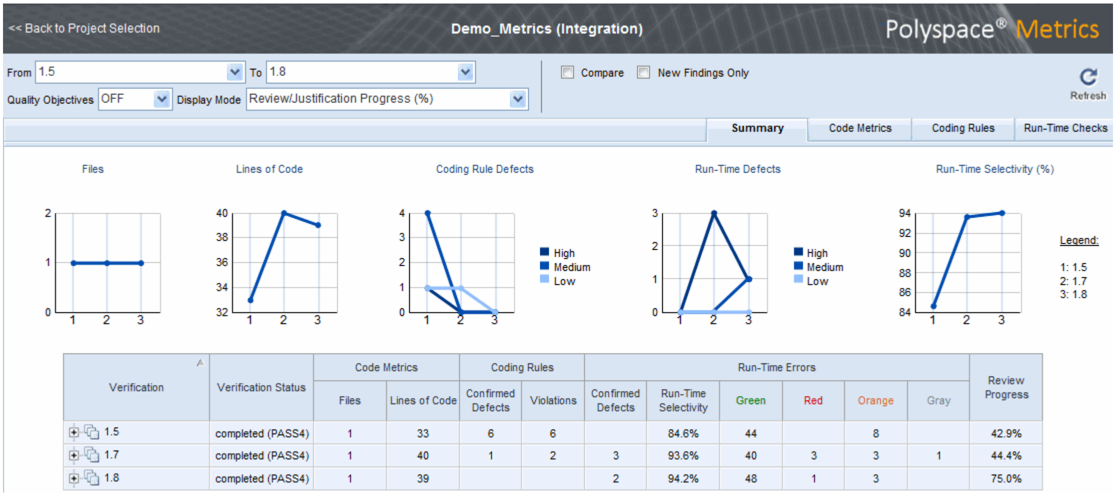
Review Overall Progress

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 12-11.

2. Click anywhere in the row that contains your project. You see the **Summary** view.



From 1.5 To 1.8

Quality Objectives OFF Display Mode Review/Justification Progress (%)

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	
1.5	completed (PASS4)	1	33	6	6		84.6%	44		8		42.9%
1.7	completed (PASS4)	1	40	1	2	3	93.6%	40	3	3	1	44.4%
1.8	completed (PASS4)	1	39			2	94.2%	48	1	3		75.0%

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:

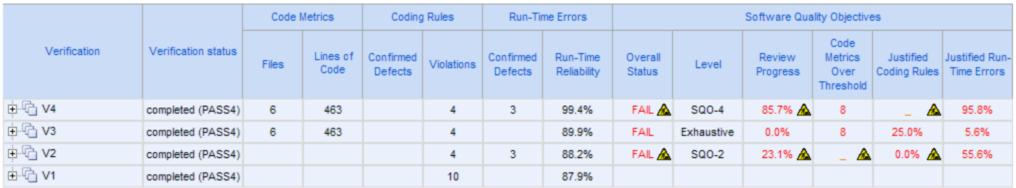
- Plots that reveal how the number of verified files, lines of code, defects, and run-time selectivity vary over the different versions of your project
- A table containing summary information about your project versions.

  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 12-22.

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%						

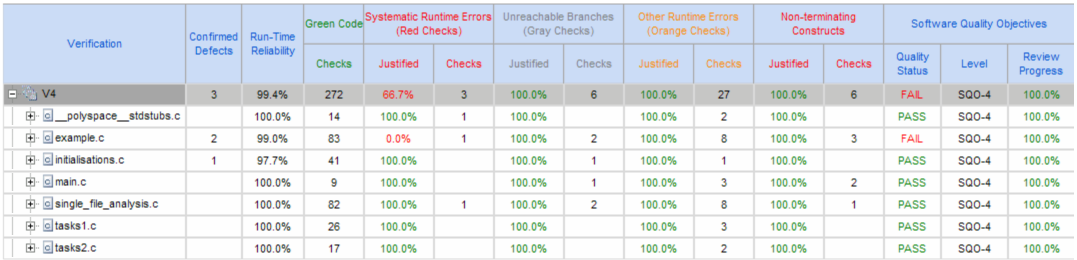
Under **Software Quality Objectives**, you look at **Review Progress** for the latest version (V4), which indicates that the review of verification results is incomplete (only 85.7% reviewed). You also see that the Overall Status is FAIL. This status indicates that, although the review is incomplete, 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" on page 12-31.

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.

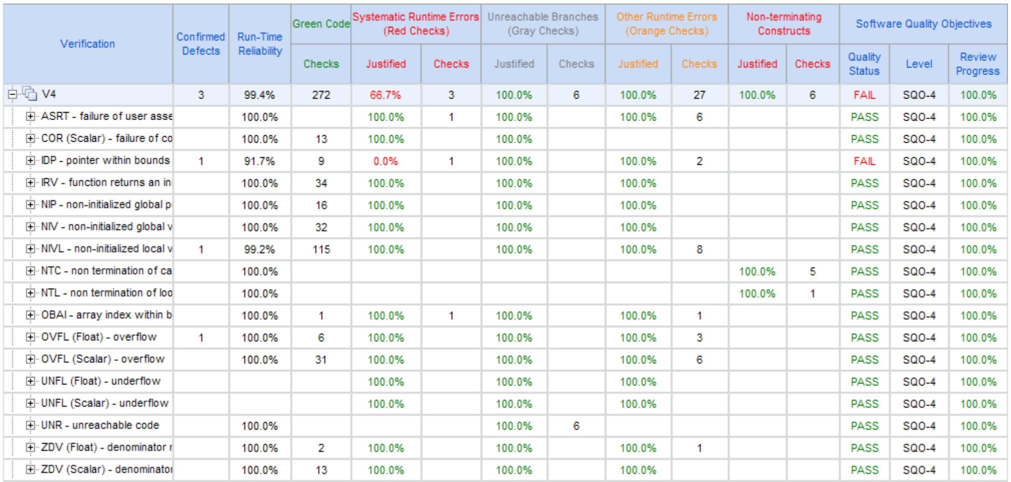


Verification	Confirmed Defects	Run-Time Reliability	Green Code	Systematic Runtime Errors (Red Checks)		Unreachable Branches (Gray Checks)		Other Runtime Errors (Orange Checks)		Non-terminating Constructs		Software Quality Objectives		
			Checks	Justified	Checks	Justified	Checks	Justified	Checks	Justified	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 any of these checks in the Polyspace verification environment, in the relevant cell, click the numeric value for the check. The Polyspace verification environment opens with the Results Manager perspective displaying verification information for this check.

Note If you update any check information through the Polyspace verification environment (see "Review Coding Rule Violations and Run-Time Checks" on page 12-24), 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 Coding Rule Violations and Run-Time Checks" on page 12-24.

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

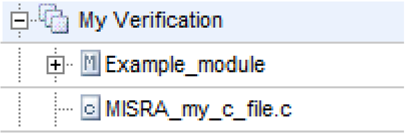
   - A table with information about the selected project version

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

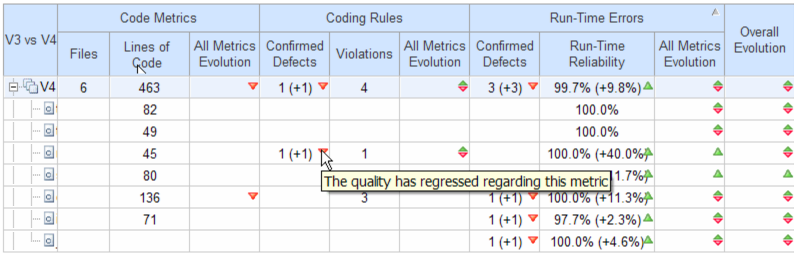
You can compare metrics of two versions of a project.

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.



V3 vs V4	Code Metrics			Coding Rules			Run-Time Errors			Overall Evolution
	Files	Lines of Code	All Metrics Evolution	Confirmed Defects	Violations	All Metrics Evolution	Confirmed Defects	Run-Time Reliability	All Metrics Evolution	
V4	6	463	▼	1 (+1) ▼	4	▲▼	3 (+3) ▼	99.7% (+9.8%) ▲	▲▼	▲▼
		82						100.0%	▲▼	▲▼
		49						100.0%	▲▼	▲▼
		45		1 (+1) ▼	1	▲▼		100.0% (+40.0%) ▲	▲	▲▼
		80						1.7%) ▲	▲	▲
		136	▼		3		1 (+1) ▼	100.0% (+11.3%) ▲	▲▼	▲▼
		71					1 (+1) ▼	97.7% (+2.3%) ▲	▲▼	▲▼
							1 (+1) ▼	100.0% (+4.6%) ▲	▲▼	▲▼

The quality has regressed regarding this metric

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 Coding Rule Violations and Run-Time Checks

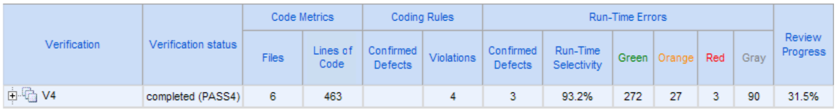
If you have installed Polyspace on your computer, you can use Polyspace Metrics to review and add information about coding rule violations and run-time checks produced by a verification.

Note By default, Polyspace Metrics does not use coding rule violations to evaluate software quality for C++ projects. However, you can customize software quality objectives (SQO) to incorporate coding rule violations. See "Customize Software Quality Objectives" on page 12-31.

You may use the **Review Progress** metric in the **Summary** view to decide when your team of developers should start work on the next version of the software. For example, you may wait until the review is complete (**Review Progress** cell displays 100%), before informing your development team.

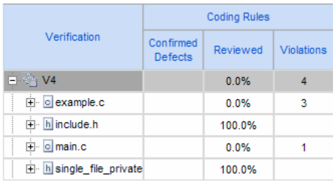
Coding Rule Violations

Consider an example, where you see the following in the **Summary** view.



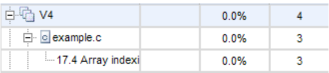
Verification	Verification status	Code Metrics		Coding Rules		Run-Time Errors						Review Progress
		Files	Lines of Code	Confirmed Defects	Violations	Confirmed Defects	Run-Time Selectivity	Green	Orange	Red	Gray	
⊞ V4	completed (PASS4)	6	463		4	3	93.2%	272	27	3	90	31.5%

Review progress is incomplete (31.5%), and there are four coding rule violations. In the **Violations** cell, click `4`, which takes you to the Polyspace Metrics **Coding Rules** view.



Verification	Coding Rules		
	Confirmed Defects	Reviewed	Violations
V4		0.0%	4
example.c		0.0%	3
include.h		100.0%	
main.c		0.0%	1
single_file_private		100.0%	

The **Reviewed** column reveals the files that you have not reviewed completely. In this example, `example.c` is unreviewed (`0.0%`). To continue reviewing violations in this file, expand `example.c`.



V4		0.0%	4
example.c		0.0%	3
17.4 Array indexi		0.0%	3

You see that there are three violations of rule `17.4`.

Note If you want to review coding rule violations with reference to the coding rules, in the Polyspace Metrics **Coding Rules** view, from the **Group by** drop-down list, select `Coding Rules` and expand a specific coding rule.

On the row corresponding to rule `17.4`, click the value in the **Review Progress** cell, `3`. This action opens the Polyspace verification environment and takes you to the Results Manager perspective. On the **Results Summary** tab, you see the list of unreviewed violations.

Double-click a row. In the **Check Details** pane, you see information about the violated rule. In the **Source** pane, you see the code that causes this rule violation.

Select the **Check Review** tab. If you want to classify the violation as a defect, from the **Classification** drop-down list, select `High`, `Medium`, or `Low` . This will increment the **Confirmed Defect** value in Polyspace Metrics.

You can assign a status to this violation. From the **Status** drop-down list, select a status, for example, `Fix` or `No action planned`. When you assign a status to a violation, the software considers the violation to be *reviewed*.

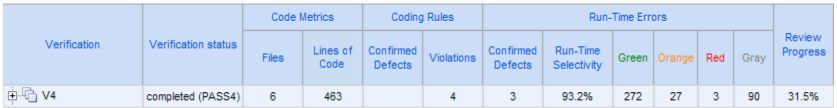
If you consider the presence of a violation justifiable, select the **Justified** check box. In the **Comments** column, you can enter remarks justifying this violation.

Save the review. See "Save Review Comments and Justifications" on page 12-28.

Note Classifying a coding rule violation as a defect or assigning a status for an unreviewed violation in the Polyspace verification environment, increases the corresponding metric values (**Confirmed Defects** and **Review Progress**) in the **Summary** and **Coding Rules** views of Polyspace Metrics.

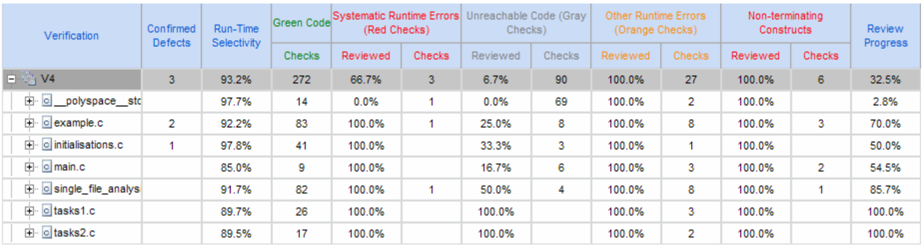
Run-Time Checks

Consider an example, where you see the following in the **Summary** view.



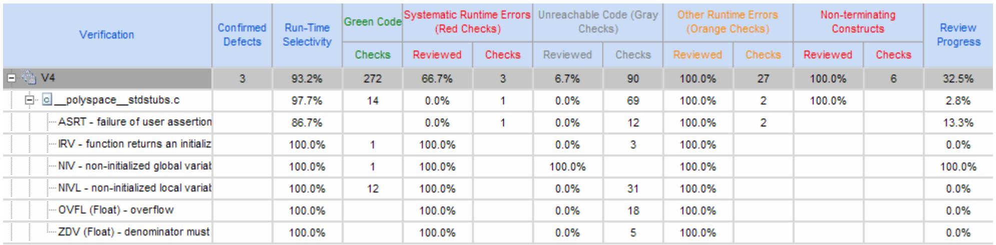
Verification	Verification status	Code Metrics		Coding Rules		Run-Time Errors						Review Progress
		Files	Lines of Code	Confirmed Defects	Violations	Confirmed Defects	Run-Time Selectivity	Green	Orange	Red	Gray	
⊞ V4	completed (PASS4)	6	463		4	3	93.2%	272	27	3	90	31.5%

Under **Run-Time Errors**, click any cell value. This action takes you to the **Run-Time Checks** view.



Verification	Confirmed Defects	Run-Time Selectivity	Green Code	Systematic Runtime Errors (Red Checks)		Unreachable Code (Gray Checks)		Other Runtime Errors (Orange Checks)		Non-terminating Constructs		Review Progress
			Checks	Reviewed	Checks	Reviewed	Checks	Reviewed	Checks	Reviewed	Checks	
⊟ V4	3	93.2%	272	66.7%	3	6.7%	90	100.0%	27	100.0%	6	32.5%
⊞ __polyspace__stc		97.7%	14	0.0%	1	0.0%	69	100.0%	2	100.0%		2.8%
⊞ example.c	2	92.2%	83	100.0%	1	25.0%	8	100.0%	8	100.0%	3	70.0%
⊞ initialisations.c	1	97.8%	41	100.0%		33.3%	3	100.0%	1	100.0%		50.0%
⊞ main.c		85.0%	9	100.0%		16.7%	6	100.0%	3	100.0%	2	54.5%
⊞ single_file_analys		91.7%	82	100.0%	1	50.0%	4	100.0%	8	100.0%	1	85.7%
⊞ tasks1.c		89.7%	26	100.0%		100.0%		100.0%	3	100.0%		100.0%
⊞ tasks2.c		89.5%	17	100.0%		100.0%		100.0%	2	100.0%		100.0%

The **Review Progress** column reveals the progress level for each file, for example, `2.8%` for `__polyspace__stdstubs.c`. Expand `__polyspace__stdstubs.c`.



Verification	Confirmed Defects	Run-Time Selectivity	Green Code	Systematic Runtime Errors (Red Checks)		Unreachable Code (Gray Checks)		Other Runtime Errors (Orange Checks)		Non-terminating Constructs		Review Progress
			Checks	Reviewed	Checks	Reviewed	Checks	Reviewed	Checks	Reviewed	Checks	
V4	3	93.2%	272	66.7%	3	6.7%	90	100.0%	27	100.0%	6	32.5%
__polyspace__stdstubs.c		97.7%	14	0.0%	1	0.0%	69	100.0%	2	100.0%		2.8%
ASRT - failure of user assertion		86.7%		0.0%	1	0.0%	12	100.0%	2			13.3%
IRV - function returns an initializ		100.0%	1	100.0%		0.0%	3	100.0%				0.0%
NIV - non-initialized global variat		100.0%	1	100.0%		100.0%		100.0%				100.0%
NIVL - non-initialized local variat		100.0%	12	100.0%		0.0%	31	100.0%				0.0%
OVFL (Float) - overflow		100.0%		100.0%		0.0%	18	100.0%				0.0%
ZDV (Float) - denominator must		100.0%		100.0%		0.0%	5	100.0%				0.0%

In the row containing the ASRT check, click the value in the red **Checks** cell, which opens the Polyspace verification environment with the Results Manager perspective. The software displays the ASRT check on the **Results Summary** tab.

Double-click the row with the ASRT check, which brings the check into the **Check Details** pane.

On the **Check Review** tab, using the drop-down list for the **Classification** field, you can classify the check as a defect (`High`, `Medium`, or `Low`) or specify that the check is `Not a defect`.

Using the drop-down list for the **Status** field, you can assign a status for the check, for example, `Fix` or `Investigate`. When you assign a status, the software considers the check to be *reviewed*.

If you think that the presence of the check in your code can be justified, select the check box **Justified**. In the **Comment** field, enter remarks that justify this check.

Save the review. See "Save Review Comments and Justifications" on page 12-28.

Note Classifying a run-time check as a defect or assigning a status for an unreviewed check in the Polyspace verification environment increases the corresponding metric values (**Confirmed Defects** and **Review Progress**) in the **Summary** and **Run-Time Checks** views of Polyspace Metrics.

Save Review Comments and Justifications

By default, when you save your project (**Ctrl+S**), the software saves your comments and justifications to a local folder. See "Configure Server for Remote Verification and Polyspace Metrics".

If you want to save your comments and justifications to a local folder *and* the Polyspace Metrics repository, on the Results Manager toolbar, click the button .

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 **Options > Preferences > Server configuration**.

2 Select the check box **Save justifications in the Polyspace Metrics repository**.

Note In Polyspace Metrics, click Refresh to view updated information.

Fix Defects

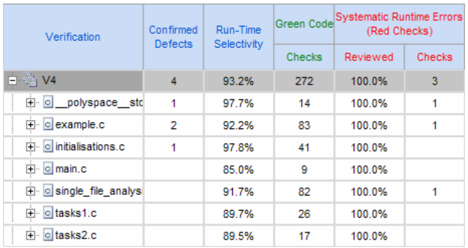
If you are a software developer, you can begin to fix defects in code when, for example:

- 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%	

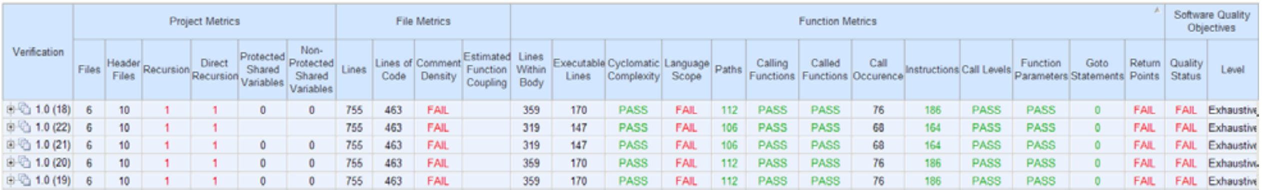
In the **Confirmed Defects** column, click a non-zero cell value. For example, if you click 2, Polyspace Code Prover opens with the checks visible in the **Results Summary** tab.

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.

Review Code Complexity

Polyspace Metrics supports the generation of code complexity metrics. The majority of these metrics are predefined and based on the Hersteller Initiative Software (HIS) standard.

To review the complexity of the code in your project, in the **Summary** view, click any value in a **Code Metrics** cell. The **Code Metrics** view opens.



Verification	Project Metrics						File Metrics				Function Metrics													Software Quality Objectives	
	Files	Header Files	Recursion	Direct Recursion	Protected Shared Variables	Non-Protected Shared Variables	Lines	Lines of Code	Comment Density	Estimated Function Coupling	Lines Within Body	Executable Lines	Cyclomatic Complexity	Language Scope	Paths	Calling Functions	Called Functions	Call Occurence	Instructions	Call Levels	Function Parameters	Goto Statements	Return Points	Quality Status	Level
⊞ 1.0 (18)	6	10	1	1	0	0	755	463	FAIL		359	170	PASS	FAIL	112	PASS	PASS	76	186	PASS	PASS	0	FAIL	FAIL	Exhaustive
⊞ 1.0 (22)	6	10	1	1			755	463	FAIL		319	147	PASS	FAIL	106	PASS	PASS	68	164	PASS	PASS	0	FAIL	FAIL	Exhaustive
⊞ 1.0 (21)	6	10	1	1	0	0	755	463	FAIL		319	147	PASS	FAIL	106	PASS	PASS	68	164	PASS	PASS	0	FAIL	FAIL	Exhaustive
⊞ 1.0 (20)	6	10	1	1	0	0	755	463	FAIL		359	170	PASS	FAIL	112	PASS	PASS	76	186	PASS	PASS	0	FAIL	FAIL	Exhaustive
⊞ 1.0 (19)	6	10	1	1	0	0	755	463	FAIL		359	170	PASS	FAIL	112	PASS	PASS	76	186	PASS	PASS	0	FAIL	FAIL	Exhaustive

The software generates numeric values or pass/fail results for various metrics. For information about:

- The Hersteller Initiative Software (HIS) standard, see HIS Source Code Metrics.

- Other, non-HIS, code metrics, see “Descriptions of Code Metrics” on page 12-47 and “SQO Level 1” on page 12-33.
- How Polyspace evaluates these metrics and how you can customize code complexity metrics, see “About Customizing Software Quality Objectives” on page 12-31 and “SQO Level 1” on page 12-33.

Customize Software Quality Objectives

In this section...

"About Customizing Software Quality Objectives" on page 12-31

"SQO Level 1" on page 12-33

"SQO Level 2" on page 12-37

"SQO Level 3" on page 12-37

"SQO Level 4" on page 12-38

"SQO Level 5" on page 12-38

"SQO Level 6" on page 12-38

"SQO Exhaustive" on page 12-39

"Coding Rules Set 1" on page 12-39

"Coding Rules Set 2" on page 12-41

"Run-Time Checks Set 1" on page 12-43

"Run-Time Checks Set 2" on page 12-44

"Run-Time Checks Set 3" on page 12-45

"Status Acronyms" on page 12-45

About Customizing Software Quality Objectives

When you run your first verification to produce metrics, Polyspace software uses *predefined* software quality objectives (SQO) to evaluate quality. In addition, when you use Polyspace Metrics for the first time, Polyspace creates the following XML file that contains definitions of these software quality objectives:

```
RemoteDataFolder/Custom-SQO-Definitions.xml
```

`RemoteDataFolder` is the folder where Polyspace stores data generated by remote verifications.

If you want to customize SQOs and modify the way quality is evaluated, you must change `Custom-SQO-Definitions.xml`. This XML file has the following form:

```
<?xml version="1.0" encoding="utf-8"?>
<MetricsDefinitions>
  SQO Level 1
  SQO Level 2
  SQO Level 3
  SQO Level 4
  SQO Level 5
  SQO Level 6
  SQO Exhaustive
  Coding Rules Set 1
  Coding Rules Set 2
  Run-Time Checks Set 1
  Run-Time Checks Set 2
  Run-Time Checks Set 3
  Status Acronym 1
  Status Acronym 2
</MetricsDefinitions>
```

You can redefine the pass/fail thresholds for the various SQO levels of Polyspace Metrics by editing the content of elements that make up `MetricsDefinitions`, for example, *`SQO Level 2`*, and *`Run-Time Checks Set 1`*. In addition, you can create elements that contain SQO levels, and coding rule and run-time check sets that you define. You can use these new elements to replace or augment the default elements.

Note Although Polyspace provides support for MISRA C++ and JSF++ coding rules, Polyspace Metrics does not generate a default coding rules set for these standards in `Custom-SQO-Definitions.xml`. However, you can define your own set for these standards. See “Coding Rules Set 1” on page 12-39.

The following topics provide information about `MetricsDefinitions` elements and how SQO levels are calculated. Use this information when you modify or create elements.

SQO Level 1

The default *SQO Level 1* element is:

```
<SQO ID="SQO-1">
  <!-- HIS metrics -->
   <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>MISRA_Rules_Set_1</Num_Unjustified_Violations>
   </SQO>
```

The SQ0 Level 1 element is composed of sub-elements with data that specify thresholds. The sub-elements represent metrics that are calculated in a verification. If the metrics do not exceed the thresholds, the code meets the quality level specified by SQO Level 1.

By default, Polyspace Metrics does not evaluate C++ coding rule violations for SQO Level 1. However, you can incorporate coding rule violations by adding the sub-element `Num_Unjustified_Violations` to the list of sub-elements in *SQO Level 1*.

For example, to apply a MISRA C++ rules set, add the following sub-element:

```
<Num_Unjustified_Violations>MISRA_Cpp_Rules_Set</Num_Unjustified_  \
 Violations>
```

`MISRA_Cpp_Rules_Set` is the ID attribute of the MISRA C++ coding rules set that you create. For information about creating MISRA C++ and JSF++ rule sets, see "Coding Rules Set 1" on page 12-39.

The following table describes the Hersteller Initiative Software (HIS) standard metrics specified by the sub-elements and provides default thresholds.

Element	Default threshold	Description of metric
`comf`	20	Comment density of a file
`path`	80	Number of paths through a function
`goto`	0	Number of `goto` statements
`vg`	10	Cyclomatic complexity
`calling`	5	Number of calling functions
`calls`	7	Number of calls
`param`	5	Number of parameters per function
`stmt`	50	Number of instructions per function
`level`	4	Number of call levels in a function
`return`	1	Number of `return` statements in a function

`vocf`	4	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
		The computation is based on the preprocessed source code. Consider the following code.
		`int f(int i)`
		`  {`

Element	Default threshold	Description of metric

		`    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`	0	Number of recursions
`ap_cg_direct_cycle`	0	Number of direct recursions
`Num_Unjustified_ Violations`	See "Coding Rules Set 1" on page 12-39	Number of unjustified violations of MISRA C rules specified by "Coding Rules Set 1" on page 12-39

For more information about these metrics, see HIS Source Code Metrics.

The following points also apply:

- 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.

Polyspace Metrics also supports the evaluation of non-HIS code metrics, which the following table describes.

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 bodyA variable declaration with initialization is treated as a statement, but not as an execution line of function body.
`ncalls`	Number of calls within function bodyIncludes explicit and implicit calls to constructors.
`pshv`	Number of protected shared variables
`unpshv`	Number of unprotected shared variables

To generate these metrics, insert the sub-elements into the SQO Level 1 element and specify thresholds:

```
<SQO ID="SQO-1">
  <!-- HIS metrics -->
   ...
   ...
<!-- Other non-HIS metrics -->
   <fco>user_defined_threshold</fco>
   <flin>user_defined_threshold</flin>
   <fxln>user_defined_threshold</fxln>
   <ncalls>user_defined_threshold</ncalls>
   <pshv>user_defined_threshold</pshv>
   <unpshv>user_defined_threshold</unpshv>
</SQO>
```

SQO Level 2

The default `SQO Level 2` element is:

```
<SQO ID="SQO-2" ParentID="SQO-1">
  <Num_Unjustified_Red>0</Num_Unjustified_Red>
  <Num_Unjustified_NT_Constructs>0</Num_Unjustified_NT_Constructs>
</SQO>
```

To fulfill requirements of SQO Level 2, the code must meet the requirements of SQO Level 1 **and** the following:

- Number of unjustified red checks `Num_Unjustified_Red` must not be greater than the threshold (default is zero)
- Number of unjustified NTC and NTL checks `Num_Unjustified_NT_Constructs` must not be greater than the threshold (default is zero)

SQO Level 3

The default `SQO Level 3` element is:

```
<SQO ID="SQO-3" ParentID="SQO-2">
  <Num_Unjustified_UNR>0</Num_Unjustified_UNR>
</SQO>
```

To fulfill requirements of SQO Level 3, the code must meet the requirements of SQO Level 2 **and** the number of unjustified UNR checks must not exceed the threshold (default is zero).

SQO Level 4

The default `SQO Level 4` element is:

```
<SQO ID="SQO-4" ParentID="SQO-3">
  <Percentage_Proven_Or_Justified>Runtime_Checks_Set_1</Percentage_Proven_Or_Justified>
</SQO>
```

To fulfill requirements of SQO Level 4, the code must meet the requirements of SQO Level 3 **and** the following ratio as a percentage

```
(green checks + justified orange checks) / (green checks + all orange checks)
```

must not be less than the thresholds specified by "Run-Time Checks Set 1" on page 12-43.

SQO Level 5

The default `SQO Level 5` element is:

```
<SQO ID="SQO-5" ParentID="SQO-4">
  <Num_Unjustified_Violations>MISRA_Rules_Set_2</Num_Unjustified_Violations>
  <Percentage_Proven_Or_Justified>Runtime_Checks_Set_2</Percentage_Proven_Or_Justified>
</SQO>
```

To fulfill requirements of SQO Level 5, the code must meet the requirements of SQO Level 4 **and** the following:

- Number of unjustified violations of MISRA C rules must not exceed thresholds specified by "Coding Rules Set 2" on page 12-41.
- Percentage of green and justified checks must not be less than the thresholds specified by "Run-Time Checks Set 2" on page 12-44

SQO Level 6

The default `SQO Level 6` element is:

```
<SQO ID="SQO-6" ParentID="SQO-5">
  <Percentage_Proven_Or_Justified>Runtime_Checks_Set_3</Percentage_Proven_Or_Justified>
   </SQO>
```

To fulfill requirements of SQO Level 6, the code must meet the requirements of SQO Level 5 **and** the percentage of green and justified checks must not be less than the thresholds specified by "Run-Time Checks Set 3" on page 12-45.

SQO Exhaustive

The default `Exhaustive` element is:

```
<SQO ID="Exhaustive" ParentID="SQO-1">
  <Num_Unjustified_Violations>0</Num_Unjustified_Violations>
  <Num_Unjustified_Red>0</Num_Unjustified_Red>
  <Num_Unjustified_NT_Constructs>0</Num_Unjustified_NT_Constructs>
  <Num_Unjustified_UNR>0</Num_Unjustified_UNR>
  <Percentage_Proven_Or_Justified>100</Percentage_Proven_Or_Justified>
</SQO>
```

To fulfill the requirements for this level, the code must meet the requirements of SQO Level 1**and** the following:

- Number of unjustified violations of MISRA C rules must not exceed the threshold (default is zero)
- Number of unjustified red checks must not exceed the threshold (default is zero)
- Number of unjustified NTC and NTL checks must not exceed the threshold (default is zero)
- Number of unjustified UNR checks must not exceed the threshold (default is zero)
- Percentage of green and justified checks must not be less than the threshold (default is 100%)

Coding Rules Set 1

For C code, this element defines a set of MISRA C rules that can be applied to the code during the compilation phase, with corresponding violation thresholds.

For C++ code, you can specify the `CodingRulesSet` element to contain a set of MISRA C++ or JSF++ rules. The software applies these rules to the code during the compilation phase together with the violation thresholds that you specify.

MISRA C Rules

The default structure of Coding Rules Set 1 is:

```
<CodingRulesSet ID="MISRA_Rules_Set_1">
  <Rule Name="MISRA_C_8_11">0</Rule>
  <Rule Name="MISRA_C_8_12">0</Rule>
  <Rule Name="MISRA_C_11_2">0</Rule>
  <Rule Name="MISRA_C_11_3">0</Rule>
  <Rule Name="MISRA_C_12_12">0</Rule>
  <Rule Name="MISRA_C_13_3">0</Rule>
  <Rule Name="MISRA_C_13_4">0</Rule>
  <Rule Name="MISRA_C_13_5">0</Rule>
  <Rule Name="MISRA_C_14_4">0</Rule>
  <Rule Name="MISRA_C_14_7">0</Rule>
  <Rule Name="MISRA_C_16_1">0</Rule>
  <Rule Name="MISRA_C_16_2">0</Rule>
  <Rule Name="MISRA_C_16_7">0</Rule>
  <Rule Name="MISRA_C_17_3">0</Rule>
  <Rule Name="MISRA_C_17_4">0</Rule>
  <Rule Name="MISRA_C_17_5">0</Rule>
  <Rule Name="MISRA_C_17_6">0</Rule>
  <Rule Name="MISRA_C_18_3">0</Rule>
  <Rule Name="MISRA_C_18_4">0</Rule>
  <Rule Name="MISRA_C_20_4">0</Rule>
</CodingRulesSet>
```

To modify the default set, you can:

- Add rules by inserting a `Rule` element with the relevant `Name` attribute. For example, to add MISRA C rule 13.1 with a zero threshold, specify the following element in `CodingRulesSet>`

  ```
  <Rule Name="MISRA_C_13_1">0</Rule>
  ```

- Remove rules.

MISRA C++ Rules

To create a MISRA C++ rule set, specify the `CodingRulesSet` element using the following `Rule Name` element:

```
<Rule Name= MISRA_CPP_Rule_Number >Threshold</Rule>
```

For example:

```
<CodingRulesSet ID="MISRA_Cpp_Rules_Set">
  <Rule Name="MISRA_CPP_0_1_2">0</Rule>
  <Rule Name="MISRA_CPP_5_0_6">0</Rule>
  ....
</CodingRulesSet>
```

JSF++ Rules

To create a JSF++ rule set, specify the `CodingRulesSet` element using the following `Rule Name` element:

```
<Rule Name= JSF_CPP_Rule_Number >Threshold</Rule>
```

For example:

```
<CodingRulesSet ID="JSF_Cpp_Rules_Set">
  <Rule Name="JSF_CPP_180">0</Rule>
  <Rule Name="JSF_CPP_190">0</Rule>
  ....
</CodingRulesSet>
```

Coding Rules Set 2

This element defines a set of MISRA C rules that can be applied to the code during the compilation phase, with corresponding violation thresholds. The default structure of Coding Rules Set 2 is:

```
  <CodingRulesSet ID="MISRA_Rules_Set_2" ParentID="MISRA_Rules_Set_1">
      <Rule Name="MISRA_C_6_3">0</Rule>
      <Rule Name="MISRA_C_8_7">0</Rule>
      <Rule Name="MISRA_C_9_2">0</Rule>
      <Rule Name="MISRA_C_9_3">0</Rule>
      <Rule Name="MISRA_C_10_3">0</Rule>
      <Rule Name="MISRA_C_10_5">0</Rule>
```

```
   <Rule Name="MISRA_C_11_1">0</Rule>
   <Rule Name="MISRA_C_11_5">0</Rule>
   <Rule Name="MISRA_C_12_1">0</Rule>
   <Rule Name="MISRA_C_12_2">0</Rule>
   <Rule Name="MISRA_C_12_5">0</Rule>
   <Rule Name="MISRA_C_12_6">0</Rule>
   <Rule Name="MISRA_C_12_9">0</Rule>
   <Rule Name="MISRA_C_12_10">0</Rule>
   <Rule Name="MISRA_C_13_1">0</Rule>
   <Rule Name="MISRA_C_13_2">0</Rule>
   <Rule Name="MISRA_C_13_6">0</Rule>
   <Rule Name="MISRA_C_14_8">0</Rule>
   <Rule Name="MISRA_C_14_10">0</Rule>
   <Rule Name="MISRA_C_15_3">0</Rule>
   <Rule Name="MISRA_C_16_3">0</Rule>
   <Rule Name="MISRA_C_16_8">0</Rule>
   <Rule Name="MISRA_C_16_9">0</Rule>
   <Rule Name="MISRA_C_19_4">0</Rule>
   <Rule Name="MISRA_C_19_9">0</Rule>
   <Rule Name="MISRA_C_19_10">0</Rule>
   <Rule Name="MISRA_C_19_11">0</Rule>
   <Rule Name="MISRA_C_19_12">0</Rule>
   <Rule Name="MISRA_C_20_3">0</Rule>
</CodingRulesSet>
```

To modify the default set, you can:

- Add rules by inserting a `Rule` element with the relevant `Name` attribute. For example, to add MISRA C rule 6.1 with a zero threshold, specify the following element in `CodingRulesSet>`

  ```
  <Rule Name="MISRA_C_6_1">0</Rule>
  ```

- Remove rules.

Run-Time Checks Set 1

The Run-Time Checks Set 1 is composed of `Check` elements with data that specify thresholds. The `Name` and `Type` attribute in each `Check` element defines a run-time check, while the element data specifies a threshold in percentage. The default structure of Run-Time Checks Set 1 is:

```
<RuntimeChecksSet ID="Runtime_Checks_Set_1">
      <Check Name="OBAI">80</Check>
      <Check Name="ZDV" Type="Scalar">80</Check>
      <Check Name="ZDV" Type="Float">80</Check>
      <Check Name="NIVL">80</Check>
      <Check Name="NIV">60</Check>
      <Check Name="IRV">80</Check>
      <Check Name="FRIV">80</Check>
      <Check Name="FRV">80</Check>
      <Check Name="UOVFL" Type="Scalar">60</Check>
      <Check Name="UOVFL" Type="Float">60</Check>
      <Check Name="OVFL" Type="Scalar">60</Check>
      <Check Name="OVFL" Type="Float">60</Check>
      <Check Name="UNFL" Type="Scalar">60</Check>
      <Check Name="UNFL" Type="Float">60</Check>
      <Check Name="IDP">60</Check>
      <Check Name="NIP">60</Check>
      <Check Name="POW">80</Check>
      <Check Name="SHF">80</Check>
      <Check Name="COR">60</Check>
      <Check Name="NNR">50</Check>
      <Check Name="EXCP">50</Check>
      <Check Name="EXC">50</Check>
      <Check Name="NNT">50</Check>
      <Check Name="CPP">50</Check>
      <Check Name="OOP">50</Check>
      <Check Name="ASRT">60</Check>
   </RuntimeChecksSet>
```

When you use Run-Time Checks Set 1 in evaluating code quality, the software calculates the following ratio as a percentage for each run-time check in the set:

`(green checks + `*`justified`*` orange checks)/(green checks + `*`all`*` orange checks)`

If the percentage values do not exceed the thresholds in the set, the code meets the quality level.

To modify the default set, you can change the check threshold values.

Run-Time Checks Set 2

This set is similar to “Run-Time Checks Set 1” on page 12-43, but has more stringent threshold values.

```
<RuntimeChecksSet ID="Runtime_Checks_Set_2">
     <Check Name="OBAI">90</Check>
     <Check Name="ZDV" Type="Scalar">90</Check>
     <Check Name="ZDV" Type="Float">90</Check>
     <Check Name="NIVL">90</Check>
     <Check Name="NIV">70</Check>
     <Check Name="IRV">90</Check>
     <Check Name="FRIV">90</Check>
     <Check Name="FRV">90</Check>
     <Check Name="UOVFL" Type="Scalar">80</Check>
     <Check Name="UOVFL" Type="Float">80</Check>
     <Check Name="OVFL" Type="Scalar">80</Check>
     <Check Name="OVFL" Type="Float">80</Check>
     <Check Name="UNFL" Type="Scalar">80</Check>
     <Check Name="UNFL" Type="Float">80</Check>
     <Check Name="IDP">70</Check>
     <Check Name="NIP">70</Check>
     <Check Name="POW">90</Check>
     <Check Name="SHF">90</Check>
     <Check Name="COR">80</Check>
     <Check Name="NNR">70</Check>
     <Check Name="EXCP">70</Check>
     <Check Name="EXC">70</Check>
     <Check Name="NNT">70</Check>
     <Check Name="CPP">70</Check>
     <Check Name="OOP">70</Check>
     <Check Name="ASRT">80</Check>
  </RuntimeChecksSet>
```

Run-Time Checks Set 3

This set is similar to “Run-Time Checks Set 1” on page 12-43, but has more stringent threshold values.

```
<RuntimeChecksSet ID="Runtime_Checks_Set_3">
      <Check Name="OBAI">100</Check>
      <Check Name="ZDV" Type="Scalar">100</Check>
      <Check Name="ZDV" Type="Float">100</Check>
      <Check Name="NIVL">100</Check>
      <Check Name="NIV">80</Check>
      <Check Name="IRV">100</Check>
      <Check Name="FRIV">100</Check>
      <Check Name="FRV">100</Check>
      <Check Name="UOVFL" Type="Scalar">100</Check>
      <Check Name="UOVFL" Type="Float">100</Check>
      <Check Name="OVFL" Type="Scalar">100</Check>
      <Check Name="OVFL" Type="Float">100</Check>
      <Check Name="UNFL" Type="Scalar">100</Check>
      <Check Name="UNFL" Type="Float">100</Check>
      <Check Name="IDP">80</Check>
      <Check Name="NIP">80</Check>
      <Check Name="POW">100</Check>
      <Check Name="SHF">100</Check>
      <Check Name="COR">100</Check>
      <Check Name="NNR">90</Check>
      <Check Name="EXCP">90</Check>
      <Check Name="EXC">90</Check>
      <Check Name="NNT">90</Check>
      <Check Name="CPP">90</Check>
      <Check Name="OOP">90</Check>
      <Check Name="ASRT">100</Check>
   </RuntimeChecksSet>
```

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**. See “Run-Time Checks” on page 12-26.

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 all users of your Polyspace server.

Descriptions of 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. This measure is provided only from the verification PASS0.	No
	Non-Protected Shared Variables	Number of unprotected shared variables. This measure is provided only from the verification `PASS0`.	No

Level	Metric name	Description	HIS metric?
File	**Lines**	Number of lines. Physical lines including comment and blank lines	No
	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 12-54.	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
	Estimated Function Coupling	Inter-file dependency. Metric is equal to:	No

Level	Metric name	Description	HIS metric?
		sum of call occurrences – number of functions defined in the file + 1. The function coupling is calculated in a preprocessed file.	
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
	Cyclomatic Complexity	Number of decisions + 1. The `?:` operator is considered a decision, but the combination of `&& ||` is considered to be only one decision.	Yes
	Language Scope	The language scope is an indicator of the cost of maintaining or changing functions.	Yes

Level	Metric name	Description	HIS metric?

		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))`	

<table>
<tr><th>Level</th><th>Metric name</th><th>Description</th><th>HIS metric?</th></tr>
<tr><td></td><td><b>Paths</b></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><b>Calling Functions</b></td><td>Number of distinct callers of a function. Call through pointer is not considered.</td><td>Yes</td></tr>
<tr><td></td><td><b>Called Functions</b></td><td>Number of distinct functions called by a function. Call through pointer is not considered. See description for <b>Call Occurences</b></td><td>Yes</td></tr>
</table>

Level	Metric name	Description	HIS metric?

	Call Occurences	Number of call occurrences within function body.
		Similar to **Called Functions** except that each call of a function is counted.
		Consider the following code.
		`int callee_1() {return 0;}`
		`int callee_2() {return 0;}`
		
		`int get()`
		`{`
		`  return  callee_1() + callee_1() + callee_2() + callee_2();`
		`}`
		For this code, the **Called Functions** value is 2 but the **Call Occurences** value is 4.
			No

	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`,	Yes

Level	Metric name	Description	HIS metric?
		`do-while`, `for`, `goto`, `if`, `return`, `switch`, `while`.	
	Call Levels	Depth of function nesting. Maximum depth of control structures within a function body. The value of 1 means either no control structure exists within a function body or all existing control structures are not nested within another control structure.	Yes
	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

Number of Lines of Code Calculation

For the following code, the line count in a text editor is 15 lines.

```
1   #include <stddef.h>
2
3   unsigned char v1,v2,v3;
4
5   unsigned char myfunc(void)
6   {
7     if(v1>v2)
8     {
9        v3=v2
10      + v1;
11    }
12
13    return v3;
14  }
15
```

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" on page 12-55

"Administer Repository From Command Line" on page 12-56

"Backup Results Repository" on page 12-57

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 no confirmation is 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 no confirmation is 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 "Configure Server for Remote Verification and 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” on page 13-2
- “Configure Simulink Model” on page 13-3
- “Recommended Model Settings for Code Analysis” on page 13-5
- “Check Simulink Model Settings” on page 13-7
- “Annotate Blocks with Known Errors or Coding-Rule Violations” on page 13-9

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 13-5.
- 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 13-7
- You can constrain signals in your model to lie within specified ranges. See “Specify Signal Ranges” on page 14-2.
- You can highlight blocks that you know contain checks or coding rule violations. See “Annotate Blocks with Known Errors or Coding-Rule Violations” on page 13-9.

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 `ert.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'`	Select `discrete (no continuous states)` from **Solver > Solver** drop-down list	Warning
`SystemTargetFile`	`'ert.tlc'`	Specify `ert.tlc` (for Embedded Coder) in **Code Generation > System target file**	Error

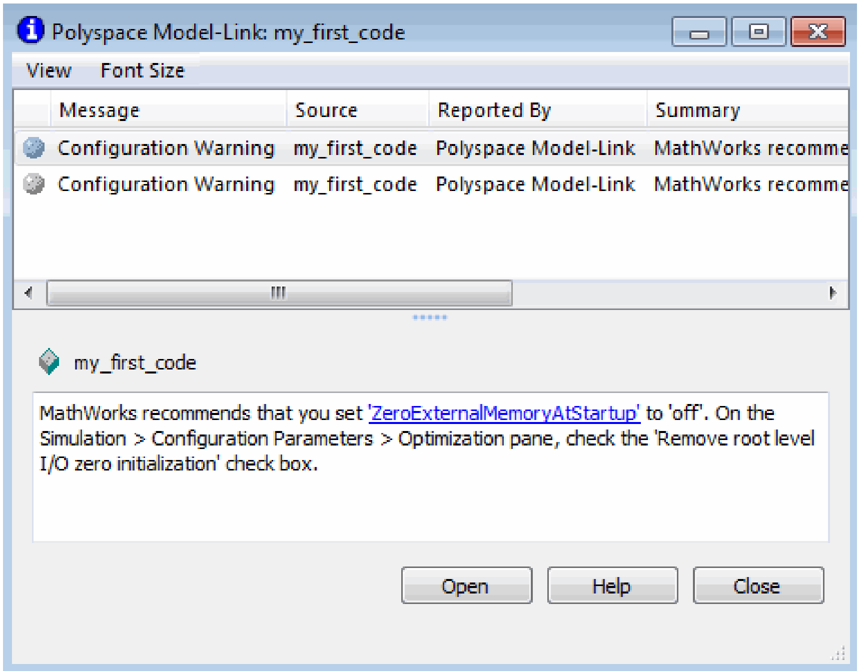
Parameter	Recommended value	How you specify value in Configuration Parameters dialog box	If you do not use recommended value...
`GenerateComments`	`'on'`	Select check box **Code Generation > Comments > Include Comments**	Error
`ZeroExternalMemoryAtStartup`	`'off'` when **Configuration Parameters > Polyspace > 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.



Message	Source	Reported By	Summary
Configuration Warning	my_first_code	Polyspace Model-Link	MathWorks recomme
Configuration Warning	my_first_code	Polyspace Model-Link	MathWorks recomme

my_first_code

MathWorks recommends that you set 'ZeroExternalMemoryAtStartup' to 'off'. On the Simulation > Configuration Parameters > Optimization pane, check the 'Remove root level I/O zero initialization' check box.

For more information on model settings, see “Recommended Model Settings for Code Analysis” on page 13-5.

Note If you alter your model settings, build the model again to generate fresh code. If the generated code version does not match your model version, the software produces warnings when you run the analysis.

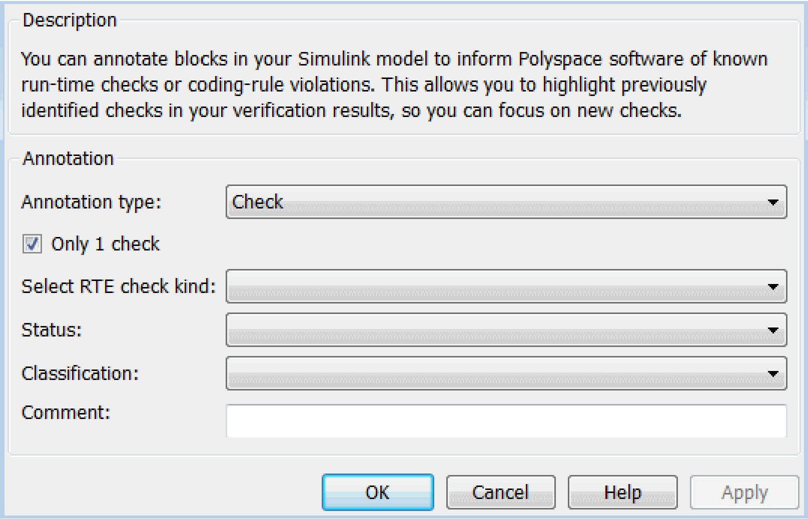
Annotate Blocks with Known Errors or Coding-Rule Violations

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 Annotations > Edit**. The Polyspace Annotation dialog box opens.



Description

You can annotate blocks in your Simulink model to inform Polyspace software of known run-time checks or coding-rule violations. This allows you to highlight previously identified checks in your verification results, so you can focus on new checks.

Annotation

Annotation type: Check

☑ Only 1 check

Select RTE check kind:

Status:

Classification:

Comment:

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`

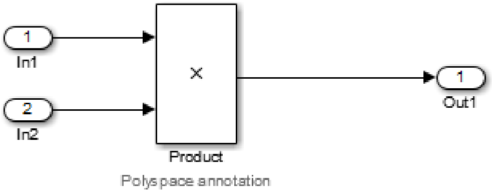
  (This status also marks the result as justified.)
- `Other`
- `Restart with different options`
- `Undecided`

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

- "Specify Signal Ranges" on page 14-2
- "Annotate Code to Justify Polyspace Checks" on page 14-7
- "Configure Data Range Settings" on page 14-9
- "Main Generation for Model Verification" on page 14-12
- "Embedded Coder Considerations" on page 14-14
- "TargetLink Considerations" on page 14-21
- "Generate and Verify Code with Configured Model" on page 14-24
- "View Results in Polyspace® Code Prover™" on page 14-26
- "Identify Errors in Simulink Models" on page 14-28

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 14-2.
- Constraining signals through the base workspace. See “Specify Signal Range through Base Workspace” on page 14-4.

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.

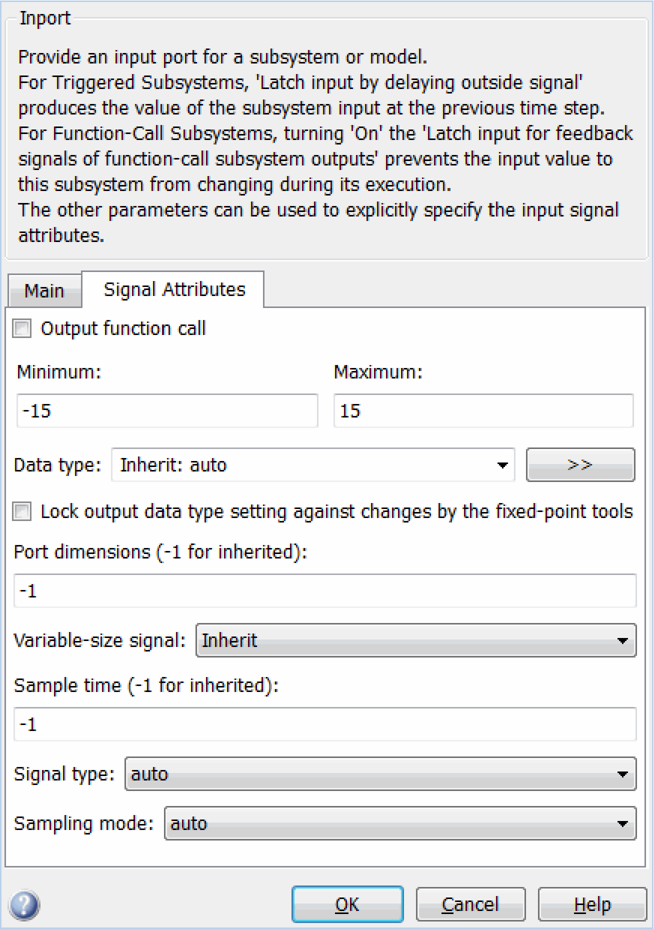
Specifying a range through source block parameters is often easier than creating signal objects in the base workspace, but must be repeated for each source block. For information on using the base workspace, see “Specify Signal Range through Base Workspace” on page 14-4.

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.



Inport

Provide an input port for a subsystem or model.
For Triggered Subsystems, 'Latch input by delaying outside signal' produces the value of the subsystem input at the previous time step.
For Function-Call Subsystems, turning 'On' the 'Latch input for feedback signals of function-call subsystem outputs' prevents the input value to this subsystem from changing during its execution.
The other parameters can be used to explicitly specify the input signal attributes.

□ Output function call

Minimum: -15

Maximum: 15

Data type: Inherit: auto

□ Lock output data type setting against changes by the fixed-point tools

Port dimensions (-1 for inherited): -1

Variable-size signal: Inherit

Sample time (-1 for inherited): -1

Signal type: auto

Sampling mode: auto

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 14-2.

To specify an input signal range through the base workspace:

1. Configure the signal to use, for example, the `ExportedGlobal` storage class:

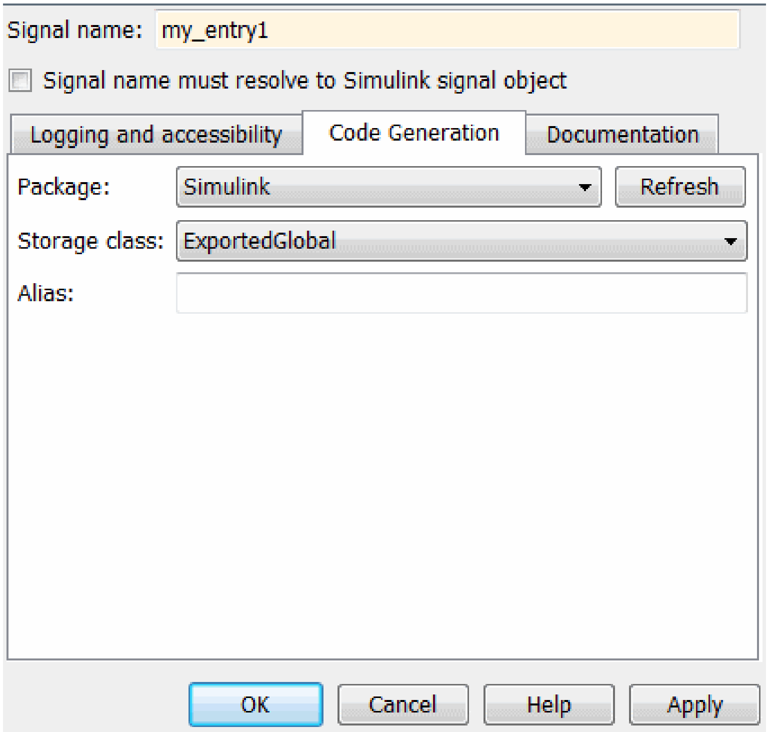
   a. Right-click the signal. From the context menu, select **Properties**. The Signal Properties dialog box opens.

   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`.



Signal name: my_entry1

□ Signal name must resolve to Simulink signal object

Package: Simulink

Storage class: ExportedGlobal

Alias:

f Click **OK**, which applies your changes and closes the dialog box.

Note For information about supported storage classes, see “Data Range Specification” on page 14-15.

---

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`.

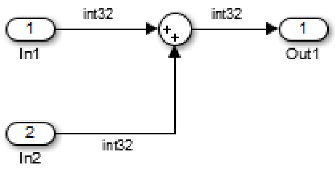
e Set the **Maximum** value for the signal, for example, to `15`.

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:

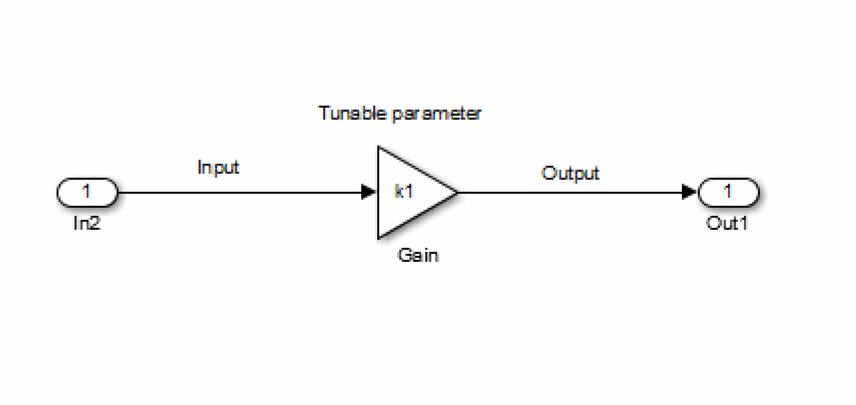
- **Contextual Verification** — Prove code works under predefined working conditions. This limits the scope of the verification to specific variable ranges, and verifies the code within these ranges.
- **Robustness Verification —** Prove code works under all conditions, including "abnormal" conditions for which the code was not designed. This can be thought of as "worst case" verification.

For more information, see:

- "Choose Robustness or Contextual Verification" on page 2-4.
- Data Range Specification — Model Link SL
- Data Range Specification — Model Link TL

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” on page 14-2.

   - `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” on page 14-2. 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...

"Subsystems" on page 14-14

"Default Options" on page 14-14

"Data Range Specification" on page 14-15

"Recommended Polyspace® Code Prover™ options for Verifying Generated Code" on page 14-15

"Hardware Mapping Between Simulink and Polyspace" on page 14-20

Subsystems

A dialog will be presented after clicking on the Polyspace for Embedded Coder block if multiple subsystems are present in a diagram. Simply select the subsystem to analyze from the list. The subsystem list is generated from the directory structure from the code that has been generated.

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
-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. See “Configure Data Range Settings” on page 14-9.

The software automatically creates a Polyspace Data Range Specification (DRS) 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 Code Prover 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 Model Link** 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
Target & Compiler		
`-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.

Option	Recommended Value	Comments
`-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`	`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".
`-dos`	Selected	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) • **Source files** – All source files selected for the verification (`-sources` option)

Option	Recommended Value	Comments
Verification Assumptions		
`-allow-negative-operand-in-shift`	Selected	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
`-ignore-float-rounding`	Selected	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		
`-0`	`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: • `-00` corresponds to static interval verification. • `-01` corresponds to complex polyhedron model of domain values. • `-02` corresponds to more complex algorithms to closely model domain values (a mixed approach with integer lattices and complex polyhedrons). • `-03` 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
`-to`	**`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. **`pass0`** – When verifying code for the first time. **`pass4`** – When performing subsequent verifications of code.	Specifies the phase after which the verification stops. 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" on page 14-21

"Subsystems" on page 14-21

"Default Options" on page 14-21

"Data Range Specification" on page 14-22

"Lookup Tables" on page 14-23

"Code Generation Options" on page 14-23

TargetLink Support

For Windows, Polyspace Code Prover is tested with releases 3.1, 3.2, and 3.3 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.

Subsystems

A dialog will be presented after clicking on the Polyspace for TargetLink block if multiple subsystems are present in a diagram. Simply select the subsystem to analyze from the list.

Default Options

The following default options are set by the tool:

```
-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
```

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" on page 14-9.

The software automatically creates a Polyspace Data Range Specification (DRS) 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).

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. Server verification is specified by default. If you want to specify client verification, select **Code > Polyspace > Options**. When the **Configuration Parameters > Polyspace Model Link** pane opens, clear the **Send to Polyspace server** check box. Then click **OK**.
7. Right-click the subsystem controller. From the context menu, select **Polyspace > Polyspace for Embedded Coder**. The verification starts.

To monitor the progress of the verification:

- If you specified server verification, select **Code > Polyspace > Open Spooler**. Use the Polyspace Queue Manager (Spooler) 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**.

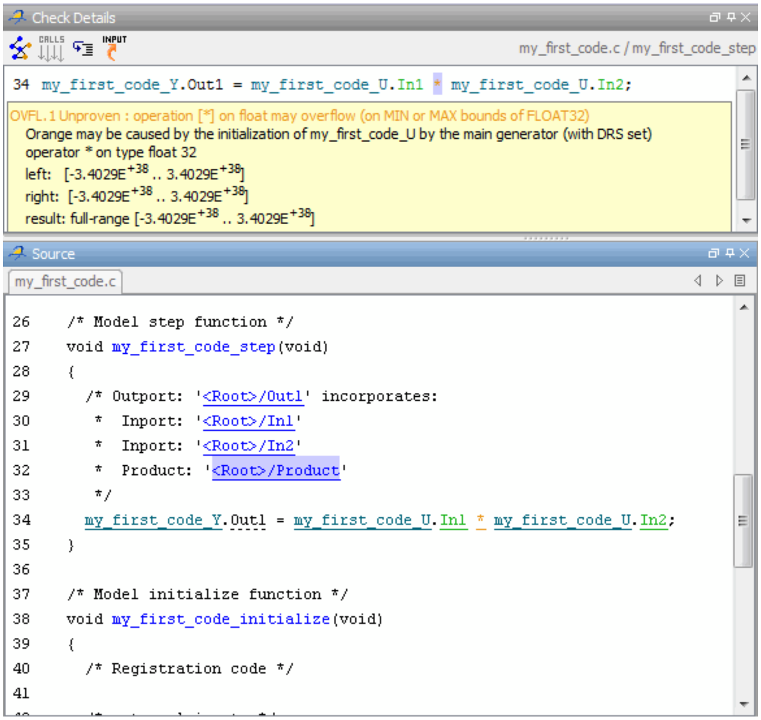
Note If you set **Model reference verification depth** to `All` and selected **Model by model verification**, the Select the Result Folder to Open in Polyspace dialog box opens. The dialog box displays a hierarchy of referenced models from which the software generates code. To view the verification results 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.



```
my_first_code_Y.Out1 = my_first_code_U.In1 * my_first_code_U.In2;
```

OVFL.1 Unproven : operation [*] on float may overflow (on MIN or MAX bounds of FLOAT32)
Orange may be caused by the initialization of my_first_code_U by the main generator (with DRS set)
operator * on type float 32
left: [-3.4029E^{+38} .. 3.4029E^{+38}]
right: [-3.4029E^{+38} .. 3.4029E^{+38}]
result: full-range [-3.4029E^{+38} .. 3.4029E^{+38}]

```
/* Model step function */
void my_first_code_step(void)
{
  /* Outport: '<Root>/Out1' incorporates:
   *  Inport: '<Root>/In1'
   *  Inport: '<Root>/In2'
   *  Product: '<Root>/Product'
   */
  my_first_code_Y.Out1 = my_first_code_U.In1 * my_first_code_U.In2;
}

/* Model initialize function */
void my_first_code_initialize(void)
{
  /* Registration code */

```

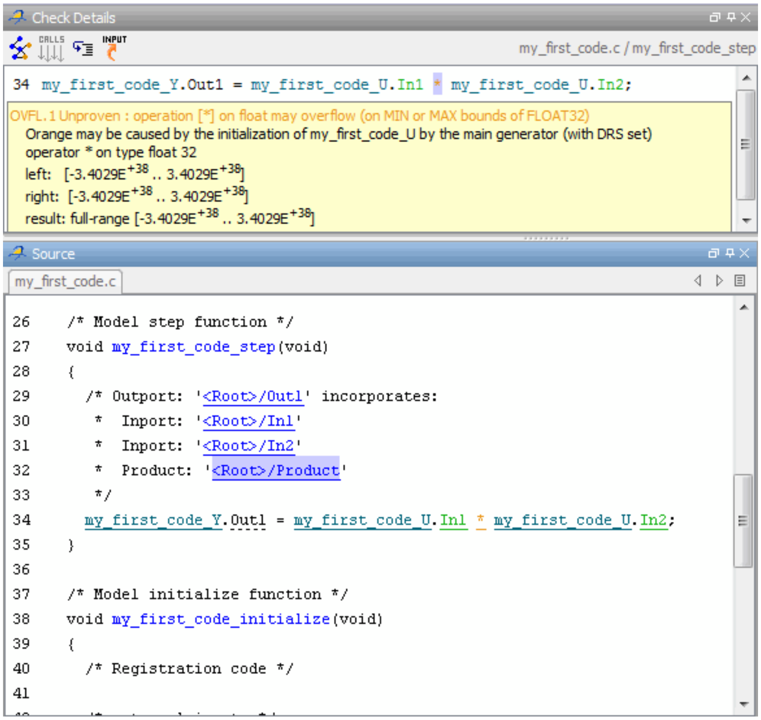
For more information on reviewing run-time checks, see “Run-Time Error Review”.

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.



```
my_first_code_Y.Out1 = my_first_code_U.In1 * my_first_code_U.In2;
```

OVFL.1 Unproven : operation [*] on float may overflow (on MIN or MAX bounds of FLOAT32)
Orange may be caused by the initialization of my_first_code_U by the main generator (with DRS set)
operator * on type float 32
left: [-3.4029E^{+38} .. 3.4029E^{+38}]
right: [-3.4029E^{+38} .. 3.4029E^{+38}]
result: full-range [-3.4029E^{+38} .. 3.4029E^{+38}]

```
/* Model step function */
void my_first_code_step(void)
{
  /* Outport: '<Root>/Out1' incorporates:
   *  Inport: '<Root>/In1'
   *  Inport: '<Root>/In2'
   *  Product: '<Root>/Product'
   */
  my_first_code_Y.Out1 = my_first_code_U.In1 * my_first_code_U.In2;
}

/* Model initialize function */
void my_first_code_initialize(void)
{
  /* Registration code */

```

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" on page 14-2.

   Applying either solution should address the issue and cause the orange check to turn green.

If your operating system is Windows Vista™ or Windows 7, you may encounter problems with the trace-back functionality if one of the following conditions apply:

- User Account Control (UAC) is enabled.
- You do not have administrator privileges.

If you have a MATLAB session running and your model is open, a possible workaround is:

1. Open a DOS window in administrator mode.
2. Go to your MATLAB installation folder.
3. From the `bin` folder, enter `matlab -regserver`.
4. Click the link again.

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 the following commands:

```
HILITEDATA = struct('HiliteType', 'find', 'ForegroundColor', 'black', ...
                    'BackgroundColor', color);
set_param(0, 'HiliteAncestorsData', HILITEDATA);
```

Where *`color`* is one of the following:

- `'cyan'`
- `'magenta'`
- `'orange'`
- `'lightBlue'`
- `'red'`
- `'green'`
- `'blue'`
- `'darkGreen'`

Configure Code Analysis Options

- “Polyspace Configuration for Generated Code” on page 15-2
- “Include Handwritten Code” on page 15-3
- “Specify Remote Analysis” on page 15-5
- “Configure Analysis Depth for Referenced Models” on page 15-6
- “Specify Location of Results” on page 15-7
- “Check Coding Rules Compliance” on page 15-8
- “Configure Polyspace Options from Simulink” on page 15-10
- “Configure Polyspace Project Properties” on page 15-11
- “Create a Polyspace Configuration File Template” on page 15-12
- “Specify Header Files for Target Compiler” on page 15-15
- “Open Polyspace Results Automatically” on page 15-16
- “Remove Polyspace Options From Simulink Model” on page 15-18

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:

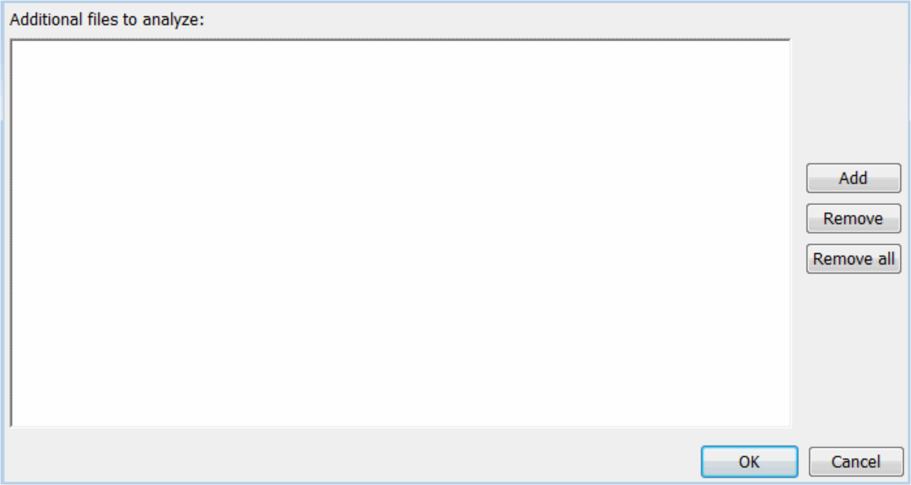
- You may incorporate separately created code within the code generated from your Simulink model. See "Include Handwritten Code" on page 15-3.
- By default, the Polyspace analysis is contextual and treats tunable parameters as constants. You can specify a verification that considers robustness, including tunable parameters that lie within a range of values. See "Configure Data Range Settings" on page 14-9.
- You may customize the options for your analysis. For example, to specify the target environment or adjust precision settings. See "Configure Polyspace Options from Simulink" on page 15-10 and "Recommended Polyspace® Code Prover™ options for Verifying Generated Code" on page 14-15.
- You may create specific configurations for batch runs. See "Create a Polyspace Configuration File Template" on page 15-12.
- 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 15-15.

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** checkbox.
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 16-5.

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 C and MISRA AC AGC 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 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 all MISRA C coding rules.

C Code Settings (Continued)

Setting	Description
`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 all 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 all 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 all JSF C++ coding rules. Polyspace stops after rules checking.

3 Click **Apply** to save your settings.

Configure Polyspace Options from Simulink

From Simulink, you can use a simplified version of the Polyspace Project Manager to customize Polyspace options. For example, you can specify the target processor type, target operating system, and compilation flags.

To open the **Configuration** pane of the Project Manager:

1. From the Simulink model window, select **Code > Polyspace > Options**. The **Polyspace** pane opens.

2. Click **Configure**. The Polyspace Configuration pane opens.

   The first time you open the configuration, the software sets the following options:

   - **Target operating system** (`-OS-target`) – Set to `no-predefined-OS`
   - **Use result folder** (`-results-dir`) – Set to `results_`*`modelname`*

   The software also configures other options automatically, but the settings depend on the code generator used.

3. Set other options required by your application.

   For recommended options for verifying generated code, see “Recommended Polyspace® Code Prover™ options for Verifying Generated Code” on page 14-15.

   For descriptions of all options, see “Analysis Options for C Code” or “Analysis Options for C Code”.

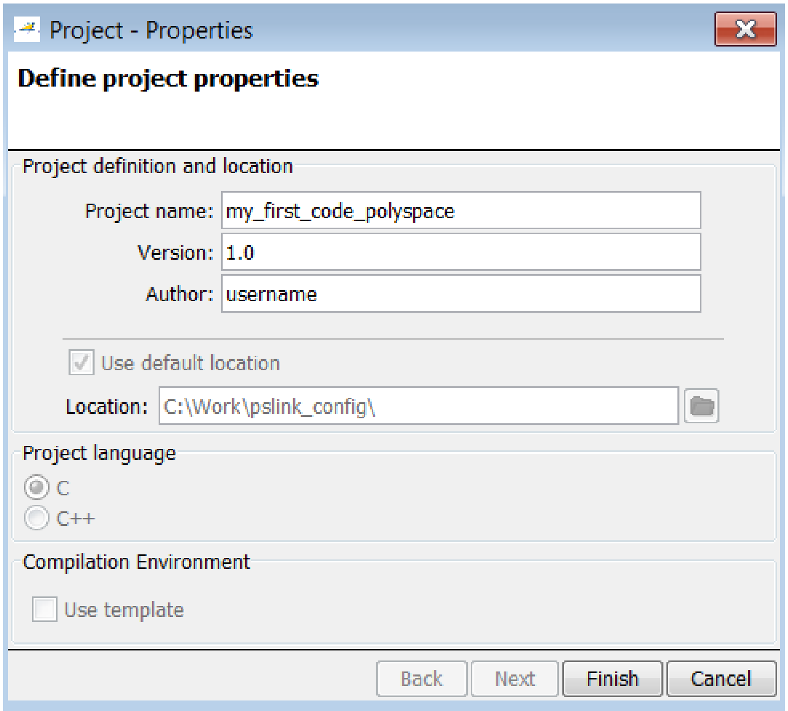
Configure Polyspace Project Properties

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 .



Project - Properties

Define project properties

Project definition and location

Project name: my_first_code_polyspace

Version: 1.0

Author: username

☑ Use default location

Location: C:\Work\pslink_config\

Project language

● C

○ C++

Compilation Environment

□ Use template

Create a Polyspace Configuration File Template

During a batch run, you may want use different configurations. The software provides the command `PolyspaceSetTemplateCFGFile`, which allows you to apply a configuration defined by a configuration file template. See "MATLAB Functions for Polyspace Batch Runs" on page 16-9.

To create a configuration file template:

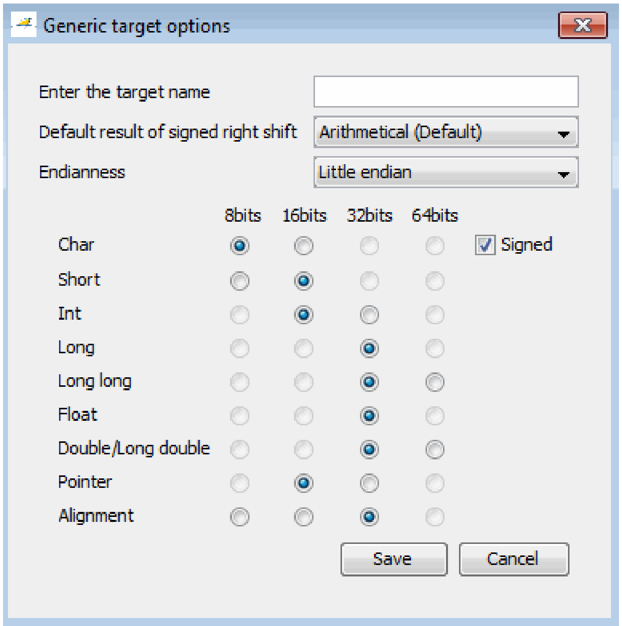
1 In the Simulink model window, select **Code > Polyspace > Options**. The **Polyspace** pane opens.

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.



Enter the target name

Default result of signed right shift: Arithmetical (Default)

Endianness: Little endian

	8bits	16bits	32bits	64bits	
Char	●	○	○	○	☑ Signed
Short	○	●	○	○	
Int	○	●	○	○	
Long	○	○	●	○	
Long long	○	○	●	○	
Float	○	○	●	○	
Double/Long double	○	○	●	○	
Pointer	○	●	○	○	
Alignment	○	○	●	○	

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 `PolyspaceSetTemplateCFGFile` command in the MATLAB Command Window. For example:

```
PolyspaceSetTemplateCFGFile ('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 -.

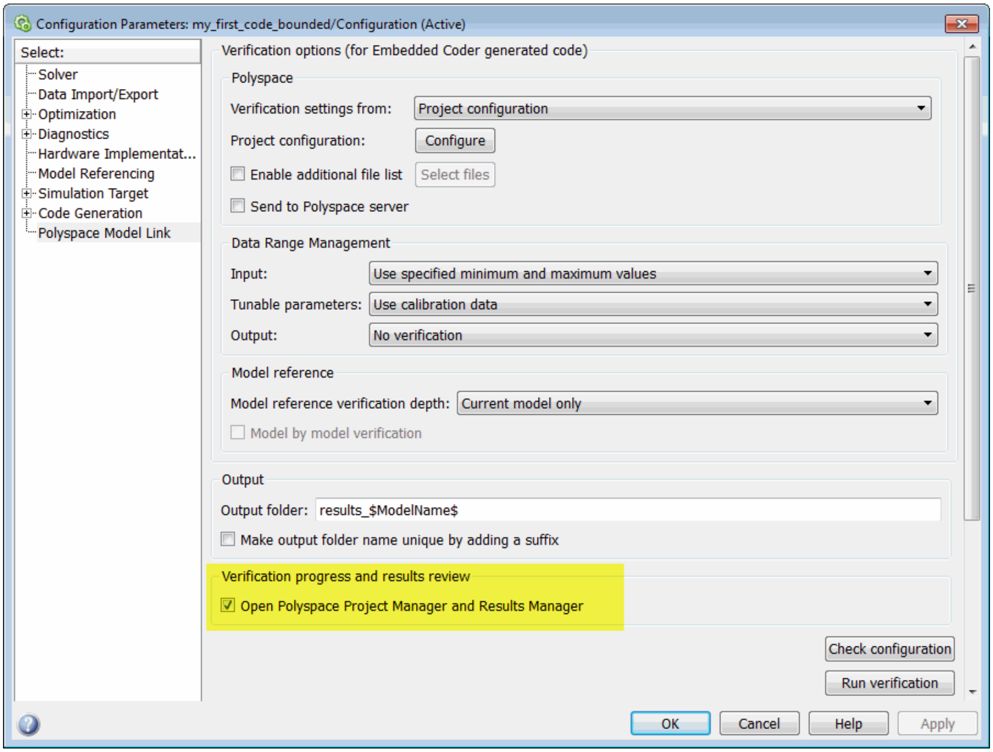
Open Polyspace Results Automatically

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.



Configuration Parameters: my_first_code_bounded/Configuration (Active)

Verification options (for Embedded Coder generated code)

Polyspace

Verification settings from: Project configuration

Project configuration: Configure

□ Enable additional file list

□ Send to Polyspace server

Data Range Management

Input: Use specified minimum and maximum values

Tunable parameters: Use calibration data

Output: No verification

Model reference

Model reference verification depth: Current model only

□ Model by model verification

Output

Output folder: results_$ModelName$

□ Make output folder name unique by adding a suffix

Verification progress and results review

☑ Open Polyspace Project Manager and Results Manager

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 **Remove Options from Current Configuration**.
3. Save the model.

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Run Polyspace on Generated Code

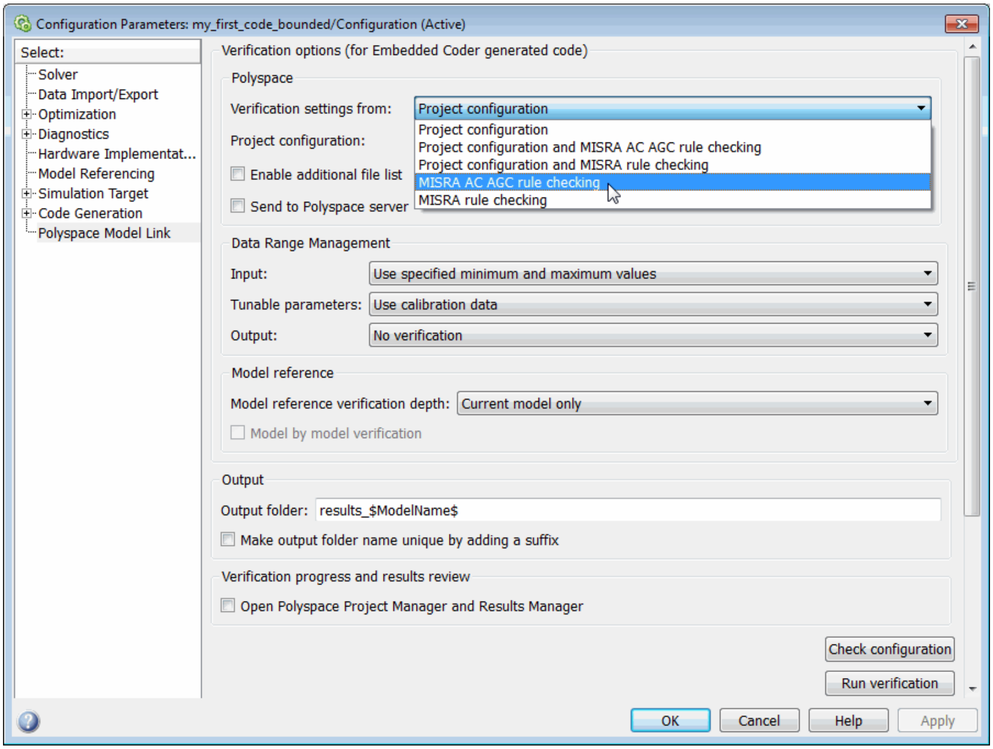
- “Specify Type of Analysis to Perform” on page 16-2
- “Run Analysis for Embedded Coder” on page 16-5
- “Run Analysis for TargetLink” on page 16-7
- “Monitor Progress” on page 16-8
- “MATLAB Functions for Polyspace Batch Runs” on page 16-9

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 pane opens.



Configuration Parameters: my_first_code_bounded/Configuration (Active)

Verification options (for Embedded Coder generated code)

Polyspace

Verification settings from: Project configuration

Project configuration:

□ Enable additional file list

□ Send to Polyspace server

Data Range Management

Input: Use specified minimum and maximum values

Tunable parameters: Use calibration data

Output: No verification

Model reference

Model reference verification depth: Current model only

□ Model by model verification

Output

Output folder: results_$ModelName$

□ Make output folder name unique by adding a suffix

Verification progress and results review

□ Open Polyspace Project Manager and Results Manager

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 all 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 all 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.

C++ Code Settings (Continued)

Setting	Description
`Project configuration and JSF C++ rule checking`	Run Polyspace using the options specified in the **Project configuration** and check compliance with all 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 all 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 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 Queue Manager.

The software writes all 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 all 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 Queue Manager

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" on page 16-8

"Remote Batch Analyses" on page 16-8

Local Analyses

For a local Polyspace runs, you can follow the progress of the software in the MATLAB Command Window. The software also saves all 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 Queue Manager.

From Simulink, select **Code > Polyspace > Open Spooler**

For more information, see "Verification Management".

MATLAB Functions for Polyspace Batch Runs

In addition to pslinkrun, pslinkoptions, PolyspaceAnnotation, and PolySpaceViewer, you can run the following commands in the Command Window.

In addition to pslinkrun, pslinkoptions, PolySpaceViewer, and PolyspaceAnnotation, you can run the following commands in the Command Window.

Command	Description
PolySpaceSpooler	Open the Polyspace Queue Manager (Spooler), which allows you to manage remote batch runs.
PolySpaceSetTemplateCFGFile	Select a template file, for example, during a batch run.
PolySpaceGetTemplateCFGFile	Get the currently selected template file (empty by default).
PolySpaceReconfigure	In case of a Polyspace release update without enabling the MATLAB plug-in.
ver	Display version numbers of MathWorks products, including Polyspace plug-in.

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Functions

PolyspaceAnnotation

Purpose

Annotate Simulink blocks with known Polyspace results

Syntax

```
PolyspaceAnnotation('type',typeValue,'kind',kindValue,Name,
   Value)
```

Description

`PolyspaceAnnotation('type',typeValue,'kind',kindValue,Name, Value)`adds an annotation of type `typeValue` and kind `kindValue` to the currently selected block in the model. You can also specify a different block using a `Name,Value` pair argument. You can also add notes about a priority classification, an action status, or other comments using `Name,Value` pairs.

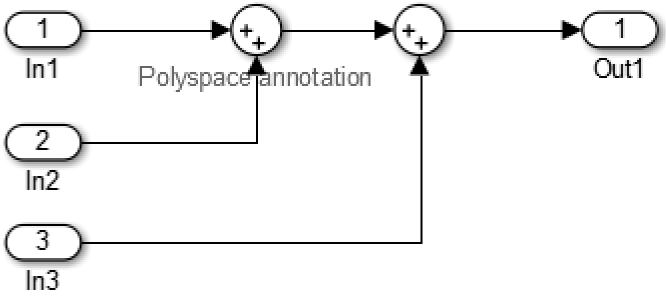
In the generated code associated with the annotated block, code comments are added before and after the lines of code. Polyspace reads these comments and marks any Polyspace results of the specified `kind` with the annotated information.

When you add annotations, you can identify known errors and coding rule violations to focus on new results.

Limitations

- You can have only one annotation per block. If a block produces both a rule violation and an error, only one type can be annotation.
- Even though you apply annotations to individual blocks, the scope of the annotation may be larger. The generated code from one block can overlap with another causing the annotation to also overlap.

  For example, consider this model.



The first summation block has a Polyspace annotation, but the second does not. However, the associated generated code adds all three inputs in one line of code. Therefore, the annotation justifies both summations:

```
/*
* polyspace:begin<RTE:OVFL:Medium:Fix>
*/
annotate_y.Out1 = (annotate_u.In1 + annotate_U.In2) + annotate_U.In

/* polyspace:end<RTE:OVFL:Medium:Fix> */
```

Input Arguments

typeValue - type of result

'RTE' | 'MISRA-C' | 'MISRA-CPP' | 'JSF'

The type of result with which to annotate the block, specified as:

- `RTE' for run-time errors.
- `MISRA-C' for MISRA C coding rule violations (C code only).
- `MISRA-CPP' for MISRA C++ coding rule violations (C++ code only).
- `JSF' for JSF C++ coding rule violations (C++ code only).

Example: `type','MISRA-C'

kindValue - specific check or coding rule

check acronym | rule number

The specific check or coding rule specified by the acronym of the check or the coding rule number. For the specific input for each type of annotation, see the following table.

Type Value	Kind Values
`RTE'	Use the abbreviation associated with the type of check that you want to annotate. For example, 'UNR' – Unreachable Code. For the list of possible checks see:"Run-Time Checks for C Code" or "Run-Time Checks for C++ Code".
`MISRA-C'	Use the rule number that you want to annotate. For example, '2.2'. For the list of supported MISRA C rules and their numbers, see "Supported MISRA C Rules" on page 11-60.
`MISRA-CPP'	Use the rule number that you want to annotate. For example, '0-1-1'. For the list of supported MISRA C++ rules and their numbers, see "Supported MISRA C++ Coding Rules" on page 11-102.
`JSF'	Use the rule number that you want to annotate. For example, '3'. For the list of supported JSF C++ rules and their numbers, see "Supported JSF C++ Coding Rules" on page 11-128.

Example:

```
PolyspaceAnnotation('type','MISRA-CPP','kind','1-2-3')
```

Data Types

`char`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`' '`). You can specify several name and value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`.

Example: ‘block’,’MyModel\Sum’, ‘status’,’fix’

’block’ - block to be annotated

`gcb` (default) | block name

Block to be annotated specified by the block name. If you do not use this option, the block returned by the function `gcb` is annotated.

Example: `'block','MyModel\Sum'`

’class’ - classification of the check

`'high'` | `'medium'` | `'low'` | `'not a defect'` | `'unset'`

Classification of the check specified as `high`, `medium`, `low`, `not a defect`, or `unset`.

Example: `'class','high'`

’status’ - action status

`'undecided'` | `'investigate'` | `'fix'` | `'improve'` | `'restart with different options'` | `'justify with annotation'` | `'no action planned'` | `'other'`

Action status of the check specified as `undecided`, `investigate`, `fix`, `improve`, `restart with different options`, `justify with annotation`, `no action planned`, or `other`.

The statuses, `justify with annotation` and `no action planned`, also mark the result as justified.

Example: `'status','no action planned'`

’comment’ - additional comments

string

Additional comments specified as a string. The comments provide more information about why the results are justified.

Example: `'comment','defensive code'`

Examples

Annotate a Block and Run a Polyspace Code Prover Verification

Use the Polyspace annotation function to annotate a block and see the annotation in the verification results.

At the MATLAB command line, load and open the example model WhereAreTheErrors_v2:

```
open(WhereAreTheErrors_v2)
```

Set the current block to the division block of the `10* x // (x-y)` subsystem:

```
gcb = 'WhereAreTheErrors_v2/10* x // (x-y)/Divide';
```

Add an annotation to the current block to mark any division by zero (DIV) errors as justified with the annotation.

```
PolyspaceAnnotation('type','RTE','kind','ZDV','status',...
 'justify with annotation','comment','verified not an error');
```

In Simulink, the division block of the `10* x // (x-y)` subsystem now has a Polyspace annotation.

Back at the MATLAB command line, generate code for the model:

```
slbuild('WhereAreTheErrors_v2');
```

Run a Polyspace Code Prover verification on your model:

```
pslinkrun('WhereAreTheErrors_v2');
```

After the analysis has finished, open the result in the Polyspace environment:

```
PolySpaceViewer('WhereAreTheErrors_v2');
```

If you look at orange division by zero error, the check is justified and includes the status and comments from your annotation.

Annotate a Block and Run a Polyspace Bug Finder Analysis

Use the Polyspace annotation function to annotate a block and see the annotation in the analysis results.

At the MATLAB command line, load and open the example model WhereAreTheErrors_v2:

```
WhereAreTheErrors_v2
```

Add an annotation to the switch block to annotate any violations to MISRA C rule 13.7. Also, add to the annotation a comment, a classification, and a status.

```
PolyspaceAnnotation('type','Misra-C', 'kind', '13.7','block',...
'WhereAreTheErrors_v2/Switch1','status','improve','comment','look into
```

In the WhereAreTheErrors_v2 model in Simulink, you can see a Polyspace annotation added to the switch block.

At the MATLAB command line, generate code for the model:

```
slbuild('WhereAreTheErrors_v2');
```

Run an analysis on your model:

```
pslinkrun('WhereAreTheErrors_v2');
```

After the analysis is finished, open the results in the Polyspace environment:

```
PolySpaceViewer('WhereAreTheErrors_v2');
```

Results 10–14 are all MISRA C 13.7 rule violations. The annotation information that you added to the switch block appears in all four results, because all four results are from the switch block.

See Also

`pslinkoptions` | `pslinkrun` | `PolySpaceViewer` | `gcb`

Concepts

- “MATLAB Functions for Polyspace Batch Runs” on page 16-9

Purpose

Create options object to customize Polyspace runs from MATLAB command line

Syntax

```
opts = pslinkoptions(codegen)
opts = pslinkoptions(model)
```

Description

`opts = pslinkoptions(codegen)` returns an options object with the configuration options for code generated by `codegen`.

`opts = pslinkoptions(model)` returns an options object with the configuration options for the Simulink model `model`.

Input Arguments

codegen - Code generator

`'ec' | 'tl'`

Code generator, specified as either `'ec'` for Embedded Coder or `'tl'` for TargetLink. Each argument creates a Polyspace options object with configuration options specific to that code generator.

For a description of all configuration options and their values, see .

Example: `embedded_coder_opt = pslinkoptions('ec')`

Example: `target_link_opt = pslinkoptions('tl')`

Data Types
`char`

model - Simulink model

`model name`

Simulink model, specified by the model name. Creates a Polyspace options object with the configuration options of that model. If no options have been set, the object has all default configuration options. If a code generator has been set, the object has the default options for that code generator.

For a description of all configuration options and their values, see .

Example: `model_opt = pslinkoptions('my_model')`

Data Types
`char`

Output Arguments

opts - Polyspace configuration options
options object

Polyspace configuration options, returned as an options object. The object is used with `pslinkrun` to run a Polyspace from the MATLAB command line.

The following table provides possible values and a description for each configuration option. Depending on the code generator, the object will have different configuration options. The value in curly brackets `{}` is the default.

Configuration Option	Values	Description
`ResultDir`	`{'C:\Polyspace_Results\results_$`*`ModelName`*`$'}`	Specify location of results folder. Can be either an absolute path or a path relative to the current folder.
`VerificationSettings`	`{'PrjConfig'} | 'PrjConfigAndMisraAGC' | 'PrjConfigAndMisra' | 'MisraAGC' | 'Misra'`	Specify checking of coding rules for C: **`'PrjConfig'`** – Inherit all options from project configuration and run complete analysis. **`'PrjConfigAndMisraAGC'`** – Inherit all options from project configuration, enable MISRA AC AGC rule checking, and run complete analysis. **`'PrjConfigAndMisra'`** – Inherit all options from project configuration, enable MISRA C rule

Configuration Option	Values	Description
		checking, and run complete analysis. **'MisraAGC'** – Enable MISRA AC AGC rule checking, and run compilation phase only. **'Misra'** – Enable MISRA C rule checking, and run compilation phase only.
`OpenProjectManager`	`{false} | true`	Open Polyspace Metrics or Project Manager to monitor the progress. Afterward, you can switch to the Results Manager perspective to review the results.
`AddSuffixToResultDir`	`{false} | true`	Modify location of results folder by appending a unique number to the folder name instead of overwriting an existing folder.
`EnableAdditionalFileList`	`{false} | true`	Specify whether additional files must be analyzed. You can specify these additional files with the `AdditionalFileList` option
`AdditionalFileList`	`{0x1 cell}`	List additional files to analyze.

Configuration Option	Values	Description
`InputRangeMode`	`{'DesignMinMax'} | 'FullRange'`	Specify whether to use data ranges defined in blocks and workspace or treat inputs as full-range values.
`ParamRangeMode`	`{'None'} | 'DesignMinMax'`	Specify whether to use constant values of parameters specified in the code, or use a range defined in blocks and workspace.
`OutputRangeMode`	`{'None'} | 'DesignMinMax'`	Specify whether to apply assertions to outputs (using a range defined in blocks and workspace).
`VerificationMode`	`{'BugFinder'} | 'CodeProver'`	Specify whether to run a Bug Finder analysis or Code Prover verification.
`AutoStubLUT` *Only for TargetLink*	`{false} | true`	Specify whether to include Lookup Table code in the analysis.

Configuration Option	Values	Description
`ModelRefVerifDepth` *Only for Embedded Coder*	`{'Current model only'} | '1' | '2' | '3' | 'All'`	Specify analysis of generated code with respect to model reference hierarchy levels.
`ModelRefByModelRefVerif` *Only for Embedded Coder*	`{false} | true`	Specify whether to analyze code from models within model reference hierarchies jointly or separately.
`CxxVerificationSettings` *Only for Embedded Coder*	`{'PrjConfig'} | 'PrjConfigAndMisraCxx' | 'PrjConfigAndJSF' | 'MisraCxx' | 'JSF'`	Specify checking of coding rules for C++: **`'PrjConfig'`** – Inherit all options from project configuration and run complete analysis. **`'PrjConfigAndMisraCxx'`** – Inherit all options from project configuration, enable MISRA C++ rule checking, and run complete analysis. **`'PrjConfigAndJSF'`** – Inherit all options from project configuration, enable JSF rule checking, and run complete analysis. **`'MisraCxx'`** – Enable MISRA C++ rule checking, and run compilation phase only.

Configuration Option	Values	Description
		'JSF' – Enable JSF rule checking, and run compilation phase only.

Examples

Use a Simulink model to create and edit an options objects

Load the Simulink model psdemo_model_link_sl:

```
load_system('psdemo_model_link_sl_v2')
```

From the MATLAB command line, create a Polyspace options object from the model:

```
model_opt = pslinkoptions('psdemo_model_link_sl_v2')
```

```
model_opt =

                   ResultDir: 'results_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 0
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
              InputRangeMode: 'DesignMinMax'
              ParamRangeMode: 'None'
             OutputRangeMode: 'None'
            VerificationMode: 'BugFinder'
          ModelRefVerifDepth: 'Current model only'
     ModelRefByModelRefVerif: 0
     CxxVerificationSettings: 'PrjConfig'
```

The model is already configured for Embedded Coder, so only the Embedded Coder configuration options appear.

Change the results folder name option:

```
model_opt.ResultDir = 'results_v1_$ModelName$';

model_opt =

                   ResultDir: 'results_v1_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 0
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
              InputRangeMode: 'DesignMinMax'
              ParamRangeMode: 'None'
             OutputRangeMode: 'None'
            VerificationMode: 'BugFinder'
          ModelRefVerifDepth: 'Current model only'
     ModelRefByModelRefVerif: 0
     CxxVerificationSettings: 'PrjConfig'
```

Set the OpenProjectManager to true, to monitor progress in the Polyspace interface.

```
model_opt.OpenProjectManager = true

model_opt =

                   ResultDir: 'results_v1_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 1
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
              InputRangeMode: 'DesignMinMax'
              ParamRangeMode: 'None'
             OutputRangeMode: 'None'
            VerificationMode: 'BugFinder'
          ModelRefVerifDepth: 'Current model only'
     ModelRefByModelRefVerif: 0
     CxxVerificationSettings: 'PrjConfig'
```

Create and edit an options object for Embedded Coder at the command line

Create a Polyspace options object called `new_opt` with Embedded Coder parameters:

```
new_opt = pslinkoptions('ec')
```

```
new_opt = 

                   ResultDir: 'results_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 0
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
              InputRangeMode: 'DesignMinMax'
              ParamRangeMode: 'None'
             OutputRangeMode: 'None'
            VerificationMode: 'BugFinder'
          ModelRefVerifDepth: 'Current model only'
     ModelRefByModelRefVerif: 0
     CxxVerificationSettings: 'PrjConfig'
```

Set the `OpenProjectManager` option to true to follow the progress in the Polyspace interface:

```
new_opt.OpenProjectManager = true
```

```
new_opt = 

                   ResultDir: 'results_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 1
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
```

```
               InputRangeMode: 'DesignMinMax'
               ParamRangeMode: 'None'
              OutputRangeMode: 'None'
             VerificationMode: 'BugFinder'
           ModelRefVerifDepth: 'Current model only'
      ModelRefByModelRefVerif: 0
      CxxVerificationSettings: 'PrjConfig'
```

Change the configuration to check for both run-time errors and MISRA C coding rule violations:

```
new_opt.VerificationSettings = 'PrjConfigAndMisra'

new_opt =

                    ResultDir: 'results_$ModelName$'
         VerificationSettings: 'PrjConfigAndMisra'
           OpenProjectManager: 1
         AddSuffixToResultDir: 0
     EnableAdditionalFileList: 0
           AdditionalFileList: {0x1 cell}
               InputRangeMode: 'DesignMinMax'
               ParamRangeMode: 'None'
              OutputRangeMode: 'None'
             VerificationMode: 'BugFinder'
           ModelRefVerifDepth: 'Current model only'
      ModelRefByModelRefVerif: 0
      CxxVerificationSettings: 'PrjConfig'
```

See Also

`PolyspaceAnnotation | pslinkrun | PolySpaceViewer`

Concepts

- “MATLAB Functions for Polyspace Batch Runs” on page 16-9

pslinkrun

Purpose

Run Polyspace analysis on generated code from MATLAB command line

Syntax

```
resultsFolder = pslinkrun
resultsFolder = pslinkrun(system)
resultsFolder = pslinkrun(system,opts)
resultsFolder = pslinkrun(system,opts,asModelRef)
```

Description

`resultsFolder = pslinkrun` on generated code from the current system and returns the location of the results folder. It uses the analysis options associated with the current system. The current system, or model, is the system returned by the command `bdroot`.

`resultsFolder = pslinkrun(system)` runs Polyspace on the code generated from the model or subsystem specified by `system`. It uses the analysis options associated with `system`.

`resultsFolder = pslinkrun(system,opts)` analyzes `system` using the analysis options from the options object `opts`.

`resultsFolder = pslinkrun(system,opts,asModelRef)` uses `asModelRef` to specify which type of generated code to analyze, standalone code or model reference code. This option is useful when you want to analyze only a referenced model instead of an entire model hierarchy.

Input Arguments

system - Model or system

`bdroot` (default) | model or system name

Model or system that you want to analyze, specified as a string, with the model or system name in single quotes. The default value is the system returned by `bdroot`.

Example: `resultsFolder = pslinkrun('demo')` where `demo` is the name of a model.

Data Types
`char`

opts - Analysis options

options associated with `system` (default) | Polyspace options object

Analysis options for the analysis, specified as an options object or the options already associated with the model or system. The function `pslinkoptions` creates an options object. You can customize the options object by changing the

Example: `pslinkrun('demo', opts_demo)` where `demo` is the name of a model and `opts_demo` is an options object.

asModelRef - Indicator for model reference analysis

`false` (default) | `true`

Indicator for model reference analysis, specified as true or false.

- If `asModelRef` is false (default), Polyspace analyzes code generated as standalone code. This option is equivalent to choosing **Verify Code Generated For > Model** in the Simulink Polyspace options.
- If `asModelRef` is true, Polyspace analyzes code generated as model referenced code. This option is equivalent to choosing **Verify Code Generated For > Referenced Model** in the Simulink Polyspace options.

Data Types
`logical`

Output Arguments

resultsFolder - Variable for location of the results folder

string

Variable for location of the results folder, specified as a string. The default value of this variable is `results_$ModelName$`. You can change this value in the configuration options using `pslinkoptions`.

Data Types
`char`

Examples

Run Polyspace from the Command Line

Use a Simulink model to generate code, set configuration options, and then run an analysis from the command line.

Create a variable `model` to store the name of the Polyspace example model, `WhereAreTheErrors_v2`:

```
model = 'WhereAreTheErrors_v2';
```

This step is not necessary to use the function, but will make the rest of the example easier.

Load the model:

```
load_system(model);
```

From the MATLAB command line, build the model to generate code:

```
slbuild(model);
```

Create a Polyspace options object from the model:

```
opts = pslinkoptions(model)
```

```
opts = 

                   ResultDir: 'results_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 0
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
              InputRangeMode: 'DesignMinMax'
              ParamRangeMode: 'None'
             OutputRangeMode: 'None'
            VerificationMode: 'CodeProver'
          ModelRefVerifDepth: 'Current model only'
     ModelRefByModelRefVerif: 0
     CxxVerificationSettings: 'PrjConfig'
```

Run Polyspace using your options object:

```
results = pslinkrun(model,opts)
```

The results are saved to the folder `results_WhereAreTheErrors_v2`.

Build and Analyze Referenced Model Code from the Command Line

Use a Simulink model to generate reference code, set configuration options, and then run an analysis from the command line.

Create a variable `model` to store the name of the Polyspace example model, `WhereAreTheErrors_v2`:

```
model = 'WhereAreTheErrors_v2';
```

This step is not necessary to use the function, but will make the rest of the example easier.

Load the model:

```
load_system(model)
```

From the MATLAB command line, build the model to generate code as if it is referenced by another model:

```
slbuild(model,'ModelReferenceRTWTargetOnly')
```

Create a Polyspace options object from the model:

```
opts = pslinkoptions(model)
```

```
opts = 

                   ResultDir: 'results_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 0
     AddSuffixToResultDir: 0
 EnableAdditionalFileList: 0
       AdditionalFileList: {0x1 cell}
           InputRangeMode: 'DesignMinMax'
           ParamRangeMode: 'None'
          OutputRangeMode: 'None'
         VerificationMode: 'CodeProver'
       ModelRefVerifDepth: 'Current model only'
  ModelRefByModelRefVerif: 0
  CxxVerificationSettings: 'PrjConfig'
```

Run Polyspace software:

```
results = pslinkrun(model,opts,true)
```

The results are saved to the folder `results_mr_WhereAreTheErrors_v2`.

See Also

`PolyspaceAnnotation` | `pslinkoptions` | `PolySpaceViewer` | `bdroot`

Concepts

- “MATLAB Functions for Polyspace Batch Runs” on page 16-9

Purpose

Open analysis results in the Polyspace environment

Syntax

```
PolySpaceViewer(system)
```

Description

`PolySpaceViewer(system)` opens the Polyspace results associated with the model or subsystem `system` in the Polyspace environment. If `system` has not been analyzed, Polyspace opens to the Project Manager perspective.

Input Arguments

system - Simulink model

system | subsystem

Simulink model specified by the system or subsystem name.

Example: `PolySpaceViewer(`myModel')`

Examples

Open Results in the Polyspace environment from the Command Line

Use the preconfigured model `WhereAreTheErrors_v2` to run a Polyspace analysis and open the results in the Polyspace environment.

Load the model `WhereAreTheErrors_v2`:

```
load_system('WhereAreTheErrors_v2')
```

Open the Polyspace Viewer:

```
PolySpaceViewer('WhereAreTheErrors_v2')
```

The Polyspace environment opens to the Project Manager page because the model does not yet have Polyspace results.

Build the model to generate C code:

```
slbuild('WhereAreTheErrors_v2');
```

Create a Polyspace options object to set the configuration options:

```
config = pslinkoptions('WhereAreTheErrors_v2')

config =

                   ResultDir: 'results_$ModelName$'
        VerificationSettings: 'PrjConfig'
          OpenProjectManager: 0
        AddSuffixToResultDir: 0
    EnableAdditionalFileList: 0
          AdditionalFileList: {0x1 cell}
              InputRangeMode: 'DesignMinMax'
              ParamRangeMode: 'None'
             OutputRangeMode: 'None'
            VerificationMode: 'CodeProver'
          ModelRefVerifDepth: 'Current model only'
     ModelRefByModelRefVerif: 0
     CxxVerificationSettings: 'PrjConfig'
```

Change the analysis options to also check for MISRA coding rule violations:

```
config.VerificationSettings = 'PrjConfigAndMisra';
```

Run Polyspace on `WhereAreTheErrors_v2` using the configuration options object that you created:

```
pslinkrun('WhereAreTheErrors_v2', config);
```

Open the results in the Polyspace environment:

```
PolySpaceViewer('WhereAreTheErrors_v2');
```

The analysis results of `WhereAreTheErrors_v2` appear in the Polyspace Results Manager.

See Also

`PolyspaceAnnotation` | `pslinkoptions` | `pslinkrun`

Concepts

- “MATLAB Functions for Polyspace Batch Runs” on page 16-9

Using Polyspace Software in the Eclipse IDE

- "Install Polyspace Plug-In for Eclipse" on page 18-2
- "Verify Code in the Eclipse IDE" on page 18-5

Install Polyspace Plug-In for Eclipse

In this section...

"Install Polyspace Plug-In for Eclipse IDE" on page 18-2

"Uninstall Polyspace Plug-In for Eclipse IDE" on page 18-4

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 18-4.

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.

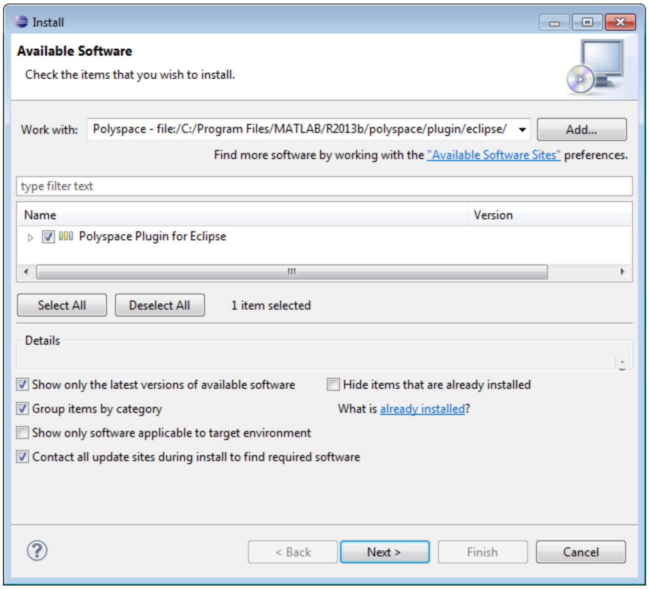
5. Navigate to the *`MATLAB_Install`*`\matlab\polyspace\plugin\eclipse` folder. Then click **OK**.

   `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`.



Available Software

Check the items that you wish to install.

Work with: Polyspace - file:/C:/Program Files/MATLAB/R2013b/polyspace/plugin/eclipse/

Find more software by working with the "Available Software Sites" preferences.

type filter text

Name	Version
☑ Polyspace Plugin for Eclipse	

1 item selected

Details

☑ Show only the latest versions of available software

☐ Hide items that are already installed

☑ Group items by category

What is already installed?

☐ Show only software applicable to target environment

☑ Contact all update sites during install to find required software

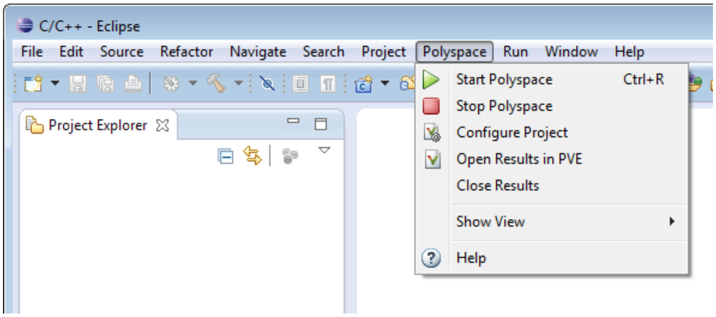
8 Click **Next**.

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 Log** 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 any changes to take effect.

Verify Code in the Eclipse IDE

In this section...

"Code Verification in the Eclipse IDE" on page 18-5

"Create an Eclipse Project" on page 18-5

"Set Up Polyspace Verification with Eclipse Editor" on page 18-6

"Start Verification from Eclipse Editor" on page 18-7

"Review Verification Results from Eclipse Editor" on page 18-7

Code Verification in the Eclipse IDE

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 Set up the Polyspace verification.

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 18-2.

Create an 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.

Set Up Polyspace Verification with Eclipse Editor

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 from Eclipse Editor

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 **Start Polyspace Code Prover**, or select **Polyspace > Start Polyspace**.

   You can see the progress of the verification in the **Polyspace Log** 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** pane.
3. To stop a verification, select **Polyspace > Stop Polyspace**. Alternatively you can use the 🟥 button in the **Polyspace Log** view.

For more information, see "Monitor Progress of Verification" on page 7-17.

Review Verification Results from Eclipse Editor

You can examine results of the verification either in Eclipse or the Polyspace verification environment. After verification is over:

- View the results in Eclipse on the **Results Summary** pane. Select a check to see detailed information on the **Check Details** pane. For more information, see:
  - "Results Summary" on page 9-63
  - "Check Details" on page 9-79
- To open results in the Polyspace verification environment, select **Polyspace > Open Results in PVE**.

Tip Open results in the Polyspace verification environment if you want to save them for later reference. The results in Eclipse are overwritten every time a new verification is performed. However, any **Status**, **Classification** or **Comment** you enter is imported automatically into the new verification.

For information on reviewing and interpreting Polyspace results, see "Run-Time Error Review" .

Using Polyspace Software in Visual Studio

- “Install Polyspace Add-In for Visual Studio” on page 19-2
- “Verify Code in Visual Studio” on page 19-4

Install Polyspace Add-In for Visual Studio

Install Polyspace Add-In for Visual Studio

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 19-3.

To install the Polyspace add-in:

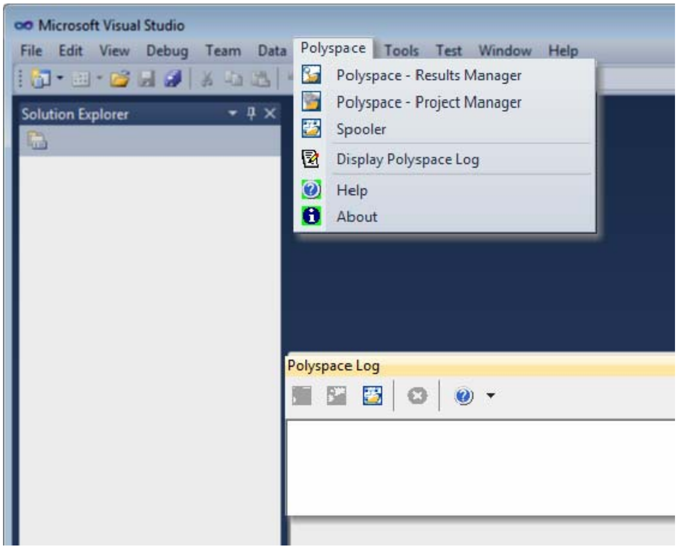
1. In the Visual Studio editor, select **Tools > Options** to open the Options dialog box.
2. Select the **Environment > Add-in/Macros Security** pane to display the list of Visual Studio add-in folders.
3. Select the following check boxes:
   - **Allow macros to run**
   - **Allow Add-in components 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" on page 19-4

"Create Visual Studio Project" on page 19-4

"Set Up and Start Verification in Visual Studio" on page 19-6

"Monitor Verification in Visual Studio" on page 19-14

"Review Verification Results in Visual Studio" on page 19-16

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 19-2.

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** .

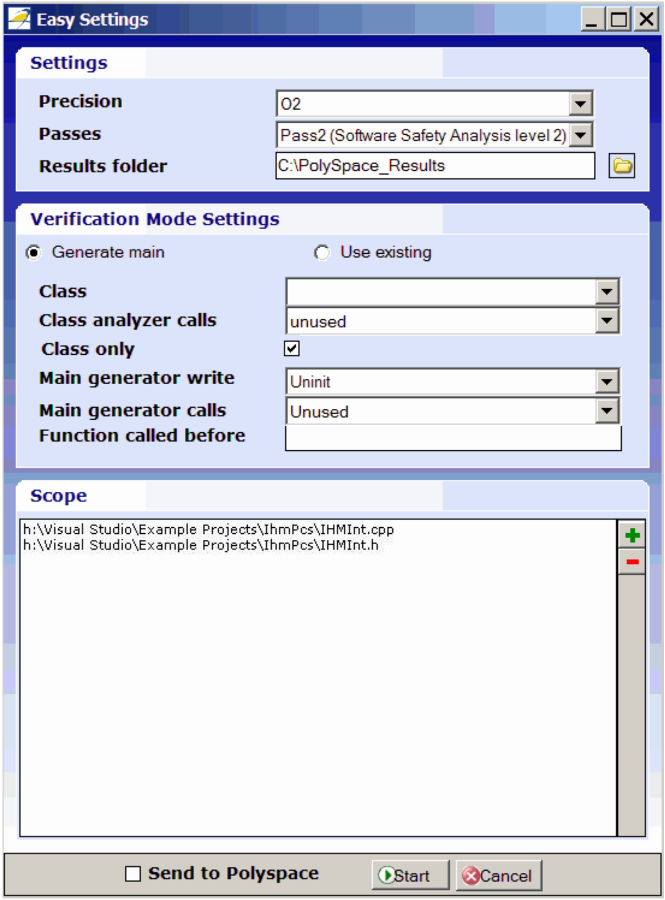
3 Add the files you want to the project (for example, `CppExample`).

Set Up and Start Verification 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.



Precision	O2
Passes	Pass2 (Software Safety Analysis level 2)
Results folder	C:\PolySpace_Results

● Generate main ○ Use existing

Class	
Class analyzer calls	unused
Class only	☑
Main generator write	Uninit
Main generator calls	Unused
Function called before	

```
h:\Visual Studio\Example Projects\IhmPcs\IHMInt.cpp
h:\Visual Studio\Example Projects\IhmPcs\IHMInt.h
```

□ Send to Polyspace

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 19-11.

4 Click **Start** to start the verification.

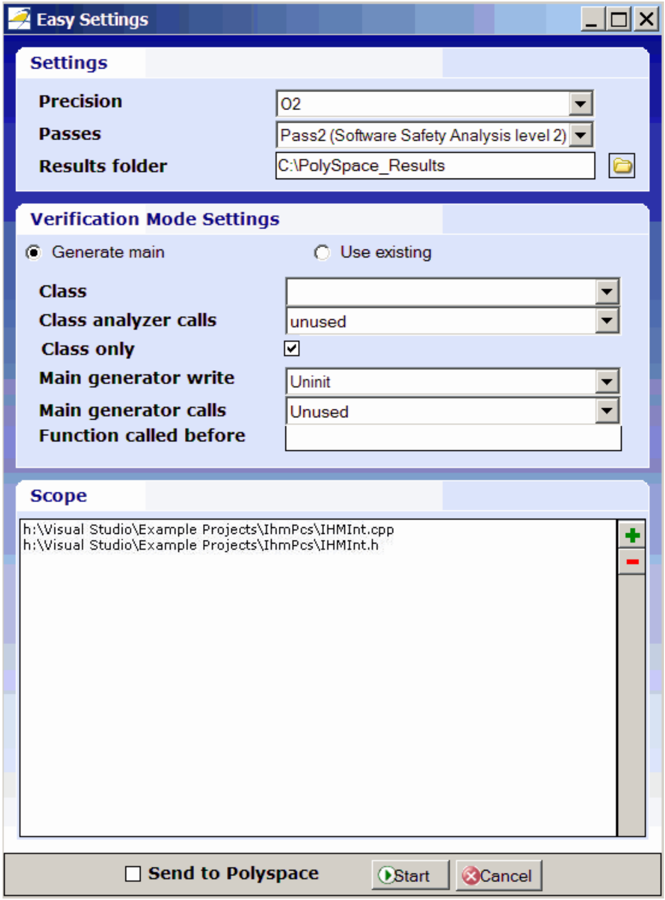
Verify Classes

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.



Easy Settings

Settings

Precision: O2

Passes: Pass2 (Software Safety Analysis level 2)

Results folder: C:\PolySpace_Results

Verification Mode Settings

● Generate main ○ Use existing

Class:

Class analyzer calls: unused

Class only: ☑

Main generator write: Uninit

Main generator calls: Unused

Function called before:

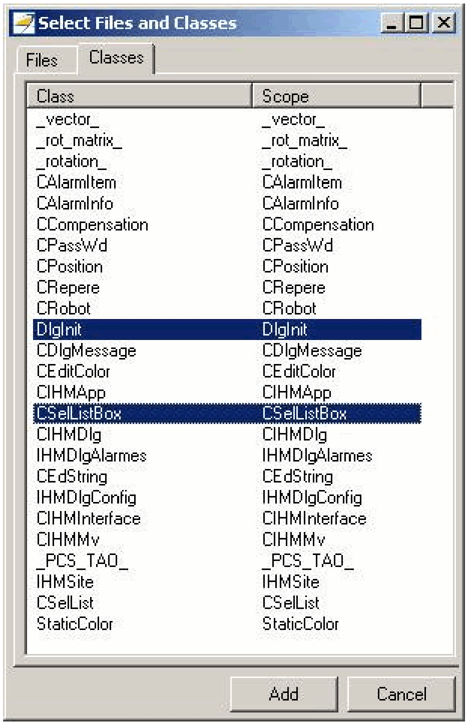
Scope

```
h:\Visual Studio\Example Projects\IhmPcs\IHMInt.cpp
h:\Visual Studio\Example Projects\IhmPcs\IHMInt.h
```

□ Send to Polyspace

2 In the Scope window, click ✚.

The Select Files and Classes dialog box opens.



Class	Scope
vector	_vector_
_rot_matrix_	_rot_matrix_
rotation	_rotation_
CAlarmItem	CAlarmItem
CAlarmInfo	CAlarmInfo
CCompensation	CCompensation
CPassWd	CPassWd
CPosition	CPosition
CRepere	CRepere
CRobot	CRobot
DlgInit	DlgInit
CDlgMessage	CDlgMessage
CEditColor	CEditColor
CIHMApp	CIHMApp
CSelListBox	CSelListBox
CIHMDlg	CIHMDlg
IHMDlgAlarmes	IHMDlgAlarmes
CEdString	CEdString
IHMDlgConfig	IHMDlgConfig
CIHMInterface	CIHMInterface
CIHMMv	CIHMMv
_PCS_TAO_	_PCS_TAO_
IHMSite	IHMSite
CSelList	CSelList
StaticColor	StaticColor

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:

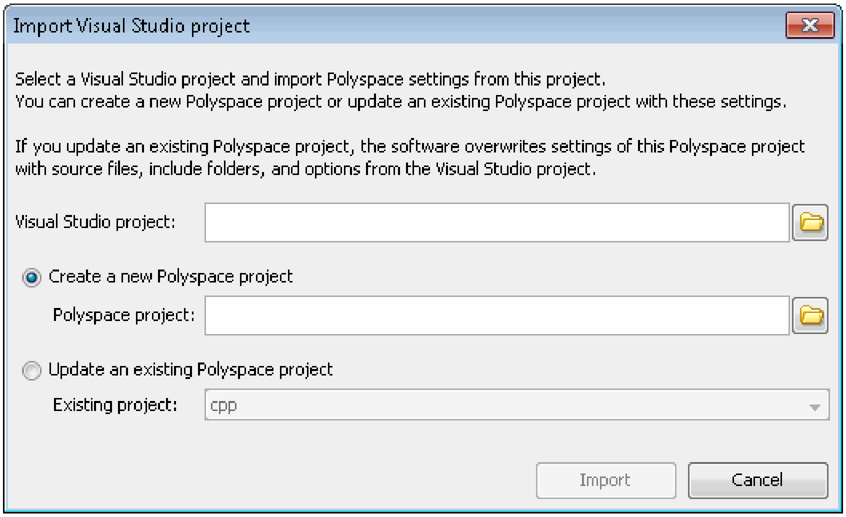
- Source files
- Include folders
- Preprocessing directives (`-D`, `-U`)
- Polyspace specific options about dialect used

Note This feature supports Visual Studio versions 2003, 2005, and 2008.

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.



Import Visual Studio project

Select a Visual Studio project and import Polyspace settings from this project.
You can create a new Polyspace project or update an existing Polyspace project with these settings.

If you update an existing Polyspace project, the software overwrites settings of this Polyspace project with source files, include folders, and options from the Visual Studio project.

Visual Studio project:

● Create a new Polyspace project

Polyspace project:

○ Update an existing Polyspace project

Existing project: cpp

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:

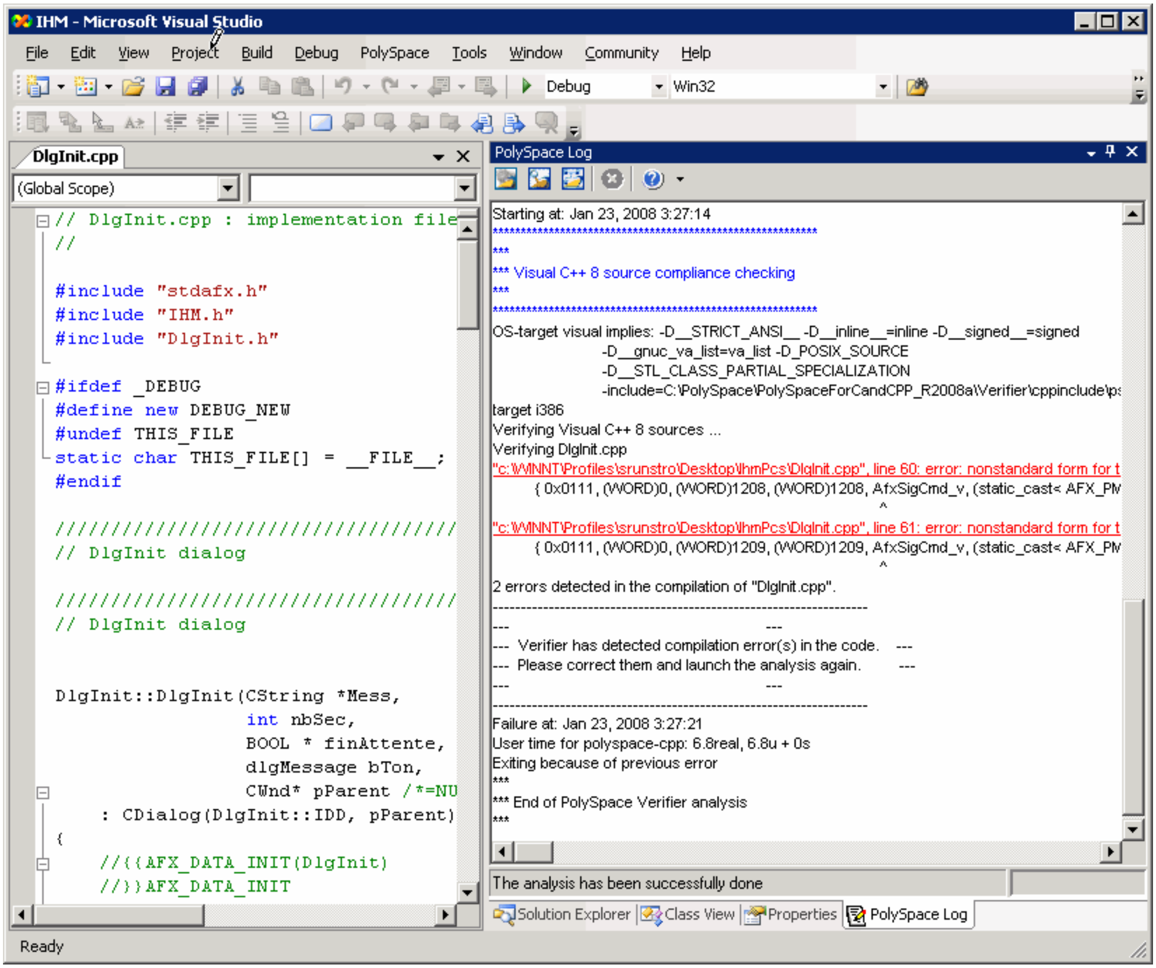
Visual Studio Option	Polyspace Option
`/D <name>`	`-D` *`<name>`*
`/U <name>`	`-U` *`<name>`*
`/MT`	`-D_MT`
`/MTd`	`-D_MT -D_DEBUG`
`/MD`	`-D_MT -D_DLL`
`/MDd`	`-D_MT -D_DLL -D_DEBUG`
`/MLd`	`-D_DEBUG`
`/Zc:wchar_t`	`-wchar-t-is keyword`
`/Zc:forScope`	`-for-loop-index-scope in`
`/FX`	`-support-FX-option-results`
`/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.


IHM - Microsoft Visual Studio
File Edit View Project Build Debug PolySpace Tools Window Community Help
Debug
Win32
DlgInit.cpp
(Global Scope)
PolySpace Log

```
// DlgInit.cpp : implementation file
//

#include "stdafx.h"
#include "IHM.h"
#include "DlgInit.h"

#ifdef _DEBUG
#define new DEBUG_NEW
#undef THIS_FILE
static char THIS_FILE[] = __FILE__;
#endif

/////////////////////////////////////
// DlgInit dialog

/////////////////////////////////////
// DlgInit dialog


DlgInit::DlgInit(CString *Mess,
                 int nbSec,
                 BOOL * finAttente,
                 dlgMessage bTon,
                 CWnd* pParent /*=NU
    : CDialog(DlgInit::IDD, pParent)
{
    //{{AFX_DATA_INIT(DlgInit)
    //}}AFX_DATA_INIT
```

```
Starting at: Jan 23, 2008 3:27:14
************************************************************
***
*** Visual C++ 8 source compliance checking
***
************************************************************
OS-target visual implies: -D__STRICT_ANSI__ -D__inline__=inline -D__signed__=signed
                          -D__gnuc_va_list=va_list -D_POSIX_SOURCE
                          -D__STL_CLASS_PARTIAL_SPECIALIZATION
                          -include=C:\PolySpace\PolySpaceForCandCPP_R2008a\Verifier\cppinclude\p
target i386
Verifying Visual C++ 8 sources ...
Verifying DlgInit.cpp
"c:\WINNT\Profiles\srunstro\Desktop\IhmPcs\DlgInit.cpp", line 60: error: nonstandard form for t
          { 0x0111, (WORD)0, (WORD)1208, (WORD)1208, AfxSigCmd_v, (static_cast< AFX_PM
                                                             ^
"c:\WINNT\Profiles\srunstro\Desktop\IhmPcs\DlgInit.cpp", line 61: error: nonstandard form for t
          { 0x0111, (WORD)0, (WORD)1209, (WORD)1209, AfxSigCmd_v, (static_cast< AFX_PM
                                                             ^
2 errors detected in the compilation of "DlgInit.cpp".
------------------------------------------------------------
---                                              ---
---  Verifier has detected compilation error(s) in the code.   ---
---  Please correct them and launch the analysis again.        ---
---                                              ---
------------------------------------------------------------
Failure at: Jan 23, 2008 3:27:21
User time for polyspace-cpp: 6.8real, 6.8u + 0s
Exiting because of previous error
***
*** End of PolySpace Verifier analysis
***
```

The analysis has been successfully done

If the verification is being carried out on a server, use the Polyspace Spooler to follow the verification progress. Select **Polyspace > Spooler**, which opens the Polyspace Queue Manager 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 > Spooler** and in the Polyspace Queue Manager Interface dialog box, stop the verification.

For more information on the Polyspace Spooler, see “Manage Previous Verifications With Polyspace Metrics” on page 7-13.

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 none are.

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.

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