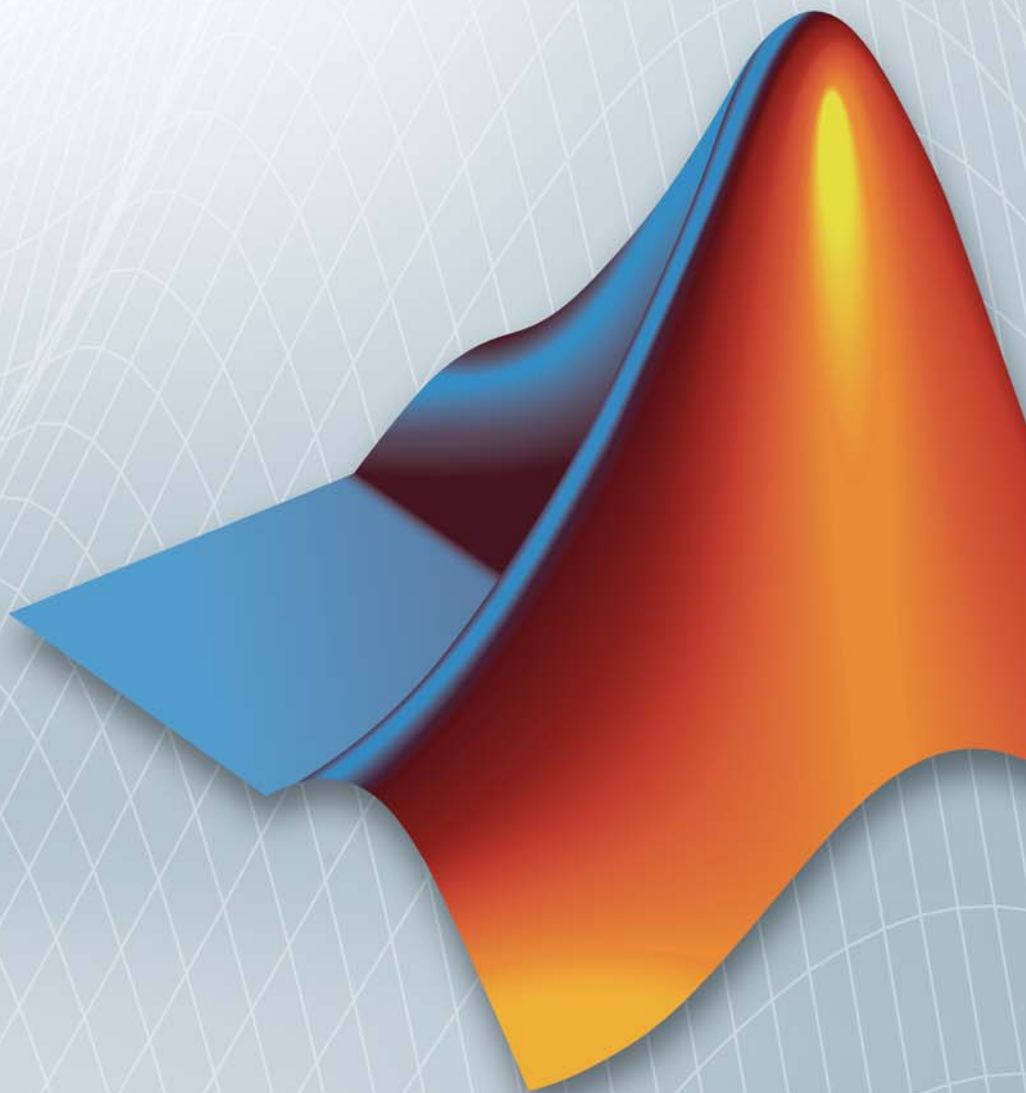


Polyspace[®] Products for C 8

Reference



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Polyspace® Products for C Reference

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Option Descriptions

1

| | |
|--|-------------|
| Polyspace Analysis Options Overview | 1-2 |
| General Options | 1-3 |
| General Options Overview | 1-3 |
| Send to Polyspace Server (-server) | 1-4 |
| Add to results repository (-add-to-results-repository) | 1-5 |
| Keep all preliminary results files (-keep-all-files) | 1-5 |
| Calculate code metrics (-code-metrics) | 1-6 |
| Report Generation | 1-7 |
| Report template name (-report-template) | 1-7 |
| Output format (-report-output-format) | 1-8 |
| Report name (-report-output-name) | 1-9 |
| Target/Compiler Options | 1-10 |
| Overview | 1-10 |
| Target processor type (-target) | 1-11 |
| Generic Target Options | 1-12 |
| Target Operating System (-OS-target) | 1-18 |
| Defined Preprocessor Macros (-D) | 1-19 |
| Undefined Preprocessor Macros (-U) | 1-20 |
| Include (-include) | 1-20 |
| Command/script to apply to preprocessed files (-post-preprocessing-command) | 1-21 |
| Command/script to apply after the end of the code verification (-post-analysis-command) | 1-22 |
| Compliance with Standards Options | 1-24 |
| Code from DOS or Windows filesystem (-dos) | 1-25 |
| Ignore assembly code (-discard-asm) | 1-26 |
| Handle #pragma asm/endasm directives (-asm-begin/-asm-end) | 1-26 |
| Strict (-strict) | 1-27 |
| Give all warnings (-wall) | 1-28 |

| | |
|---|-------------|
| Permissive (-permissive) | 1-28 |
| Allow non int types for bitfields | |
| (-allow-non-int-bitfield) | 1-29 |
| Accept integral type conflicts (-permissive-link) | 1-29 |
| Allow undefined global variables | |
| (-allow-undef-variables) | 1-30 |
| Ignore overflowing computations on constants | |
| (-ignore-constant-overflows) | 1-30 |
| Allow anonymous unions/structure fields | |
| (-allow-unnamed-fields) | 1-31 |
| Allow negative operand for left shifts | |
| (-allow-negative-operand-in-shift) | 1-31 |
| Allow language extensions | |
| (-allow-language-extensions) | 1-32 |
| Igore missing header files (-ignore-missing-headers) .. | 1-33 |
| Check MISRA-C rules | 1-34 |
| MISRA C rules configuration (-misra2) | 1-34 |
| Files and folders to ignore (-includes-to-ignore) | 1-35 |
| Keil/IAR support (-dialect) | 1-36 |
| Sfr type support (-sfr-types) | 1-36 |
| | |
| Polyspace Inner Settings Options | 1-38 |
| Run a verification unit by unit (-unit-by-unit) | 1-40 |
| Unit by Unit common source files | |
| (-unit-by-unit-common-source) | 1-40 |
| Main Generator Behavior for Polyspace Software | 1-41 |
| Generate a main (-main-generator) | 1-42 |
| Variables written before loop | |
| (-variables-written-before-loop) | 1-43 |
| Variables written in loop | |
| (-variables-written-in-loop) | 1-43 |
| Functions called before loop | |
| (-function-called-before-loop) | 1-44 |
| Functions called in loop (-functions-called-in-loop) .. | 1-44 |
| Functions called after loop | |
| (-function-called-after-loop) | 1-45 |
| Variable/function range setup | |
| (-data-range-specifications) | 1-46 |
| Stub all functions (-permissive-stubber) | 1-47 |
| No automatic stubbing (-no-automatic-stubbing) | 1-47 |
| Division round down (-div-round-down) | 1-48 |
| Do not consider all global variables to be initialized | |
| (-no-def-init-glob) | 1-49 |

| | |
|---|-------------|
| Enable pointer arithmetic out of bounds of fields (-allow-ptr-arith-on-struct) | 1-49 |
| Allows incomplete or partial allocation of structures (-size-in-bytes) | 1-51 |
| Ignore float rounding (-ignore-float-rounding) | 1-52 |
| Detect overflows on (-scalar-overflows-checks) | 1-54 |
| Overflows computation mode (-scalar-overflows-behavior) | 1-56 |
| Enum type definition (-enum-type-definition) | 1-56 |
| Functions known to cause NTC (-known-NTC) | 1-57 |
| Continue with compile error (-continue-with-compile-error) | 1-57 |
| Verification time limit (-timeout) | 1-58 |
| Automatic Orange Tester (-prepare-automatic-tests) | 1-58 |
| Run verification in 32 or 64-bit mode (-machine-architecture) | 1-59 |
| Number of processes for multiple CPU core systems (-max-processes) | 1-60 |
| Other Options | 1-60 |
| | |
| Precision/Scaling Options | 1-63 |
| Precision Level (-0) | 1-64 |
| Specific Precision (-modules-precision) | 1-65 |
| Launch code verification from beginning of (-from) | 1-66 |
| To end of (-to) | 1-67 |
| Sensitivity context (-context-sensitivity) | 1-68 |
| Automatic selection for sensitivity context (-context-sensitivity-auto) | 1-68 |
| Improve precision of interprocedural analysis (-path-sensitivity-delta) | 1-68 |
| Retype variables of pointer types (-retype-pointer) | 1-69 |
| Retype symbols of integer types (-retype-int-pointer) .. | 1-70 |
| Depth of analysis inside structures (-k-limiting) | 1-72 |
| Inline (-inline) | 1-72 |
| Optimize huge static initializers (-no-fold) | 1-73 |
| Respect types in fields (-respect-types-in-fields) | 1-73 |
| Respect types in global variables (-respect-types-in-globals) | 1-74 |
| Reduce task complexity (-lightweight-thread-model) .. | 1-75 |
| Less range information (-less-range-information) | 1-75 |
| No pointer information (-no-pointer-information) | 1-76 |

| | |
|--|-------------|
| Multitasking Options (Polyspace® Server for C/C++ Verifications Only) | 1-78 |
| Entry point for Interrruption (-entry-points) | 1-78 |
| Critical section details | |
| (-critical-section-begin/end) | 1-79 |
| Temporal exclusion point | |
| (-temporal-exclusions-file) | 1-79 |
| | |
| Batch Options | 1-81 |
| -server | 1-81 |
| -sources-list-file | 1-82 |
| -v -version | 1-82 |
| -h[elp] | 1-83 |
| -prog | 1-83 |
| -date | 1-83 |
| -author | 1-84 |
| -verif-version | 1-85 |
| -results-dir | 1-85 |
| -sources | 1-86 |
| -I | 1-87 |
| | |
| Deprecated Options | 1-89 |
| -continue-with-red-error (Deprecated) | 1-89 |
| -continue-with-existing-host (Deprecated) | 1-89 |
| -allow-unsupported-linux (Deprecated) | 1-90 |
| -quick (Deprecated) | 1-90 |

Check Descriptions

2

| | |
|--|------------|
| Colored Source Code for C | 2-2 |
| Illegal Pointer Access to Variable or Structure Field: | |
| IDP | 2-3 |
| Array Conversion Must Not Extend Range: COR | 2-4 |
| Array Index Within Bounds: OBAI | 2-5 |
| Initialized Return Value: IRV | 2-6 |
| Non-Initialized Variables: NIV/NIVL | 2-7 |
| Non-Initialized Pointer: NIP | 2-8 |
| POW (Deprecated) | 2-8 |
| User Assertion: ASRT | 2-8 |

| | |
|--|------|
| Scalar and Float Overflows: OVFL | 2-10 |
| Scalar and Float Underflows: UNFL (Deprecated) | 2-14 |
| Float Underflows and Overflows: UOVFL (Deprecated) .. | 2-14 |
| Scalar or Float Division by Zero: ZDV | 2-14 |
| Shift Amount in 0..31 (0..63):SHF | 2-15 |
| Left Operand of Left Shift is Negative: SHF | 2-16 |
| Function Pointer Must Point to a Valid Function: COR ... | 2-16 |
| Wrong Type for Argument: COR | 2-18 |
| Wrong Number of Arguments: COR | 2-19 |
| Wrong Return Type of a Function Pointer: COR | 2-20 |
| Wrong Return Type for Arithmetic Functions: COR | 2-20 |
| Pointer Within Bounds: IDP | 2-21 |
| Non Termination of Call or Loop | 2-34 |
| Unreachable Code: UNR | 2-45 |
| Inspection Points | 2-47 |

Approximations Used During Verification

3

| | |
|--|-----|
| Why Polyspace Verification Uses Approximations | 3-2 |
| What is Static Verification | 3-2 |
| Exhaustiveness | 3-3 |
| Approximations Made by Polyspace Verification | 3-4 |
| Volatile Variables | 3-4 |
| Structures with Volatile Fields | 3-4 |
| Absolute Addresses | 3-5 |
| Pointer Comparison | 3-5 |
| Shared Variables | 3-5 |
| Trigonometric Functions | 3-6 |
| Unions | 3-6 |
| Constant Pointer | 3-7 |

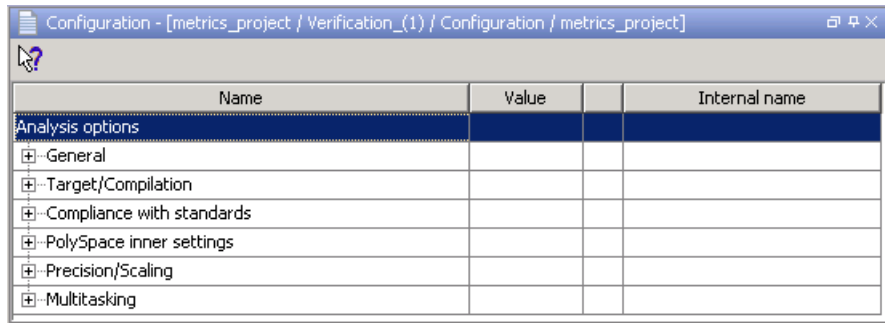
| | |
|--------------------------------|-----|
| Complete Examples | 4-2 |
| Simple C Example | 4-2 |
| Apache Example | 4-2 |
| cxref Example | 4-3 |
| T31 Example | 4-3 |
| Dishwasher1 Example | 4-3 |
| Satellite Example | 4-4 |

Option Descriptions

- “Polyspace Analysis Options Overview” on page 1-2
- “General Options” on page 1-3
- “Target/Compiler Options” on page 1-10
- “Compliance with Standards Options” on page 1-24
- “Polyspace Inner Settings Options” on page 1-38
- “Precision/Scaling Options” on page 1-63
- “Multitasking Options (Polyspace® Server for C/C++ Verifications Only)” on page 1-78
- “Batch Options” on page 1-81
- “Deprecated Options” on page 1-89

Polyspace Analysis Options Overview

The analysis options in the upper-right section of the Launcher window include identification information and parameters that Polyspace® software uses during the verification process.



Polyspace software groups the analysis options into various categories. To display the parameters for a specific category, expand the category on the left side of the dialog box.

Note Each of the parameters in the **Analysis options** window can also be set from the command line using the `polyspace -c` command. Each parameter description includes the corresponding command line information.

General Options

| Name | Value | Internal name |
|------------------------------------|-------------------------------------|----------------------------|
| Analysis options | | |
| [-] General | | |
| Send to Polyspace Server | <input checked="" type="checkbox"/> | -server |
| Add to results repository | <input type="checkbox"/> | -add-to-results-repository |
| Keep all preliminary results files | <input type="checkbox"/> | -keep-all-files |
| Calculate code metrics | <input type="checkbox"/> | -code-metrics |
| [-] Report Generation | <input type="checkbox"/> | |
| Report template name | Developer ▾ | -report-template |
| Output format | RTF ▾ | -report-output-format |

In this section...

“General Options Overview” on page 1-3

“Send to Polyspace Server (-server)” on page 1-4

“Add to results repository (-add-to-results-repository)” on page 1-5

“Keep all preliminary results files (-keep-all-files)” on page 1-5

“Calculate code metrics (-code-metrics)” on page 1-6

“Report Generation” on page 1-7

“Report template name (-report-template)” on page 1-7

“Output format (-report-output-format)” on page 1-8

“Report name (-report-output-name)” on page 1-9

General Options Overview

This General section contains options relating to where the verification is run and what data is generated during verification. This includes whether to run verification on a server or client, and whether to generate reports and code metrics.

Send to Polyspace Server (-server)

Specify whether verification runs on the server or client system.

Settings

Default: On

- On
Run verification on the Polyspace server. The server to use is specified in the Polyspace preferences.
- Off
Run verification on the client system.

Tips

- Specifying this option in the GUI sends the verification to the default server.
- You specify the default server in the **Server Configuration** tab of the Polyspace preferences dialog box (**Options > Preferences**).
- When specifying the `-server` option at the command line, you can specify the name or IP address of a specific server, along with the appropriate port number.
- If you do not specify a server, the default server referenced in the preferences file is used.
- If you do not specify a port number, port 12427 is used by default.

Command-Line Information

Parameter: `-server`

Value: *name or IP address:port number*

Example: `polyspace-remote-c server 192.168.1.124:12400`

Add to results repository (-add-to-results-repository)

Specify whether verification results are added to the Polyspace Metrics results database, allowing Web-based reporting of results and code metrics.

Settings

Default: Off



On

Verification results are stored in the Polyspace Metrics results database. This allows you to use the Polyspace Metrics Web interface to view verification results and code metrics.



Off

Verification results are not added to the database.

Dependency

- This option is available only for server verifications.

Command-Line Information

Parameter: `-add-to-results-repository`

Example: `polyspace-c -server -add-to-results-repository`

Keep all preliminary results files (-keep-all-files)

Specify whether to retain all intermediate results and associated working files.

Settings

Default: Off



On

Retain all intermediate results and associated working files. You can restart a verification from the end of any complete pass if the source code remains unchanged.



Off

Erase all intermediate results and associated working files. If you want to restart a verification, do so from the beginning.

Tips

- When you select this option you can restart Polyspace verification from the end of any complete pass (provided the source code remains entirely unchanged). If this option is not used, you must restart the verification from scratch.
- This option is applicable only to client verifications. Intermediate results are always removed before results are downloaded from the Polyspace server.
- To cleanup intermediate files at a later time, you can select **Tools > Clean Results** in the Launcher. This option deletes the preliminary result files from the results folder.

Command-Line Information

Parameter: -keep-all-files

Example: polyspace-c -keep-all-files

Calculate code metrics (-code-metrics)

Specify whether to calculate software quality metrics, such as cyclomatic number, during verification.

Settings

Default: On



On

Calculate software quality metrics, including project metrics, file metrics, and function metrics.



Off

Do not calculate software quality metrics.

Tips

- You can view software quality metrics data in the Polyspace Metrics Web interface, or by running a Software Quality Objectives report from the Polyspace verification environment.
- Project metrics include number of recursions, number of include headers, and number of files.
- File metrics include comment density, and number of lines.
- Function metrics include cyclomatic number, number of static paths, number of calls, and Language scope.

Command-Line Information

Parameter: `-code-metrics`

Example: `polyspace-c -code-metrics`

Report Generation

Specify whether to create verification report using report generation options

Settings

Default: Off

On
Create report.

Off
No report created.

Report template name (-report-template)

Specify report template for generating verification report.

Settings

Default:

C:\Polyspace\Polyspace_Common\ReportGenerator\templates\Developer.rpt

- Report generated at the end of the verification process, before execution of any post-analysis-command.

Command-Line Information

Parameter: report-template

Type: string

Value: any valid script file name

Example: polyspace-c -report-template
c:/polyspace/my_template

Output format (-report-output-format)

Specify output format of report

Settings

Default: RTF

RTF

Generate an .rtf format report.

HTML

Generate an .html format report.

PDF

Generate a .pdf format report.

Word

Generate a .doc format report.

Word is not available on UNIX® platforms. RTF is used instead.

XML

Generate and .xml format report.

Note 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.

Command-Line Information

Parameter: report-output-format

Type: string

Value: RTF | HTML | PDF | Word | XML

Default: RTF

Shell script example:

```
polyspace-c -report-template my_template report-output-format pdf
```

Report name (-report-output-name)

Specify name of verification report file

Settings

Default: *Prog_TemplateName.Format* where:

- *Prog* is the argument of the prog option
- *TemplateName* is the name of the report template specified by the report-template option
- *Format* is the file extension for the format specified by the report-output-format option.

Command-Line Information

Parameter: report-output-name

Type: string

Value: any valid value

Default: *Prog_TemplateName.Format*

Shell script example:

```
polyspace-c -report-template my_template report-output-name Airbag_V3.rtf
```

Target/Compiler Options

| Name | Value | Internal name |
|--|------------|-----------------------------|
| Analysis options | | |
| + General | | |
| - Target/Compilation | | |
| Target processor type | i386 ▼ ... | -target |
| Target operating system | Linux ▼ | -OS-target |
| Defined Preprocessor Macros | ... | -D |
| Undefined Preprocessor Macros | ... | -U |
| Include | ... | -include |
| Command/script to apply to preprocessed files | ... | -post-preprocessing-command |
| Command/script to apply after the end of the code verification | ... | -post-analysis-command |

In this section...

“Overview” on page 1-10

“Target processor type (-target)” on page 1-11

“Generic Target Options” on page 1-12

“Target Operating System (-OS-target)” on page 1-18

“Defined Preprocessor Macros (-D)” on page 1-19

“Undefined Preprocessor Macros (-U)” on page 1-20

“Include (-include)” on page 1-20

“Command/script to apply to preprocessed files
(-post-preprocessing-command)” on page 1-21

“Command/script to apply after the end of the code verification
(-post-analysis-command)” on page 1-22

Overview

This section allows details of the target processor and operating system to be specified. Header files should not be entered here; instead, include directories should be added using the relevant field under the Compile flag options.

Target processor type (-target)

This option specifies the target processor type, and in doing so informs the verification of the size of fundamental data types and of the endianness of the target machine.

Possible values are:

- i386 (default)
- sparc
- m68k
- powerpc
- c-167
- tms320c3x
- sharc21x61
- necv850
- hc08
- hc12
- mpc5xx
- c18
- x86_64
- mcpu... (Advanced)

mcpu is a reconfigurable Micro Controller/Processor Unit target. You can use this type to configure one or more generic targets.

You can analyze code intended for an unlisted processor type using one of the other processor types, they share common data properties.

For information on specifying a generic target, or modifying the mcpu target, see “Generic Target Options” on page 1-12.

Default:

i386

Example shell script entry:

```
polyspace-c -target m68k ...
```

Generic Target Options

The *Generic target options* dialog box is only available when you select a *mcpu* target.

Allows the specification of a generic "*Micro Controller/Processor Unit*" or *mcpu* target name. Initially, it is necessary to use the GUI to specify the name of a new *mcputarget* – say, "MyTarget".

That new target is added to the *-target* options list. The new target's default characteristics are as follows, using the *type [size, alignment]* format.

- *char [8, 8, char [16,16]]*
- *short [8,8], short [16, 16]*
- *int [16, 16]*
- *long [32, 32], long long [32, 32]*
- *float [32, 32], double [32, 32], long double [32, 32]*
- *pointer [16, 16]*
- *char is signed*
- *little-endian*

When using the command line, *MyTarget* is specified with all the options for modification:

```
polyspace-c -target MyTarget
```

For example, a specific target uses 8 bit alignment (see also *-align*), for which the command line would read:

```
polyspace-c -target mcpu -align 8
```

-little-endian

This option is only available when a *-mcpu* generic target has been chosen.

The endianness defines the byte order within a word (and the word order within a long integer). Little-endian architectures are Less Significant byte First (LSF), for example: i386.

For a little endian target, the less significant byte of a short integer (for example 0x00FF) is stored at the first byte (0xFF) and the most significant byte (0x00) at the second byte.

Example shell script entry:

```
polyspace-c -target mcpu -little-endian
```

-big-endian

This option is only available when a *-mcpu* generic target has been chosen.

The endianness defines the byte order within a word (and the word order within a long integer). Big-endian architectures are Most Significant byte First (MSF), for example: SPARC, m68k.

For a big endian target, the most significant byte of a short integer (for example 0x00FF) is stored at the first byte (0x00) and the less significant byte (0xFF) at the second byte.

Example shell script entry:

```
polyspace-c -target mcpu -big-endian
```

-default-sign-of-char [signed|unsigned]

This option is available for all targets. It allows a char to be defined as "signed", "unsigned", or left to assume the *mcpu* target's default behavior

- **default mode** – The sign of char is left to assume the target's default behavior. By default all targets are considered as signed except for *hc08* and *powerpc* targets.

- **signed** – Disregards the target's default char definition, and specifies that a "signed char" should be used.
- **unsigned** – Disregards the target's default char definition, and specifies that a "unsigned char" should be used.

Example Shell Script Entry

```
polyspace-c -default-sign-of-char unsigned -target mcpu ...
```

-char-is-16bits

This option is only available when a *-mcpu* generic target has been chosen.

The default configuration of a generic target defines a char as 8 bits. This option changes it to 16 bits, regardless of sign.

the minimum alignment of objects is also set to 16 bits and so, incompatible with the options *-short-is-8bits* and *-align 8*.

Setting the char type to 16 bits has consequences on the following:

- computation of size of for objects
- detection of underflow and overflow on chars

Without the option char for *mcpu* are 8 bits

Example shell script entry:

```
polyspace-c -target mcpu -char-is-16bits
```

-short-is-8bits

This option is only available when a *mcpu* generic target has been chosen.

The default configuration of a generic target defines a short as 16 bits. This option changes it to 8 bits, regardless of sign.

It sets a short type as 8-bit without specific alignment. That has consequences for the following:

- computation of size of objects referencing short type
- detection of short underflow/overflow

Example shell script entry

```
polyspace-c -target mcpu -short-is-8bits
```

-int-is-32bits

This option is available with a *mcpu* generic target, hc08, hc12 and mpc5xx target has been chosen.

The default configuration of a generic target defines an int as 16 bits. This option changes it to 32 bits, regardless of sign. Its alignment, when an int is used as struct member or array component, is also set to 32 bits. See also -align option.

Example shell script entry

```
polyspace-c -target mcpu -int-is-32bits
```

-long-long-is-64bits

This option is only available when a *mcpu* generic target has been chosen.

The default configuration of a generic target defines a long long as 32 bits. This option changes it to 64 bits, regardless of sign. When a long long is used as struct member or array component, its alignment is also set to 64 bits. See also -align option.

Example shell script entry

```
polyspace-c -target mcpu -long-long-is-64bits
```

-double-is-64bits

The default configuration of a generic target defines a double as 32 bits. This option, changes both double and *long double* to 64 bits. When a double or long double is used as a struct member or array component, its alignment is set to 4 bytes.

See also `-align` option.

Defining the double type as a 64 bit double precision float impacts the following:

- Computation of `sizeof` objects referencing double type
- Detection of floating point underflow/overflow

This option is available for the following targets:

- *mcpu* generic target
- *sharc21x61*
- *hc08*
- *hc12*
- *mpc5xx*

Example

```
int main(void)
{
    struct S {char x; double f;};
    double x;
    unsigned s1, s2;
    s1 = sizeof (double);
    s2 = sizeof(struct S);
    x = 3.402823466E+38; /* IEEE 32 bits float point maximum value */
    x = x * 2;
    return 0;
}
```

Using the default configuration of *sharc21x62*, Polyspace verification assumes that a value of 1 is assigned to *s1*, 2 is assigned to *s2*, and there is a consequential float overflow in the multiplication `x * 2`. Using the `-double-is-64bits` option, a value of 2 is assigned to *s1*, and no overflow occurs in the multiplication (because the result is in the range of the 64-bit floating point type)

Example shell script entry


```
polyspace-c -target mcpu -double-is-64bits
```

-pointer-is-32bits

This option is only available when a *mcpu* generic target has been chosen.

The default configuration of a generic target defines a pointer as 16 bits. This option changes it to 32 bits. When a pointer is used as struct member or array component, its alignment is also set also to 32 bits (see `-align` option).

Example shell script entry

```
polyspace-c -target mcpu -pointer-is-32bits
```

-align [8|16|32]

This option is available with a *mcpu* generic target and some other specific targets (with `hc08`, `hc12` or `mpc5xx` available values are 16 and 32). It is used to set the largest alignment of all data objects to 4/2/1 byte(s), meaning a 32, 16 or 8 bit boundary respectively.

-align 32 (Default). The default alignment of a generic target is 32 bits. This means that when objects with a size of more than 4 bytes are used as struct members or array components, they are aligned at 4 byte boundaries.

Example shell script entry with a 32 bits default alignment

```
polyspace-c -target mcpu
```

-align 16. If the `-align 16` option is used, when objects with a size of more than 2 bytes are used as struct members or array components, they are aligned at 2 bytes boundaries.

Example shell script entry with a 16 bits specific alignment:

```
polyspace-c -target mcpu -align 16
```

-align 8. If the `-align 8` option is used, when objects with a size of more than 1 byte are used as struct members or array components, are aligned at 1 byte boundaries. Consequently the storage assigned to the arrays and structures is strictly determined by the size of the individual data objects without member and end padding.

Example shell script entry with a 8 bits specific alignment:

```
polyspace-c -target mcpu -align 8
```

-logical-signed-right-shift

In the Graphical User Interface, the user can choose between arithmetical and logical computation.

- **- Arithmetic:** the sign bit remains:

```
(-4) >> 1 = -2  
(-7) >> 1 = -4  
7 >> 1 = 3
```

- **- Logical:** 0 replaces the sign bit

```
(-4) >> 1 = (-4U) >> 1 = 2147483646  
(-7) >> 1 = (-7U) >> 1 = 2147483644  
7 >> 1 = 3
```

Example shell script entry

When using the command line, arithmetic is the default computation mode. When this option is set, logical computation will be performed.

```
polyspace-c -logical-signed-right-shift
```

Target Operating System (-OS-target)

This option specifies the operating system target for your application.

Possible values are

- Linux

- Solaris
- VxWorks
- Visual
- no-predefined-OS

This information allows the appropriate system definitions to be used during preprocessing in order to analyze the included files properly.

You can use the target `no-predefined-OS` in conjunction with `-include` or/and `-D` to give all of the system preprocessor flags to be used at execution time. Details of these may be found by executing the compiler for the project in verbose mode.

Default:

Linux

Note Only the Linux[®] include files are provided with Polyspace software (see the include folder in the installation directory). Projects developed for use with other operating systems may be analyzed by using the corresponding include files for that OS. For instance, in order to analyze a VxWorks[®] project it is necessary to use the option `-I <path_to_the_VxWorks_include_folder>`

Example shell script entry:

```
polyspace-c -OS-target linux
polyspace-c -OS-target no-predefined-OS -D GCC_MAJOR=2 /
    -include /complete_path/inc/gn.h ...
```

Defined Preprocessor Macros (-D)

This option is used to define macro compiler flags to be used during compilation phase.

Only one flag can be used with each `-D` as for compilers, but the option can be used several times as shown in the example below.

Default:

Some defines are applied by default, depending on your `-OS-target` option.

Example Shell Script Entry:

```
polyspace-c -D HAVE_MYLIB -D USE_COM1 ...
```

Undefined Preprocessor Macros (-U)

This option is used to undefine a macro compiler flags

As for compilers, only one flag can be used with each `-U`, but the option can be used several times as shown in the example below.

Default:

Some undefines may be set by default, depending on your `-OS-target` option.

Example Shell Script Entry:

```
polyspace-c -U HAVE_MYLIB -U USE_COM1 ...
```

Include (-include)

This option is used to specify files to be included by each C file involved in the verification.

Default:

No file is universally included by default, but directives such as `"#include <include_file.h>"` are acted upon.

Example Shell Script Entry:

```
polyspace-c -include `pwd`/sources/a_file.h -include  
/inc/inc_file.h ...
```

```
polyspace-c -include /the_complete_path/my_defines.h ...
```

Command/script to apply to preprocessed files (-post-preprocessing-command)

When this option is used, the specified script file or command is run just after the preprocessing phase on each source file. The script executes on each preprocessed c file. The command should be designed to process the standard output from preprocessing and produce its results in accordance with that standard output.

Note You can find each preprocessed file in the results directory in the zipped file ci.zip located in <results/ALL/SRC/MACROS. The extension of the preprocessed file is .ci.

It is important to preserve the number of lines in the preprocessed .ci file. Adding a line or removing one could result in some unpredictable behavior on the location of checks and MACROS in the Polyspace viewer.

Default:

No command.

Example Shell Script Entry – file name:

To replace the keyword “Volatile” by “Import”, you can type the following command on a Linux workstation:

```
polyspace-c -post-preprocessing-command `pwd`/replace_keywords
```

where replace_keywords is the following script:

```
#!/usr/bin/perl
my $TOOLS_VERSION = "V1_4_1";
binmode STDOUT;

# Process every line from STDIN until EOF
while ($line = <STDIN>)
{
    # Change Volatile to Import
    $line =~ s/Volatile/Import/;
```

```
    print $line;
}
```

Note If you are running Polyspace software version 5.1 (r2008a) or later on a Windows® system, you cannot use Cygwin™ shell scripts. Since Cygwin is no longer included with Polyspace software, all files must be executable by Windows. To support scripting, the Polyspace installation now includes Perl. You can access Perl in

```
%POLYSPACE_C%\Verifier\tools\perl\win32\bin\perl.exe
```

To run the Perl script provided in the previous example on a Windows workstation, you must use the option `-post-preprocessing-command` with the absolute path to the Perl script, for example:

```
%POLYSPACE_C%\Verifier\bin\polyspace-c.exe
-post-preprocessing-command
%POLYSPACE_C%\Verifier\tools\perl\win32\bin\perl.exe
<absolute_path>\replace_keywords
```

Command/script to apply after the end of the code verification (-post-analysis-command)

When this option is used, the specified script file or command is executed once the verification has completed.

The script or command is executed in the results directory of the verification.

Execution occurs after the last part of the verification. The last part of is determined by the `-to` option.

Note Depending of the architecture used (notably when using remote launcher), the script can be executed on the client side or the server side.

Default:

No command.

Example Shell Script Entry – file name:

This example shows how to send an email to tip the client side off that his verification has been ended. So the command looks like:

```
polyspace-c -post-analysis-command `pwd`/end_emails
```

where end_emails is an appropriate Perl script.

Note If you are running Polyspace software version 5.1 (r2008a) or later on a Windows system, you cannot use Cygwin shell scripts. Since Cygwin is no longer included with Polyspace software, all files must be executable by Windows. To support scripting, the Polyspace installation now includes Perl. You can access Perl in

```
%POLYSPACE_C%\Verifier\tools\perl\win32\bin\perl.exe
```

To run the Perl script provided in the previous example on a Windows workstation, you must use this option with the absolute path to the Perl script, for example:

```
%POLYSPACE_C%\Verifier\bin\polyspace-c.exe -post-analysis-command  
%POLYSPACE_C%\Verifier\tools\perl\win32\bin\perl.exe  
<absolute_path>\end_emails
```

Compliance with Standards Options

| Name | Value | Internal name |
|--|-------------------------------------|----------------------------------|
| Analysis options | | |
| + General | | |
| + Target/Compilation | | |
| - Compliance with standards | | |
| Code from DOS or Windows filesystem | <input checked="" type="checkbox"/> | -dos |
| - Embedded assembler | | |
| Ignore assembly code | <input checked="" type="checkbox"/> | -discard-asm |
| Handle #pragma asm/endasm directives | <input type="checkbox"/> | ... -asm-begin/-asm-end |
| - Strict | <input type="checkbox"/> | -strict |
| Give all warnings | <input type="checkbox"/> | -Wall |
| - Permissive | <input type="checkbox"/> | -permissive |
| Allow non int types for bitfields | <input checked="" type="checkbox"/> | -allow-non-int-bitfield |
| Accept integral type conflicts | <input checked="" type="checkbox"/> | -permissive-link |
| Allow undefined global variables | <input checked="" type="checkbox"/> | -allow-undef-variables |
| Ignore overflowing computations on constants | <input type="checkbox"/> | -ignore-constant-overflows |
| Allow anonymous unions/structure fields | <input checked="" type="checkbox"/> | -allow-unnamed-fields |
| Allow negative operand for left shifts | <input checked="" type="checkbox"/> | -allow-negative-operand-in-shift |
| Allow language extensions | <input checked="" type="checkbox"/> | -allow-language-extensions |
| Ignore missing header files | <input type="checkbox"/> | -ignore-missing-headers |
| - Check MISRA C rules | <input type="checkbox"/> | |
| MISRA C rules configuration | all-rules | ... -misra2 |
| Files and folders to ignore | | ... -includes-to-ignore |
| - Keil/IAR support | default | -dialect |
| Sfr type support | | ... -sfr-types |

In this section...

“Code from DOS or Windows filesystem (-dos)” on page 1-25

“Ignore assembly code (-discard-asm)” on page 1-26

“Handle #pragma asm/endasm directives (-asm-begin/-asm-end)” on page 1-26

In this section...

“Strict (-strict)” on page 1-27

“Give all warnings (-wall)” on page 1-28

“Permissive (-permissive)” on page 1-28

“Allow non int types for bitfields (-allow-non-int-bitfield)” on page 1-29

“Accept integral type conflicts (-permissive-link)” on page 1-29

“Allow undefined global variables (-allow-undef-variables)” on page 1-30

“Ignore overflowing computations on constants
(-ignore-constant-overflows)” on page 1-30

“Allow anonymous unions/structure fields (-allow-unnamed-fields)” on
page 1-31

“Allow negative operand for left shifts
(-allow-negative-operand-in-shift)” on page 1-31

“Allow language extensions (-allow-language-extensions)” on page 1-32

“Ignore missing header files (-ignore-missing-headers)” on page 1-33

“Check MISRA-C rules” on page 1-34

“MISRA C rules configuration (-misra2)” on page 1-34

“Files and folders to ignore (-includes-to-ignore)” on page 1-35

“Keil/IAR support (-dialect)” on page 1-36

“Sfr type support (-sfr-types)” on page 1-36

Code from DOS or Windows filesystem (-dos)

This option must be used when the contents of the **include** or **source** directory comes from a DOS or Windows file system. It deals with upper/lower case sensitivity and control characters issues.

Concerned files are:

- header files: all include dir specified (-I option)

- source files: all sources files selected for the verification (`-sources` option)

```
#include "..\mY_TEst.h"^M
#include "..\mY_other_FILE.H"^M
into
#include "../my_test.h"
#include "../my_other_file.h"
```

Default:

enabled by default

Example Shell Script Entry:

```
polyspace-c -I /usr/include -dos -I ./my_copied_include_dir -D test=1
```

Ignore assembly code (-discard-asm)

This option instructs the Polyspace verification to discard assembler code. If this option is used, the assembler code should be modelled in `c`.

Default:

Embedded assembler is treated as an error.

Example Shell Script Entry:

```
polyspace-c -discard-asm ...
```

Handle #pragma asm/endasm directives (-asm-begin/-asm-end)

```
-asm-begin "mark1[mark2[...]] "
```

and

```
-asm-end "mark1[mark2[...]]"
```

These options are used to allow compiler specific asm functions to be excluded from the verification, with the offending code block delimited by two #pragma directives.

Consider the following example.

```
#pragma asm_begin_1
int foo_1(void) { /* asm code to be ignored by Polyspace */ }
#pragma asm_end_1
#pragma asm_begin_2
void foo_2(void) { /* asm code to be ignored by Polyspace */ }
#pragma asm_end_2
```

Where "asm_begin_1" and "asm_begin_2" marks the beginning of asm sections which will be discarded and "asm_end_1", respectively "asm_end_2" mark the end of those sections.

Also refer to the -discard-asm option with regards to the following code:

```
asm int foo_1(void) { /* asm code to be ignored by Polyspace */ }
asm void foo_2(void) { /* asmcode to be ignored by Polyspace */ }
```

Note The `asm-begin` and `asm-end` options must be used together.

Example Shell Script Entry:

```
polyspace-c -discard-asm -asm-begin "asm_begin_1,asm_begin_2"
-asm-end "asm_end_1,asm_end_2" ...
```

Strict (-strict)

This option selects the Strict mode of Polyspace verification. It is equivalent to using the following options:

- `-wall`
- `-no-automatic-stubbing`

This option is not compatible with the options `-asm-begin` and `-asm-end`.

Give all warnings (-wall)

Specifies that the software display all possible warnings during the C compliance phase.

Using this option can be an effective way to detect problems in the code without using the MISRA checker.

For example, when you specify this option, the software adds the following warning to the log file when trying to write into a `const` variable:

```
warning: assignment of read-only member <var>
```

Default:

By default, only warnings about compliance across different files are printed.

Example Shell Script Entry:

```
polyspace-c -Wall ...
```

Permissive (-permissive)

This option selects the Polyspace permissive mode, which is equivalent to using all of the following options:

- `-allow-non-int-bitfield`
- `-permissive-link`
- `-allow-undef-variables`
- `-ignore-constant-overflows`
- `-allow unnamed fields`

- `-allow-negative operand-in-shift`
- `-allow-language-extensions`
- `-ignore-missing-headers`

Allow non int types for bitfields (`-allow-non-int-bitfield`)

This option allows the user to define types of bitfields other than those specified by ANSI® C. The standard accepts bitfields of signed and unsigned int types only.

Default:

Bitfields must be signed or unsigned int.

Example Shell Script Entry :

```
polyspace-c -allow-non-int-bitfield ...
```

Accept integral type conflicts (`-permissive-link`)

When this option is used, Polyspace verification accepts integral type conflicts between declarations and definitions on arguments or/and returning functions.

It has an effect only

- when the size of a conflicting integral type is not greater than int, or
- conflicts occur between a pointer type and an integral type of same size.

Default:

By default, Polyspace verification does not accept any conflicts between declarations and definitions.

Allow undefined global variables (-allow-undef-variables)

When this option is used, Polyspace verification will continue in case of linkage errors due to undefined global variables. For instance when this option is used, Polyspace verification will tolerate a variable always being declared as extern

Default:

Undefined variables causes Polyspace verification to stop.

Example Shell Script Entry:

```
polyspace-c -allow-undef-variables ...
```

Ignore overflowing computations on constants (-ignore-constant-overflows)

This option specifies that the verification should be permissive with regards to overflowing computations on constants. Note that it deviates from the ANSI C standard.

For example,

```
char x = 0xff;
```

causes an overflow according to the standard, but if it is analyzed using this option it becomes effectively the same as

```
char x = -1;
```

With this second example, a red overflow will result regardless of the use of the option.

```
char x = (rnd?0xFF:0xFE);
```

Default:

```
char x = 0xff; causes an overflow
```

Example Shell Script Entry:

```
polyspace-c -ignore-constant-overflows ...
```

**Allow anonymous unions/structure fields
(-allow-unnamed-fields)**

When this option is used, Polyspace verification will continue in case of compilation errors due to unnamed fields in structures. For instance when this option is used, Polyspace verification will tolerate a structure where fields are unnamed since there are no duplicate names. With the option, the following source code is tolerate:

```
struct {  
    union { int x; int y;}  
    union {int z; int w;}  
} s;  
s.x = 2; s.z = 2;
```

Default:

Unnamed fields cause Polyspace verification to stop.

Example Shell Script Entry:

```
polyspace-c -allow-unnamed-fields ...
```

**Allow negative operand for left shifts
(-allow-negative-operand-in-shift)**

This option permits a shift operation on a negative number.

According to the ANSI C standard, such a shift operation on a negative number is illegal – for example,

```
-2 << 2
```

With this option in use, Polyspace verification considers the operation to be valid. In the example, the result would be

`-2 << 2 = -8`

Default:

A shift operation on a negative number causes a red error.

Example Shell Script Entry:

```
polyspace-c -allow-negative-operand-in-shift ...
```

Allow language extensions (-allow-language-extensions)

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

When you select this option, the following constructs are supported:

- 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__`)

In addition, when you use this option, the software ignores the following extended keywords:

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

Note This option is set automatically when you select the `-permissive` option.

You cannot use this option with the `-strict` option.

Default:

Not selected

Example Shell Script Entry:

```
polyspace-c -allow-language-extensions
```

Ignore missing header files (`-ignore-missing-headers`)

This option specifies that verification continues when the software detects that include files are missing.

When you select this option, the software displays the following warning when it detects missing header files, but attempts to complete compilation and verification.

```
warning: could not find include file name.h
```

Note Missing header files can cause compilation errors that stop the verification, even when this option is selected.

Default:

Not selected

Example Shell Script Entry:

```
polyspace-c -ignore-missing-headers ...
```

Check MISRA-C rules

This option allows you to check a set of coding rules in conformity to MISRA-C:2004. All MISRA checks are included in the log file of the verification.

MISRA C rules configuration (-misra2)

Specifies the set of coding rules to check.

Available options are:

- **all-rules** – Checks all possible MISRA C[®] coding rules. All violations are reported as warnings.
- **SQO-subset1** – Checks 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 – Coding Rules with a Direct Impact on Selectivity”.
- **SQO-subset2** – Checks 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 – Coding Rules with an Indirect Impact on Selectivity”.
- **custom** – Checks a specified set of coding rules. You must provide the name of an ASCII file containing a list of MISRA[®] rules to check.

Format of the custom file:

```
<rule number> off|error|warning  
# is considered as comments.  
Example:  
# MISRA configuration file for project C89  
10.5 off # disable misra rule number 10.5
```

```
17.2 error # violation misra rule 17.2 as an error
17.3 warning # non-respect to misra rule 17.3 is a only a warning
```

Default:

```
all-rules
```

Example shell script entry:

```
polyspace-c -misra2 all-rules ...

polyspace-c -misra2 SQO-subset1 ...

polyspace-c -misra2 misra.txt
```

Files and folders to ignore (-includes-to-ignore)

This option prevents MISRA rules checking in a given list of files or directories (all files and subdirectories under selected directory). This option is useful when non-MISRA C conforming include headers are used. A warning is displayed if one of the parameter does not exist.

This option is authorized only when -misra2 is used.

Note You can exclude all include folders from MISRA C checking by specifying "all". All files and folders included using the -I option are automatically added to -includes-to-ignore, and therefore excluded from the coding rules checker.

Example shell script entry :

```
polyspace-c -misra2 misra.txt includes-to-ignore
"c:\usr\include"

polyspace-c -misra2 misra.txt includes-to-ignore "all"
```

Keil/IAR support (-dialect)

When this option is used, Polyspace verification will take into account some non Target Support Package™ syntax and semantic associated to a chosen dialect between IAR and Keil. It refers to the well known compilers of the company IAR (www.iar.com) and Keil (www.keil.com).

Using this option, Polyspace verification will tolerate some new structure types as keyword of the language such sfr, sbit, bit etc. These structures and associated semantics are part of the compiler that have integrated it with the ANSI C language as an extension.

Example of source code with keil dialect:

```
unsigned char bdata Status[4];
sfr AU = 0xF0;
sbit OCmd = Status[0]^2;
s^2 = 1; s^6 = 0;
```

Example with iar dialect:

```
unsigned char bdata Status[4];
sfr OCmd @ 0x4FFE;
OCmd.2 = 1; s.6 = 0;
```

Example Shell Script Entry:

```
polyspace-c dialect keil
```

Sfr type support (-sfr-types)

Associated to the option -dialect, if the code uses specific sfr type keyword, it is **mandatory** to declare using **-sfr-types** option. It gives the name of the sfr type and its size in bits. The syntax is:

```
-sfr-types <sfr_name>=<size_in_bits>,
```

where <sfr_name> could be any name, but most of the time we encounter sfr, sfr16 and sfr32 . <size in bits> could be one of the values 8, 16 and 32.

Default:

No dialect used.

Example Shell Script Entry:

```
polyspace-c dialect iar sfr-types sfr=8,sfr32=32,sfrb=16
```

Polyspace Inner Settings Options

| Name | Value | Internal name |
|--|-------------------------------------|------------------------------------|
| [-] Polyspace inner settings | | |
| [-] Run a verification unit by unit | <input type="checkbox"/> | -unit-by-unit |
| Unit by unit common source files | | ... -unit-by-unit-common-source |
| [-] Generate a main | <input checked="" type="checkbox"/> | -main-generator |
| Variables written before loop | public | ... -variables-written-before-loop |
| Variables written in loop | none | ... -variables-written-in-loop |
| Functions called before loop | | ... -functions-called-before-loop |
| Functions called in loop | unused | ... -functions-called-in-loop |
| Functions called after loop | | ... -functions-called-after-loop |
| [-] Stubbing | | |
| Variable/function range setup | | ... -data-range-specifications |
| Stub all functions | <input type="checkbox"/> | -permissive-stubber |
| No automatic stubbing | <input type="checkbox"/> | -no-automatic-stubbing |
| [-] Assumptions | | |
| Division round down | <input type="checkbox"/> | -div-round-down |
| Do not consider all global variables to be initialized | <input type="checkbox"/> | -no-def-init-glob |
| Enable pointer arithmetic out of bounds of fields | <input type="checkbox"/> | -allow-ptr-arith-on-struct |
| Allows incomplete or partial allocation of structures | <input type="checkbox"/> | -size-in-bytes |
| Ignore float rounding | <input type="checkbox"/> | -ignore-float-rounding |
| Detect overflows on | signed | -scalar-overflows-checks |
| Overflow computation mode | truncate-on-error | -scalar-overflows-behavior |
| Enum type definition | defined-by-standard | -enum-type-definition |
| Functions known to cause NTC | | ... -known-NTC |
| Continue with compile error | <input type="checkbox"/> | -continue-with-compile-error |
| Verification time limit | | -timeout |
| Automatic Orange Tester | <input type="checkbox"/> | -prepare-automatic-tests |
| Run verification in 32 or 64-bit mode | auto | -machine-architecture |
| Number of processes for multiple CPU core systems | 4 | -max-processes |
| Other options | | |

In this section...

“Run a verification unit by unit (-unit-by-unit)” on page 1-40

“Unit by Unit common source files (-unit-by-unit-common-source)” on page 1-40

In this section...

“Main Generator Behavior for Polyspace Software” on page 1-41

“Generate a main (-main-generator)” on page 1-42

“Variables written before loop (-variables-written-before-loop)” on page 1-43

“Variables written in loop (-variables-written-in-loop)” on page 1-43

“Functions called before loop (-function-called-before-loop)” on page 1-44

“Functions called in loop (-functions-called-in-loop)” on page 1-44

“Functions called after loop (-function-called-after-loop)” on page 1-45

“Variable/function range setup (-data-range-specifications)” on page 1-46

“Stub all functions (-permissive-stubber)” on page 1-47

“No automatic stubbing (-no-automatic-stubbing)” on page 1-47

“Division round down (-div-round-down)” on page 1-48

“Do not consider all global variables to be initialized (-no-def-init-glob)” on page 1-49

“Enable pointer arithmetic out of bounds of fields (-allow-ptr-arith-on-struct)” on page 1-49

“Allows incomplete or partial allocation of structures (-size-in-bytes)” on page 1-51

“Ignore float rounding (-ignore-float-rounding)” on page 1-52

“Detect overflows on (-scalar-overflows-checks)” on page 1-54

“Overflows computation mode (-scalar-overflows-behavior)” on page 1-56

“Enum type definition (-enum-type-definition)” on page 1-56

“Functions known to cause NTC (-known-NTC)” on page 1-57

“Continue with compile error (-continue-with-compile-error)” on page 1-57

“Verification time limit (-timeout)” on page 1-58

In this section...

“Automatic Orange Tester (-prepare-automatic-tests)” on page 1-58

“Run verification in 32 or 64-bit mode (-machine-architecture)” on page 1-59

“Number of processes for multiple CPU core systems (-max-processes)” on page 1-60

“Other Options” on page 1-60

Run a verification unit by unit (-unit-by-unit)

This option creates a separate verification job for each source file in the project.

Each file is compiled, sent to the Polyspace Server, and verified individually. Verification results can be viewed for the entire project, or for individual units.

Note Unit by unit verification is available only for server verifications. It is not compatible with multitasking options such as `-entry-points`.

Default:

Not selected

Example Shell Script Entry:

```
polyspace-c -unit-by-unit
```

Unit by Unit common source files (-unit-by-unit-common-source)

Specifies a list of files to include with each unit verification. These files are compiled once, and then linked to each unit before verification. Functions not included in this list are stubbed.

Default:

None

Example Shell Script Entry:

```
polyspace-c -unit-by-unit-common-source  
c:/polyspace/function.c
```

Main Generator Behavior for Polyspace Software

This same options can be used for both Polyspace® Client™ for C/C++ and Polyspace® Server™ for C/C++ verifications, but the default behavior differs between the two:

- **Server Verification** – You have the choice whether to activate the main generator.
- **Client Verification** – The main generator is always activated.

Polyspace Client for C/C++ Main Generator

For client verifications, you do not need to determine whether the code contains a "main" or not. Polyspace Client for C/C++ product automatically checks your code for a main.

- If a main exists in the set of files, the verification uses that main.
- If a main does not exist, the tool generates a main using the options you specify.

Polyspace Server for C/C++ Main Generator

If you do not select the `-main-generator` option, a Polyspace Server for C/C++ verification stops if it does not detect a main. This behavior can help isolate files missing from the verification.

When you select the `-main-generator` option, the Polyspace Server for C/C++ product checks your code for a main.

- If a main exists in the set of files, the verification uses that main.
- If a main does not exist, the tool generates a main using the options you specify.

Generate a main (-main-generator)

This option activates the Polyspace main generator.

When you select this option, the main generator automatically generates a main unless a main already exists in your verification.

The generated main has the following behavior.

- 1** It initializes any variables identified by the option `-variables-written-before-loop`.
- 2** It calls any functions specified by the option `-functions-called-before-loop`. This could be considered an initialization function.
- 3** It initializes any variables identified by the option `-variables-written-in-loop`.
- 4** It calls any functions specified by the option `-functions-called-in-loop`.
- 5** It calls any functions specified by the option `-functions-called-after-loop`. This could be a terminate function for a cyclic program.

The following sections describe each of these options in detail.

Note The main generator is always active for client verifications.

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
while(1){      \\ start main loop
  init inputs   \\ -variables-written-in-loop
```

```

    step_fct()    \\ -functions-called-in-loop
  }
  terminate_fct() \\ -functions-called-after-loop

```

Variables written before loop (-variables-written-before-loop)

This option specifies how the generated main initializes global variables.

Settings available:

- `-public` (default) — every variable except static and const variables are assigned a “random” value, representing the full range of possible values
- `-none` — no global variable will be written by the main.
- `-all` — every variable except const variables are assigned a “random” value, representing the full range of possible values
- `-custom` — only variables present in the list are assigned a “random” value, representing the full range of possible values

When defining the main for a cyclic program (such as generated code from a Simulink model), use this option to define how the main initializes your init parameters.

Example

```

polyspace-c -main-generator -variables-written-before-loop none
polyspace-c -main-generator -variables-written-before-loop
custom=variable_a,variable_b

```

Variables written in loop (-variables-written-in-loop)

Specifies how the generated main initializes global variables within a cyclic program loop.

This option is useful when defining the main for a cyclic program, such as code generated from a Simulink model. When defining the main for a cyclic program, use this option to define how the main initializes inputs within the program loop.

Settings available:

- `-none` (default) — no global variable will be written by the main.
- `-public` — every variable except static and const variables are assigned a “random” value, representing the full range of possible values
- `-all` — every variable except const variables are assigned a “random” value, representing the full range of possible values
- `-custom` — only variables present in the list are assigned a “random” value, representing the full range of possible values

Example

```
polyspace-c -main-generator -variables-written-in-loop none
polyspace-c -main-generator -variables-written-in-loop
custom=variable_a,variable_b
```

**Functions called before loop
(-function-called-before-loop)**

Specifies an initialization function, or list of functions, that are called on startup after the initialization of the global variables and before the main loop.

The skeleton of the generated main looks like:

- 1** Initialization of global variables
- 2** Call the specified functions *fname1*, *fname2*
- 3** Main loop with a call to all the functions specified using the option `-functions-called-in-loop`

Example shell script entry:

```
polyspace-c -main-generator -function-called-before-loop
MyInitFunction,MyFunction2
```

Functions called in loop (-functions-called-in-loop)

Specifies the functions to be called within the loop of the generated main.

Possible values:

- `none` — no function is called. This can be used with a multitasking application without a main.
- `unused` (default) — every function is called by the generated main unless it is called elsewhere by the code undergoing verification.
- `all` — every function is called by the generated main except inlined.
- `custom` — only functions present in the list are called from the main. Inlined functions can be specified in the list.

An inline (static or extern) function is not called by the generated main program with values `all` or `unused`. An inline function can only be called with custom value: `-main-generator-calls custom=my_inlined_func`.

Note When using the `unused` option, the generated main may call functions that are also called by a function pointer, meaning these functions may be called twice.

Example:

```
polyspace-c -main-generator -functions-called-in-loop public
```

```
polyspace-c -main-generator -functions-called-in-loop
custom=function_1,function_2
```

Functions called after loop (-function-called-after-loop)

Specifies a function, or list of functions, that are called after the main loop of the generated main.

This option is useful when defining the main for a cyclic program, such as code generated from a Simulink model. When defining the main for a cyclic program, use this option to define the terminate function after the main loop.

The skeleton of the generated main looks like:

- 1 Initialization of global variables
- 2 Main loop with a call to all the functions specified using the option `-functions-called-in-loop`
- 3 Call the specified functions *fname1*, *fname2*

Example shell script entry:

```
polyspace-c -main-generator -function-called-after-loop  
MyTermFunction,MyFunction2
```

Variable/function range setup (-data-range-specifications)

This option permits the setting of specific data ranges for a list of given global variables.

For more information, see “Specifying Data Ranges for Variables and Functions (Contextual Verification)”.

File format:

The file filename contains a list of global variables with the below format:

```
variable_name val_min val_max <init|permanent|globalassert>
```

Variables scope:

Variables concern external linkage, const variables and not necessary a defined variable (i.e. could be extern with option `-allow-undef-variables`).

Note Only one mode can be applied to a global variable.

No checks are added with this option except for `globalassert` mode.

Some warning can be displayed in log file concerning variables when format or type is not in the scope.

Default:

Disable.

Example shell script entry:

```
polyspace-c -data-range-specifications range.txt ...
```

Stub all functions (-permissive-stubber)

By default, the stubber rejects functions:

- with complex function pointers as parameters
- with function pointers as return type

To eliminate these restrictions and stub all functions, specify the **Stub all functions** (-permissive-stubber) option.

Caution Using this option may produce inaccurate results.

Note This option cannot be used with the `no-automatic-stubbing` option.

No automatic stubbing (-no-automatic-stubbing)

By default, Polyspace verification automatically stubs all functions. When this option is used, the list of functions to be stubbed is displayed and the verification is stopped.

Benefits:

This option may be used where

- The entire code is to be provided, which may be the case when verifying a large piece of code. When the verification stops, it means the code is not complete.

- Manual stubbing is preferred to improve the selectivity and speed of the verification.

Note This option cannot be used with the `permissive-stubber` option.

Default:

All functions are stubbed automatically

Division round down (`-div-round-down`)

This option concerns the division and modulus of a negative number.

The ANSI standard stipulates that *"if either operand of / or % is negative, whether the result of the / operator, is the largest integer less or equal than the algebraic quotient or the smallest integer greater or equal than the quotient, is implementation defined, same for the sign of the % operator"*.

Note $a = (a / b) * b + a \% b$ is always true.

Default:

Without the option (default mode), if either operand of / or % is negative, the result of the / operator is the smallest integer greater or equal than the algebraic quotient. The result of the % operator is deduced from $a \% b = a - (a / b) * b$

Example:

```
assert(-5/3 == -1 && -5%3 == -2); is true .
```

With the `-div-round-down` option:

If either operand / or % is negative, the result of the / operator is the largest integer less or equal than the algebraic quotient. The result of the % operator is deduced from $a \% b = a - (a / b) * b$.

Example:

```
assert(-5/3 == -2 && -5%3 == 1); is true .
```

Example Shell Script Entry:

```
polyspace-c -div-round-down ...
```

Do not consider all global variables to be initialized (-no-def-init-glob)

This option specifies that Polyspace verification should not take into account default initialization defined by ANSI C. When this option is not used, default initialization are

- 0 for integers
- 0 for characters
- 0.0 for floats

With the option in use, all global variable will be treated as non initialized - and therefore cause a red error - if they are read before being written to.

Example Shell Script Entry :

```
polyspace-c -no-def-init-glob ...
```

Enable pointer arithmetic out of bounds of fields (-allow-ptr-arith-on-struct)

This option enables navigation within a structure or union from one field to another, within the rules defined below. It automatically sets the -size-in-bytes option.

Default

By default, when a pointer points to a variable then the size of the object pointed to is that of that variable - regardless of whether it is contained within a bigger object, like a structure. Therefore, going out of the scope of this variable leads to a red IDP check (Illegal Dereference Pointer). This is illustrated below.

```
struct S {char a; char b; int c;} x;
char *ptr = &x.b;
ptr ++;
*ptr = 1; // red on the dereference, because the pointed
object was "b"
```

Using this option

When this option is used in the above option, Polyspace verification considers that the object pointed to is now the host object "x". The "ptr" pointer is in fact pointing to &x, with the correct offset to the field "b" within the structure of type S (inter-fields and end-padding included). Therefore, the dereference becomes green

Consider a second example:

```
int main()
{
    struct S {
        char a;
        /* 3 bytes of padding between 'a', 'b' */
        int b;
        int c;
        char d[3];
        unsigned char e:7;
        char f;
        /* 3 bytes of end padding */
    } x;
    char *ptr;
    struct Nesting_S {
        struct S s;
        int c;
        char buf[8];
        int d;
    } x;
```

```

} z

struct S *ptr0;
char *ptr;

ptr = &z.s.f;
ptr += 4;
*(int *)ptr = 10; /* access to z.c, Green IDP */

ptr0 = &z.s;
ptr = &ptr0->f;
ptr += 4;

*(int *) ptr = 10; /* access to z.c, Green IDP */

ptr = &z.buf[0];
ptr += 8;
*(int *)ptr = 10; /* access to z.d, Green IDP */

return (0);
}

```

In the third example below, the `*ptr` access is red regardless of whether the option is set or not.

With the option set, the `ptr` pointer points to the structure+offset `z.s`, and `ptr` can safely navigate within this structure `z.s`, but `z.c` is outside it.

Without the option, the `ptr` pointer points to `z.s.f`, which is only 1 byte long. So no navigation is allowed, not even within `z.s`.

```
ptr = (char *)z.s.f; ptr += 4; *ptr = 10; // ptr points to the
first byte of c:
```

Allows incomplete or partial allocation of structures (-size-in-bytes)

This option allows incomplete or partial allocation of structures. This allocation can be made by `malloc` or `cast`.

The example below shows an example using malloc. Further explanation can be found in the section describing the partial and incomplete allocation of structures. Also refer to the `-allow-ptr-arith-on-struct` section.

```
typedef struct _little { int a; int b; } LITTLE;
typedef struct _big { int a; int b; int c; } BIG;
BIG *p = malloc(sizeof(LITTLE));
```

Default results

```
p->a = 0 ; // red pointer out of its bounds
or p->b = 0 ; // red pointer out of its bounds
or p->c = 0 ; // red pointer out of its bounds
```

Results using this option

```
if (p!= ((void *) 0) ) {
  p->a = 0 ; // green pointer within bounds
or p->b = 0 ; // green pointer within bounds
or p->c = 0 ; // red pointer out of its bounds
}
```

Ignore float rounding (`-ignore-float-rounding`)

Without this option, Polyspace verification rounds floats according to the IEEE® 754 standard: simple precision on 32-bits targets and double precision on target which define double as 64-bits.

With the option, **exact** computation is performed.

Example:

```
void ifr(float f)
{
  double a,b;
  a = 0.2;
  b = 0.2;

  if ( a + b == 0.4) {
    // reached whether -ignore-float-rounding is used or not
    assert (1);
    f = 1.0F*f;
  }
}
```

```

    }
    else {
        assert (1);
        f = 1.0F * f;
        // reached only when -ignore-float-rounding is not used
    }
}

```

Using this option can lead to different results compared to the "real life" (compiler and target dependent): Some paths will be reachable or not for Polyspace verification while they are not (or are) depending of the compiler and target. So it can potentially give approximate results (green should be unproven). This option has an impact on OVFL/UNFL checks on floats.

However, this option allows reducing the number of unproven checks because of the “delta” approximation.

For example:

- FLT_MAX (with option set) = 3.40282347e+38F
- FLT_MAX (following IEEE 754 standard) = 3.40282347e+38F ± Δ

```

void ifr(float f)
{
    double a,b;
    a = 0.2;
    b = 0.2;

    if ( a + b == 0.4) {
        assert (1);
        f = 1.0F*f;    // Overflow never occurs because f <= FLT_MAX.
                    // reached when -ignore-float-rounding is used
    }
    else {
        assert (1);
        f = 1.0F * f;    // OVFL could occur when f = (FLT_MAX + D)
                    // reached when -ignore-float-rounding is not used
    }
}

```

Default:

IEEE 754 rounding under 32 bits and 64 bits.

Example Shell Script Entry:

```
polyspace-c -ignore-float-rounding ...
```

Detect overflows on (-scalar-overflows-checks)

Specifies how verification handles overflowing computations on integers.

Possible settings are:

- **none** – The verification does not check for integer computation overflows. If a computation value exceeds the range of the result type, the result is wrapped, and no OVFL check is reported.
For example, `MAX_INT + 1` wraps to `MIN_INT`.
- **signed** (default) – Verification checks all signed integer computations and signed integer to signed integer conversions. The option `-scalar-overflows-behavior` specifies whether results for signed integers are restricted to an acceptable value or wrapped.

For unsigned integer operations, the results are wrapped, and no OVFL check is reported.

This behavior conforms to the ANSI C (ISO C++) standard.

- **signed-and-unsigned** – Verification checks all integer computations and integer conversions, including conversions that cause a change of signs.

The option `-scalar-overflows-behavior` specifies whether operation results are restricted to an acceptable value or wrapped.

This behavior is more strict than the ANSI C (ISO C++) standard requires.

Consider the examples below.

Example 1

Using the signed-and-unsigned option, the following example generates an error:

```
unsigned char x;
x = 255;
x = x+1; //overflow due to this option
```

Using the none option, however, the example does not generate an error.

```
unsigned char x;
x = 255;
x = x+1; // turns x into 0 (wrap around)
```

Example 2

Using the signed-and-unsigned option, the following example generates an error:

```
unsigned char Y=1;
Y = -Y; //overflow because of type promotion
```

In this example:

- 1** Y is coded as an unsigned char: 00000001
- 2** Y is promoted to an integer: 00000000 00000000 00000000 00000001
- 3** The operation "-" is performed, making Y: 11111111 11111111 11111111 11111110
- 4** The integer is downcast to an unsigned char, causing an overflow.

Example Shell Script Entry:

```
polyspace-c -scalar-overflows-checks signed ...
```

Overflows computation mode (-scalar-overflows-behavior)

Specifies how verification computes the results of overflowing integer computations or integer conversions.

Possible settings are:

- **truncate-on-error** (default) – Result of an overflowing operation is restricted to an acceptable value and verification stops. If the check is red, all subsequent checks are gray. If the check is orange, the verification continues with restricted values.
- **wrap-around** – Result of an overflowing operation wraps around the type range. The check has no impact on values for the rest of the verification.

For example, `MAX_INT + 1` wraps to `MIN_INT`.

Example Shell Script Entry:

```
polyspace-c -scalar-overflows-behavior wrap-around ...
```

Enum type definition (-enum-type-definition)

Allows the verification to use different base types to represent an enumerated type, depending on the enumerator values and the selected definition.

When using this option, each enum type is represented by the smallest integral type that can hold all its enumeration values.

Possible values are:

- **defined-by-standard** – Uses the integer type (signed int).
- **auto-signed-first** - Uses the first type that can hold all of the enumerator values from the following list: signed char, unsigned char, signed short, unsigned short, signed int, unsigned int, signed long, unsigned long, signed long long, unsigned long long.
- **auto-unsigned-first** - Uses the first type that can hold all of the enumerator values from the following lists:

- If enumerator values are all positive: unsigned char, unsigned short, unsigned int, unsigned long, unsigned long long.
- If one or more enumerator values are negative: signed char, signed short, signed int, signed long, signed long long.

Functions known to cause NTC (-known-NTC)

After a few verifications, you may discover that a few functions "never terminate". Some functions such as tasks and threads contain infinite loops by design, while functions that exit the program such as *kill_task*, *exit* or *Terminate_Thread* are often stubbed by means of an infinite loop. If these functions are used very often or if the results are for presentation to a third party, it may be desirable to filter all NTC of that kind in the Viewer.

This option is provided to allow that filtering to be applied. All NTC specified at launch will appear in the viewer in the known-NTC category, and filtering will be possible.

Default :

All checks for deliberate Non Terminating Calls appear as red errors, listed in the same category as any problem NTC checks.

Example Shell Script Entry :

```
polyspace-c -known-NTC "kill_task,exit"
```

```
polyspace-c -known-NTC "Exit,Terminate_Thread"
```

Continue with compile error (-continue-with-compile-error)

Specifies that verification continues even if some source files do not compile. Functions that are used but not specified are stubbed automatically.

If a source file contains global variables, you may also need to select the option `-allow-undef-variables` to enable verification.

Example Shell Script Entry :

```
polyspace-c -continue-with-compile-error ...
```

Verification time limit (-timeout)

Specifies a time limit for the verification (in hours).

If the verification does not complete within the specified time, the verification fails.

You can specify fractions of an hour in decimal form. For example:

- `-timeout 5.75` – Five hours, 45 minutes.
- `-timeout 3,5` – Three hours, 30 minutes.

Example Shell Script Entry :

```
polyspace-c -timeout 5.75 ...
```

Automatic Orange Tester (-prepare-automatic-tests)

This option activates the Polyspace Automatic Orange Tester. The Automatic Orange Tester finds runtime errors in the orange (and red) checks remaining at the end of the Polyspace verification.

The Automatic Orange Tester results contain precise information to help you identify the cause of a runtime error. This complements the results review in the Viewer module of Polyspace Client for C/C++.

For more information, see “Automatically Testing Orange Code”.

The following options are not compatible with `-prepare-automatic-tests`.

- `-entry-points`
- `-dialect`
- `-ignore-float-rounding`
- `-div-round-down`
- `-entry-points`

- `-char-is-16bits`
- `-short-is-8bits`
- `-respect-types-in-globals`
- `-respect-types-in-fields`

The following options cannot take specific values when you select `-prepare-automatic-tests`.

- `-align [8|16]`
- `-target [c-167 | tms320c3c | hc08 | sharc21x61]`
- `-data-range-specification` (in global assert mode)

In addition, when using the Automatic Orange Tester, the `-target mcpu` option must be used together with `-pointer-is-32bits`.

Default :

Disabled

Example Shell Script Entry :

```
polyspace-c -prepare-automatic-tests ...
```

Run verification in 32 or 64-bit mode (`-machine-architecture`)

This option specifies whether verification runs in 32 or 64-bit mode.

Note You should only use the option `-machine-architecture 64` for verifications that fail due to insufficient memory in 32 bit mode. Otherwise, you should always run in 32-bit mode.

Available options are:

- `-machine-architecture auto` – Verification always runs in 32-bit mode.

- `-machine-architecture 32` – Verification always runs in 32-bit mode.
- `-machine-architecture 64` – Verification always runs in 64-bit mode.

Default:

auto

Example Shell Script Entry:

```
polyspace-c -machine-architecture auto
```

Number of processes for multiple CPU core systems (-max-processes)

This option specifies the maximum number of processes that can run simultaneously on a multi-core system. The valid range is 1 to 128.

Note To disable parallel processing, set: `-max-processes 1`.

Default:

4

Example Shell Script Entry:

```
polyspace-c -max-processes 1
```

Other Options

- “`-extra-flags`” on page 1-61
- “`-c-extra-flags`” on page 1-61
- “`-il-extra-flags`” on page 1-61

-extra-flags

This option specifies an expert option to be added to the analyzer. Each word of the option (even the parameters) must be preceded by *-extra-flags*.

These flags will be given to you by Technical Support as necessary for your verifications.

Default:

No extra flags.

Example Shell Script Entry:

```
polyspace-c -extra-flags -param1 -extra-flags -param2 \  
-extra-flags 10 ...
```

-c-extra-flags

This option is used to specify an expert option to be added to a verification. Each word of the option (even the parameters) must be preceded by *-c-extra-flags*.

These flags will be given to you by MathWorks as necessary for your verifications.

Default:

No extra flags.

Example Shell Script Entry:

```
polyspace-c -c-extra-flags -param1 -c-extra-flags -param2  
-c-extra-flags 10
```

-il-extra-flags

This option is used to specify an expert option to be added to a verification. Each word of the option (even the parameters) must be preceded by *-il-extra-flags*.

These flags will be given to you by MathWorks as necessary for your verifications.

Default:

No extra flags.

Example Shell Script Entry:

```
polyspace-c -il-extra-flags -param1 -il-extra-flags -param2  
-il-extra-flags 10
```

Precision/Scaling Options

| Name | Value | Internal name |
|---|--------------------------|---------------------------|
| Analysis options | | |
| + General | | |
| + Target/Compilation | | |
| + Compliance with standards | | |
| + PolySpace inner settings | | |
| - Precision/Scaling | | |
| - Precision | | |
| Precision Level | 2 ▾ | -O |
| Specific Precision | ... | -modules-precision |
| Launch code verification from beginning of | scratch ▾ | -from |
| To end of | Software Safety... ▾ | -to |
| Sensitivity context | ... | -context-sensitivity |
| Automatic selection for sensitivity context | <input type="checkbox"/> | -context-sensitivity-auto |
| Improve precision of interprocedural analysis | | -path-sensitivity-delta |
| Retype variables of pointer types | <input type="checkbox"/> | -retype-pointer |
| Retype symbols of integer types | <input type="checkbox"/> | -retype-int-pointer |
| - Scaling | | |
| Depth of analysis inside structures | | -k-limiting |
| Inline | ... | -inline |
| Optimize huge static initializers | <input type="checkbox"/> | -no-fold |
| Respect types in fields | <input type="checkbox"/> | -respect-types-in-fields |
| Respect types in global variables | <input type="checkbox"/> | -respect-types-in-globals |
| Reduce task complexity | <input type="checkbox"/> | -lightweight-thread-model |
| Less range information | <input type="checkbox"/> | -less-range-information |
| No pointer information | <input type="checkbox"/> | -no-pointer-information |

In this section...

“Precision Level (-O)” on page 1-64

“Specific Precision (-modules-precision)” on page 1-65

“Launch code verification from beginning of (-from)” on page 1-66

In this section...

“To end of (-to)” on page 1-67

“Sensitivity context (-context-sensitivity)” on page 1-68

“Automatic selection for sensitivity context (-context-sensitivity-auto)” on page 1-68

“Improve precision of interprocedural analysis (-path-sensitivity-delta)” on page 1-68

“Retype variables of pointer types (-retype-pointer)” on page 1-69

“Retype symbols of integer types (-retype-int-pointer)” on page 1-70

“Depth of analysis inside structures (-k-limiting)” on page 1-72

“Inline (-inline)” on page 1-72

“Optimize huge static initializers (-no-fold)” on page 1-73

“Respect types in fields (-respect-types-in-fields)” on page 1-73

“Respect types in global variables (-respect-types-in-globals)” on page 1-74

“Reduce task complexity (-lightweight-thread-model)” on page 1-75

“Less range information (-less-range-information)” on page 1-75

“No pointer information (-no-pointer-information)” on page 1-76

Precision Level (-0)

This option specifies the precision level to be used. It provides higher selectivity in exchange for more verification time, therefore making results review more efficient and hence making bugs in the code easier to isolate. It does so by specifying the algorithms used to model the program state space during verification.

MathWorks recommends you begin with the lowest precision level. Red errors and gray code can then be addressed before relaunching 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.
- A higher precision level also means higher verification time
 - -O0 corresponds to static interval verification.
 - -O1 corresponds to complex polyhedron model of domain values.
 - -O2 corresponds to more complex algorithms to closely model domain values (a mixed approach with integer lattices and complex polyhedrons).
 - -O3 is only suitable for code smaller than 1000 lines of code. For such codes, the resulting selectivity might reach high values such as 98%, resulting in a very long verification time, such as an hour per 1000 lines of code.

Default:

-O2

Example Shell Script Entry:

```
polyspace-c -O1 -to pass4 ...
```

Specific Precision (-modules-precision)

This option is used to specify the list of .c files to be analyzed with a different precision from that specified generally -O(0-3) for this verification.

In batch mode, each specified module is followed by a colon and the desired precision level for it. Any number of modules can be specified in this way, to form a comma-separated list with no spaces.

Default:

All modules are treated with the same precision.

Example Shell Script Entry:

```
polyspace-c -01 \  
-modules-precision myMath:02,myText:01, ...
```

Launch code verification from beginning of (-from)

This option specifies the verification phase to start from. It can only be used on an existing verification, possibly to elaborate on the results that you have already obtained.

For example, if a verification has been completed `-to pass1`, Polyspace verification can be restarted *-from* `pass1` and hence save on verification time.

The option is usually used in a verification after one run with the `-to` option, although it can also be used to recover after power failure.

Possible values are as described in the `-to verification-phase` section, with the addition of the *scratch* option.

Note

- This option can only be used for client verifications. All server verifications start from *scratch*.
 - Unless the *scratch* option is used, this option can be used only if the previous verification was launched using the option *-keep-all-files*.
 - This option cannot be used if you modify the source code between verifications.
-

Default :

scratch

Example Shell Script Entry :

```
polyspace-c -from c-to-il ...
```

To end of (-to)

This option specifies the phase after which the verification will stop.

Benefits:

This option provides improved selectivity, making results review more efficient and making bugs in the code easier to isolate.

- A higher integration level contributes to a higher selectivity rate, leading to "finding more bugs" with the code.
- A higher integration level also means higher verification time

Note MathWorks recommends you 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.

Possible values:

- `c-compile` or "C Source Compliance Checking"
- `c-to-il` or "C to Intermediate Language"
- `pass0` or "Software Safety Analysis level 0"
- `pass1` or "Software Safety Analysis level 1"
- `pass2` or "Software Safety Analysis level 2"
- `pass3` or "Software Safety Analysis level 3"
- `pass4` or "Software Safety Analysis level 4"
- `other`

Note If you use `-to other` then Polyspace verification will continue until you stop it manually (via `kill -rte -kernel`) or stops until it has reached `pass20`.

Default:

pass4

Example Shell Script Entry:

```
polyspace-c -to "Software Safety Analysis level 3"...
```

```
polyspace-c -to pass0 ...
```

Sensitivity context (-context-sensitivity)

This option allows the precise verification of a procedure with regards to the discrete calls to it in the analyzed code.

Each check inside the procedure is split into several sub-checks depending on the context of call. Therefore if a check is red for one call to the procedure and green for another, both colors will be revealed.

This option is especially useful if a problem function is called from a multitude of places.

Automatic selection for sensitivity context (-context-sensitivity-auto)

This option is similar to the -context-sensitivity option, except that the system automatically chooses the procedures to be considered.

Improve precision of interprocedural analysis (-path-sensitivity-delta)

This option is used to improve interprocedural verification precision within a particular pass (see *-to pass1, pass2, pass3* or *pass4*). The propagation of information within procedures is done earlier than usual when this option is specified. That results in improved selectivity and a longer verification time.

Consider two verifications, one with this option set to 1 (with), and one without this option (without)

- a level 1 verification in (with) (pass1) will provide results equivalent to level 1 or 2 in the (without) verification

- a level 1 verification in (with) can last x times more than a cumulated level 1+2 verification from (without). "x" might be exponential.
- the same applies to level 2 in (with) equivalent to level 3 or 4 in (without), with potentially exponential verification time for (a)

Gains using the option

- (+) highest selectivity obtained in level 2. no need to wait until level 4
- (-) This parameter increases exponentially the verification time and might be even bigger than a cumulated verification in level 1+2+3+4
- (-) This option can only be used with less than 1000 lines of code

Default:

0

Example Shell Script Entry:

```
polyspace-c -path-sensitivity-delta 1 ...
```

Retype variables of pointer types (-retype-pointer)

This option can be used to retype variables of pointer types in order to improve precision of pointer conversions chain.

The principle consists in replacing original type by the aliased object type when a symbol of pointer type aliases to a single type of objects.

For example, following assert can be proved using -retype-pointer option:

```
struct A {int a; char b;} s = {1,2};
char *tmp = (char *)&s;
struct A *pa = (struct A*)tmp;
assert((pa->a == 1) && (pa->b == 2));
```

This principle can be applied to fields of struct/unions of a pointer type. However, this option set -size-in-bytes option and it does not have expected precision with -allow-ptr-arith-on-struct.

Moreover, this option is forbidden when using `-retype-int-pointer` option.

Default:

disable by default

Example Shell ScriptEntry:

```
polyspace-c -retype-pointer ...
```

Retype symbols of integer types (-retype-int-pointer)

This option can be used to retype variables of pointer to signed or unsigned integer types in order to improve precision of pointer conversions chain.

The principle consists in replacing original type by the aliased object type when a symbol of pointer type aliases to a single type of objects. It applies only on symbols of signed or unsigned integer types.

For example, following assert can be proved using `-retype-int-pointer` option:

```
void function(void)
{
    struct S1 {
        int x;
        int y;
        int z;
        char t;
    } s1 = {1,2,3,4};
    struct S2 {
        int first;
        void *p;
    } s2;
    int addr;
    addr = (int)&s1;
    assert(((struct S1 *)addr)->y == 2); // ASRT is verified
    s2.first = (int)&s1;
    assert(((struct S1 *)s2.first)->y == 2); // ASRT is verified
```

```
}

```

However, this option set `-size-in-bytes` and has no effect when set `-respect-types-in-globals` on global symbols of integer types and when set `-respect-types-in-fields` on fields of struct/union of integer types.

Some sides effects can be noticed on Polyspace checks concerning initialization on variables which can be stated as initialization on pointer check (NIP).

This option requires the `-retype-pointer` option.

This option should be used on:

- **Code with memory mapping** – When constant bg structures (global variable) are declared with a pointer and points to const structure, setting the option will consider that the pointer and the pointer structure are synonyms (aliased) and precision of the result will increase. Option to set: `-retype-pointer`.
- **Code close to the communication layer API** (code with lot of cast in `(void *)`) – When code contains low level drivers, generic pointer `(void *)` can be used. It is recommended to use this with an `-inline` of the functions containing these casts. Options to set: `-retype-pointer -inline`.
- **Code in which MISRA rule 11.2 is violated** – When integers contains pointers, precision can be improved when setting an option. Option to set: `-retype-int-pointer`.

These options are not set by default because they all change the option `-size-in-bytes`. Therefore, precision can reduced and some red IDP checks may be affected. In addition, using these options will consider "x" (previously int) as a pointer. This results in checks changing category (NIV to NIP).

Default:

Disable by default

Example Shell ScriptEntry:

```
polyspace-c -retype-int-pointer...
```

Depth of analysis inside structures (-k-limiting)

This is a scaling option to limits the depth of verification into nested structures during pointer verification.

This option is only available for C and C++.

Default:

There is no fixed limit.

Example Shell Script Entry:

```
polyspace-c -k-limiting 1 ...
```

In this example above, verification will be precise to only one level of nesting.

Inline (-inline)

A scaling option that creates a clone of a each specified procedure for each call to it.

Cloned procedures follow a naming convention viz:

```
procedure1_pst_cloned_nb,
```

where nb is a unique number giving the total number of cloned procedures.

Such an inlining allows the number of aliases in a given procedure to be reduced, and may also improve precision.

Restrictions :

- Extensive use of this option may duplicate too much code and may lead to other scaling problems. Carefully choose procedures to inline.
- This option should be used in response to the inlining hints provided by the alias verification
- This option should not be used on main, task entry points and critical section entry points

Optimize huge static initializers (-no-fold)

When variables are defined with huge static initialization, scaling problems may occur during the compilation phase. This option approximates the initialization of array types of integer, floating point, and char types (included string) if needed.

It can speed up the verification, but may decrease precision for some applications

Default:

Option not set.

Example Shell Script Entry:

```
polyspace-c -no-fold ...
```

Respect types in fields (-respect-types-in-fields)

This is a scaling option, designed to help process complex code. When it is applied, Polyspace verification assumes that structure fields not declared as containing pointers are never used for holding pointer values. This option should only be used with Type-safe code, when it does not cause a loss of precision. See also -respect-types-in-globals.

In the following example, we will lose precision using option -respect-types-in-fields option:

```
struct {
    unsigned x;
    int f1;
    int *z[2];
} S1;

void funct2(void) {
    int *tmp;
    int y;
    ((int**)&S1)[0] = &y; /* S1.x points on y */
    tmp = (int*)S1.x;
    y=0;
```

```
    *tmp = 1;      /* write 1 into y */
    assert(y==0);
}
```

Polyspace verification will not take care that `S1.x` contains the address of `y` resulting a green assert.

Default:

Polyspace verification assumes that structure fields may contain pointer values.

Example Shell Script Entry:

```
polyspace-c -respect-types-in-fields ...
```

**Respect types in global variables
(-respect-types-in-globals)**

This is a scaling option, designed to help process complex code. When it is applied, Polyspace verification assumes that global variables not declared as containing pointers are never used for holding pointer values. This option should only be used with Type-safe code, when it does not cause a loss of precision. See also `-respect-types-in-fields`.

In the following example, we will lose precision using option `-respect-types-in-globals` option:

```
int x;
void t1(void) {
    int y;
    int *tmp = &x;
    *tmp = (int)&y;
    y=0;
    *(int*)x = 1; // x contains address of y
    assert (y == 0); // green with the option
}
```

Polyspace verification will not take care that `x` contains the address of `y` resulting a green assert.

Default:

Polyspace verification assumes that global variables may contain pointer values.

Example Shell Script Entry:

```
polyspace-c -respect-types-in-globals ...
```

Reduce task complexity (-lightweight-thread-model)

This scaling option can be used to reduce task complexity (see also `-entry-points`).

It uses a slightly less precise model of pointer/thread interaction compared to that used by default, and is likely to prove helpful when there are a lot of pointers in an application. See “Reducing Verification Time” in the *Polyspace Products for C User’s Guide* for more explanation of when to use it.

It causes a loss of precision:

- more orange checks
- loss of precision when shared variables are reads via pointers.

Default:

disabled by default.

Example Shell Script Entry :

```
polyspace-c -lightweight-thread-model ...  
polyspace-c -lwtm ...
```

Less range information (-less-range-information)

Limits the amount of range information displayed in verification results.

When you select this option, the software provides range information on assignments, but not on reads and operators.

In addition, selecting this option enables the `no-pointer-information` option. See “No pointer information (`-no-pointer-information`)” on page 1-76.

Computing range information for reads and operators may take a long time, and can reduce the precision of the verification (causing more orange checks). Selecting this option can reduce verification time significantly, and improve the precision of the verification. Consider the following example:

```
x = y + z;
```

If you do not select this option (the default), the software displays range information when you place the cursor over `x`, `y`, `z`, or `+`. However, if you select this option, the software displays range information only when you place the cursor over `x`.

Default:

Disabled.

Example Shell Script Entry :

```
polyspace-c -less-range-information
```

No pointer information (`-no-pointer-information`)

Stops the display of pointer information in verification results.

When you select this option, the software does not provide pointer information through tooltips. As computing pointer information may take a long time, selecting this option can significantly reduce verification time.

Consider the following example:

```
x = *p;
```

If you do not select this option (the default), the software displays pointer information when you place the cursor on `p` or `*`. If you select this option, the software does not display pointer information.

Default:

Disabled.

Example Shell Script Entry :

```
polyspace-c -no-pointer-information
```

Multitasking Options (Polyspace Server for C/C++ Verifications Only)

| Name | Value | | Internal name |
|--|-------|-----|-----------------------------|
| Analysis options | | | |
| + General | | | |
| + Target/Compilation | | | |
| + Compliance with standards | | | |
| + PolySpace inner settings | | | |
| + Precision/Scaling | | | |
| - Multitasking | | | |
| ... Entry point or Interruption | | ... | -entry-points |
| ... Critical section details | | ... | -critical-section-begin/end |
| ... Temporal exclusion point (separated by space characters) | | ... | -temporal-exclusions-file |

In this section...

“Entry point for Interruption (-entry-points)” on page 1-78

“Critical section details (-critical-section-begin/end)” on page 1-79

“Temporal exclusion point (-temporal-exclusions-file)” on page 1-79

Note Concurrency options are not compatible with -main-generator options.

Entry point for Interruption (-entry-points)

This option is used to specify the tasks/entry points to be analyzed by Polyspace server, using a Comma-separated list with no spaces.

These entry points must not take parameters. If the task entry points are functions with parameters they should be encapsulated in functions with no parameters, with parameters passed through global variables instead.

Using Polyspace verification, c tasks must have the prototype "void *task_name*(void);".

Example Shell Script Entry:

```
polyspace-c -entry-points proc1,proc2,proc3 ...
```

Critical section details (-critical-section-begin/end)

```
-critical-section-begin "proc1:cs1[,proc2:cs2]"
```

and

```
-critical-section-end "proc3:cs1[,proc4:cs2]"
```

These options specify the procedures beginning and ending critical sections, respectively. Each uses a list enclosed within double speech marks, with list entries separated by commas, and no spaces. Entries in the lists take the form of the procedure name followed by the name of the critical section, with a colon separating them.

These critical sections can be used to model protection of shared resources, or to model interruption enabling and disabling.

Note This option cannot be used for client verifications, or with the `main-generator` option.

Default:

no critical sections.

Example Shell Script Entry:

```
polyspace-c -critical-section-begin "start_my_semaphore:cs" \  
  
-critical-section-end "end_my_semaphore:cs"
```

Temporal exclusion point (-temporal-exclusions-file)

This option specifies the name of a file. That file lists the sets of tasks which never execute at the same time (temporal exclusion).

The format of this file is :

- one line for each group of temporally excluded tasks,
- on each line, tasks are separated by spaces.

Note This option cannot be used for client verifications, or with the `main-generator` option.

Default:

No temporal exclusions.

Example Task Specification file

File named 'exclusions' (say) in the 'sources' directory and containing:

```
task1_group1 task2_group1
task1_group2 task2_group2 task3_group2
```

Example Shell Script Entry :

```
polyspace-c -temporal-exclusions-file sources/exclusions \  
-entry-points task1_group1,task2_group1,task1_group2,\  
task2_group2,task3_group2 ...
```


Batch Options

In this section...

“-server” on page 1-81
 “-sources-list-file” on page 1-82
 “-v | -version” on page 1-82
 “-h[elp]” on page 1-83
 “-prog” on page 1-83
 “-date” on page 1-83
 “-author” on page 1-84
 “-verif-version” on page 1-85
 “-results-dir” on page 1-85
 “-sources” on page 1-86
 “-I ” on page 1-87

-server

Using `polyspace-remote-[c] [--server [name or IP address][:<port number>]]` allows you to send a verification to a specific or referenced Polyspace server.

Note If the option `--server` is not specified, the default server referenced in the `Polyspace-Launcher.prf` configuration file will be used as the server.

When a `--server` option is associated to the batch launching command, the name or IP address and a port number need to be specified. If the port number does not exist, the 12427 value will be used by default.

Note also that `polyspace-remote-` accepts all other options.

Option Example Shell Script Entry:

```
polyspace-remote-c server 192.168.1.124:12400
```

```
polyspace-remote-c
```

```
polyspace-remote-c server Bergeron
```

-sources-list-file

This option is only available in batch mode. The syntax of *file_name* is the following:

- One file per line.
- Each file name includes its absolute or relative path.

The source files are compiled in the order in which they are specified.

Note If you do not specify any files, the software verifies all files in the source directory in alphabetical order.

Example Shell Script Entry for -sources-list-file:

```
polyspace-c -sources-list-file "C:\Analysis\files.txt"
```

```
polyspace-c -sources-list-file "files.txt"
```

-v | -version

Display the Polyspace version number.

Example Shell Script Entry:

```
polyspace-c v
```

It will show a result similar to:

```
Polyspace r2007a+
```

```
Copyright (c) 1999-2008 The Mathworks, Inc.
```

-h[elp]

Display in the shell window a simple help in a textual format giving information on all options.

Example Shell Script Entry:

```
polyspace-c h
```

-prog

Specify a name for the project.

Note The Session identifier option no longer appears in the General section of the Analysis options GUI. You specify the Project name, Version, and Author parameters in the Polyspace Project – Properties dialog box. For more information, see “Creating a Project” in the *Polyspace Products for C User’s Guide*.

Settings

Default: New_Project

- The Session identifier cannot contain spaces.
- Use only characters that are valid for UNIX file names.

Command-Line Information

Parameter: -prog

Value: any valid value

Example: polyspace-c -prog myApp ...

-date

Specify a date stamp for the verification.

Note The Date option no longer appears in the General section of the Analysis options GUI. The date is set automatically when you launch a verification.

Settings

Default: Date the verification is launched

By default, the date stamp uses the dd/mm/yyyy format.

Tip

You can specify an alternative date format by selecting **Edit > Preferences > Miscellaneous** in the Launcher.

Command-Line Information

Parameter: -date

Value: any valid value

Example: polyspace-c -date "02/01/2002"...

-author

Specify the name of the person performing the verification.

Note The Author option no longer appears in the General section of the Analysis options GUI. You specify the Project name, Version, and Author parameters in the Polyspace Project – Properties dialog box. For more information, see “Creating a Project” in the *Polyspace Products for C User’s Guide*.

Settings

Default: username of the current user.

Note The default username is obtained with the *whoami* command.

Command-Line Information

Parameter: -author

Value: any valid value

Example: polyspace-c -author "John Tester"

-verif-version

Specify a version identifier for the verification.

Note The Project Version option no longer appears in the General section of the Analysis options GUI. You specify the Project name, Version, and Author parameters in the Polyspace Project – Properties dialog box. For more information, see “Creating a Project” in the *Polyspace Products for C User’s Guide*.

Settings

Default: 1.0

Tip

This option can be used to identify different verifications.

Command-Line Information

Parameter: -verif-version

Value: any valid value

Example: polyspace-c -verif-version 1.3

-results-dir

This option specifies the directory in which Polyspace software will write the results of the verification. Note that although relative directories may be

specified, particular care should be taken with their use especially where the tool is to be launched remotely over a network, and/or where a project configuration file is to be copied using the "Save as" option.

Default:

Shell Script: The directory in which tool is launched.

From Graphical User Interface: C:\Polyspace_Results

Example Shell Script Entry:

```
polyspace-c -results-dir RESULTS ...  
export RESULTS=results_`date +%d%B_%HH%M_%A`  
polyspace-c -results-dir `pwd`/$RESULTS ...
```

- sources

Specifies a list of source files to be verified.

The list of source files must be double-quoted and separated by commas.

- -sources "*file1*[*file2*[...]]" (Linux and Solaris™)
- -sources "*file1*[,*file2*[, ...]]" (Windows, Linux and Solaris)
- -sources-list-file *file_name* (not a graphical option)

Note UNIX standard wild cards are available to specify a number of files.

The source files are compiled in the order in which they are specified.

Note If you do not specify any files, the software verifies all files in the source directory in alphabetical order.

Note The specified files must have valid extensions:
*.c|C|cc|cpp|CPP|cxx|CXX

Defaults:

```
sources/*. (c|C|cc|cpp|CPP|cxx|CXX)
```

Example Shell Script Entry under linux or solaris (*files are separated with a white space*):

```
polyspace-c -sources "my_directory/*.cpp" ...
polyspace-c -sources "my_directory/file1.cc other_dir/file2.cpp"
...
```

Example Shell Script Entry under windows (*files are separated with a comma*):

```
polyspace-c -sources "my_directory/file1.cpp,other_dir/file2.cc"
...
```

Using `-sources-list-file`, each file *name* need to be given with an absolute path. Moreover, the syntax of the file is the following:

- One file by line.
- Each file name is given with its absolute path.

Note This option is only available in batch mode

Example Shell Script Entry for `-sources-list-file`:

```
polyspace-c -sources-list-file "C:\Analysis\files.txt"
polyspace-c -sources-list-file "/home/poly/files.txt"
```

-I

This option is used to specify the name of a directory to be included when compiling C sources. Only one directory may be specified for each `-I`, but the option can be used multiple times.

Default:

- Polyspace software automatically adds the following standard include folders after any includes you specify:
 - *Polyspace_Install/Verifier/include/include-gnu*
 - *Polyspace_Install/Verifier/include/include-gnu/next*
- The `./sources` directory (if it exists), is implicitly added at the end of the "-I" list
- If you do not specify any include folders, the two standard include folders and the `./sources` directory (if it exists) are automatically included

Example Shell Script Entry-1:

```
polyspace-c -I /com1/inc -I /com1/sys/inc
```

is equivalent to

```
polyspace-c -I /com1/inc -I /com1/sys/inc -I ./sources
```

Example Shell Script Entry-2:

```
polyspace-c
```

is equivalent to

```
polyspace-c -I ./sources
```


Deprecated Options

| In this section... |
|--|
| “-continue-with-red-error (Deprecated)” on page 1-89 |
| “-continue-with-existing-host (Deprecated)” on page 1-89 |
| “-allow-unsupported-linux (Deprecated)” on page 1-90 |
| “-quick (Deprecated)” on page 1-90 |

-continue-with-red-error (Deprecated)

Note This option is deprecated in R2009a and later releases, and no longer exists in the user interface. Verification now continues to the next integration pass even if a red errors is encountered.

This option allows Polyspace verification to continue even if one of these red errors is encountered. In most cases, this will mean that the dynamic behavior of the code beyond the point where red errors are identified will be undefined, unless the red code is actually inaccessible.

-continue-with-existing-host (Deprecated)

Note This option is deprecated in R2010a and later releases, and no longer exists in the user interface. Polyspace verification now continues regardless of the system configuration. The software still checks the hardware configuration, and issues a warning if it does not satisfy requirements.

When this option is set, the verification will continue even if the system is under specified or its configuration is not as preferred by Polyspace software. Verified system parameters include the amount of RAM, the amount of swap space, and the ratio of RAM to swap.

-allow-unsupported-linux (Deprecated)

Note This option is deprecated in R2010a and later releases, and no longer exists in the user interface. Polyspace verification now continues regardless of the Linux distribution. If the Linux distribution is not officially supported, the software displays a warning in the log file.

This option specifies that Polyspace verification will be launched on an unsupported OS Linux distribution.

-quick (Deprecated)

Note This option is deprecated in R2009a and later releases.

`quick` mode is obsolete and has been replaced with verification `PASS0`. `PASS0` takes somewhat longer to run, but the results are more complete. The limitations of `quick` mode, (no NTL or NTC checks, no float checks, no variable dictionary) no longer apply. Unlike `quick` mode, `PASS0` also provides full navigation in the Viewer.

This option is used to select a very fast mode for Polyspace .

This option allows results to be generated very quickly. These are suitable for initial verification of red and gray errors only, as orange checks are too plentiful to be relevant using this option.

Check Descriptions

Colored Source Code for C

In this section...

“Illegal Pointer Access to Variable or Structure Field: IDP” on page 2-3

“Array Conversion Must Not Extend Range: COR” on page 2-4

“Array Index Within Bounds: OBAI” on page 2-5

“Initialized Return Value: IRV” on page 2-6

“Non-Initialized Variables: NIV/NIVL” on page 2-7

“Non-Initialized Pointer: NIP” on page 2-8

“POW (Deprecated)” on page 2-8

“User Assertion: ASRT” on page 2-8

“Scalar and Float Overflows: OVFL” on page 2-10

“Scalar and Float Underflows: UNFL (Deprecated)” on page 2-14

“Float Underflows and Overflows: UOVFL (Deprecated)” on page 2-14

“Scalar or Float Division by Zero: ZDV” on page 2-14

“Shift Amount in 0..31 (0..63):SHF” on page 2-15

“Left Operand of Left Shift is Negative: SHF” on page 2-16

“Function Pointer Must Point to a Valid Function: COR” on page 2-16

“Wrong Type for Argument: COR” on page 2-18

“Wrong Number of Arguments: COR” on page 2-19

“Wrong Return Type of a Function Pointer: COR” on page 2-20

“Wrong Return Type for Arithmetic Functions: COR” on page 2-20

“Pointer Within Bounds: IDP” on page 2-21

“Non Termination of Call or Loop” on page 2-34

“Unreachable Code: UNR” on page 2-45

“Inspection Points” on page 2-47

Illegal Pointer Access to Variable or Structure Field: IDP

This is a check to establish whether in the dereferencing of an expression of the form $ptr+i$, the variable/structure field initially pointed to by ptr is still the one accessed. See ANSI C standard ISO/IEC 9899 section 6.3.6.

Consider the following example.

```
1 int a;
2
3 struct {
4     int f1;
5     int f2;
6     int f3;
7 } S;
8
9 void main(void)
10 {
11     volatile int x;
12
13     if (x)
14         *(&a+1) = 2;
15     // IDP ERROR: &a +1 doesn't point to a any longer
16     if (x)
17         *(&S.f1 +1) = 2;
18     // IDP ERROR: you are not allowed to access f2 like this
19 }
```

According to the ANSI C standard, it is not permissible to access a variable (or a structure field) from a pointer to another variable. That is, $ptr+i$ may only be dereferenced if $ptr+i$ is the address of a subpart of the object pointed to by ptr (such as an element of the array pointed to by ptr , or a field of the structure pointed to by ptr).

For instance, the following code is correct because the length of the entity pointed to by ptr_s reflects the full structure length of My_struct (at line 11):

```
1 typedef struct {
2     int f1;
3     int f2;
```

```
4 int f3;
5 } My_Struct;
6
7 My_Struct s = {1,2,3};
8
9 int main(void)
10 {
11 My_Struct *ptr_s = &s;
12
13 // change to f2 field
14 *((int *)&s +1) = 2; // Correct evaluation
15
16 return 0;
17 }
```

Array Conversion Must Not Extend Range: COR

This is a check to establish whether a small array is mapped onto a bigger one through a pointer cast. Consider the following example.

```
1
2 typedef int Big[100];
3 typedef int Small[10];
4 typedef short EquivBig[200];
5
6 Small smalltab;
7 Big bigtab;
8
9 void main(void)
10 {
11 volatile int random;
12
13 Big * ptr_big = &bigtab;
14 Small * ptr_small = &smalltab;
15
16 if (random) {
17     Big *new_ptr_big = (Big*)ptr_small; // COR ERROR: array
conversion must not extend range
18 }
19 if (random) {
20     EquivBig *ptr_equivbig = (EquivBig*)ptr_big;
```

```
21  Small *ptr_new_small = (Small*)ptr_big; // Conversion
    verified
22  }
23  }
```

In the example above, a pointer is initialized to the *Big* array with the address of the *Small* array. This is not legal since it would be possible to dereference this pointer outside the *Small* array. Line 20 shows that the mapping of arrays with same size and different prototypes is acceptable.

Array Index Within Bounds: OBAI

This is a check to establish whether an index accessing an array is compatible with the length of that array.

The message associated with an OBAI check provides the range of the array. For example: Array index out of bounds [0..1023].

Consider the following example.

```
1
2 #define TAILLE_TAB 1024
3 int tab[TAILLE_TAB];
4
5 void main(void)
6 {
7     int index;
8
9     for (index = 0; index < TAILLE_TAB ; index++)
10    {
11        tab[index] = 0;
12    }
13    tab[index] = 1;
14    // OBAI ERROR: Array index out of bounds [0..1023]
15 }
```

Just after the loop, *index* equals *SIZE_TAB*. Thus *tab[index] = 1* overwrites the memory cell just after the last array element.

An OBAI check can also be localized on a + operator, as another example illustrates.

```
1 int tab[10];
2
3 void main(void)
4 {
5     int index;
6     for (index = 0; index < 10 ; index++)
7         *(tab + index) = 0;
8
9     *(tab + index) = 1; // OBAI ERROR: Array index out of bounds
10 }
```

Initialized Return Value: IRV

This is a check to establish whether a function returns an initialized value. Consider the following example.

```
1
2 extern int random_int(void);
3
4 int reply(int msg)
5 {
6     int rep = 0;
7     if (msg > 0) return rep;
8 }
9
10 void main(void)
11 {
12     int ans;
13
14     if (random_int())
15         ans = reply(1); // IRV verified: function returns an
initialised value
16     else if (random_int())
17         ans = reply(0); // IRV ERROR: function does not return an
initialised value
18     else
19         reply(0); // No IRV checks because the return value
is not used
```



```

20
21 }
22
23

```

Variables are often initialized using the return value of functions. However, in the above example the return value is not initialized for all input parameter values. In this case, the target variable will not be always be properly initialized with a valid return value.

Non-Initialized Variables: NIV/NIVL

This is a check to establish whether a variable is initialized before being read. Consider the following example.

```

1
2 extern int random_int(void);
3
4 void main(void)
5 {
6   int x,i;
7   double twentyFloat[20];
8   int y = 0;
9
10  if (random_int()) {
11    y += x; // NIV ERROR: Non
Initialised Variable (type: int 32)
12  }
13  if (random_int()) {
14    for (i = 1; i < 20; i++) {
15      if (i % 2) twentyFloat[i] = 0.0;
16    }
17    twentyFloat[2] = twentyFloat[4] + 5.0; // NIV Warning.
Only odd indexes are initialized.
18  }
19 }

```

The result of the addition is unknown at line 11 because *x* is not initialized (UNR unreachable code on "+" operator).

In addition, line 17 shows how Polyspace software prompts the user to investigate further (by means of an **orange** check) when all cells have not been initialized.

Note Associated to each message which concerns a NIV check, Polyspace software gives the type of the variable like the following examples: (type: volatile int32), (type: int 16), (type: unsigned int 8), etc.

Non-Initialized Pointer: NIP

Check to establish whether a reference is initialized before being dereferenced. Consider the following example.

```
2
3 void main(void)
4 {
5     int* p;
6     *p = 0; // NIP ERROR: reference is not initialized
7 }
```

As p is not initialized, an undefined memory cell would be overwritten at line 6 ($*p = 0$) (also leading to the unreachable **gray** check on `"*`).

POW (Deprecated)

Note The POW check is deprecated in R2009a and later. The POW check no longer appears in Polyspace results.

Check to establish whether the standard **pow** function from `math.h` library is used with an acceptable (positive) argument.

User Assertion: ASRT

This is a check to establish whether a user assertion is valid. If the assumption implied by an assertion is invalid, then the standard behavior of the `assert` macro is to abort the program. Polyspace verification therefore considers a failed assertion to be a runtime error. Consider the following example.

```
1 #include <assert.h>
2
3 typedef enum
4 {
5     monday=1, tuesday,
6     wensday, thursday,
7     friday, saturday,
8     sunday
9 } dayofweek ;
10
11 // stubbed function
12 dayofweek random_day(void);
13 int random_value(void);
14
15 void main(void)
16 {
17     unsigned int var_flip;
18     unsigned int flip_flop;
19     dayofweek curDay;
20     unsigned int constant = 1;
21
22     if (random_value()) flip_flop=1; else flip_flop=0;
23     // flip_flop can randomly be 1 or 0
24     var_flip = (constant | random_value());
25     // var_flip is always > 0
26
27     if(random_value()) {
28         assert(flip_flop==0 || flip_flop==1); // User Assertion is
29         verified
30         assert(var_flip>0); // User Assertion is
31         verified
32         assert(var_flip==0); // ASRT ERROR: Failure User
33         Assert
34     }
35
36     if (random_value()) {
37         curDay = random_day(); // Random day of the week
38         assert( curDay > thursday); // ASRT Warning: User
39         assertion may fails
40         assert( curDay > thursday); // User assertion is
```

```
verified
35  assert( curDay <= thursday); // ASRT ERROR: Failure User
Assertion
36  }
37  }
```

In the *main*, the *assert* function is used in two different manners:

- 1 To establish whether the values *flip_flop* and *var_flip* in the program are inside the domain which the program is designed to handle. If the values were outside the range implied by the *assert* (see line 28), then the program would not be able to run properly. Thus they are flagged as runtime errors.
- 2 To redefine the range of variables as shown at line 34 where *curDay* is restricted to just a few days. Indeed, Polyspace verification makes the assumption that if the program is executed without a runtime error at line 33, *curDay* can only have a value greater than *thursday* after this line.

Scalar and Float Overflows: OVFL

These are checks to establish whether arithmetic expressions overflow or underflow. This is a scalar check with integer type and float check for floating point expression. Consider the following example.

```
1 #include <float.h>
2 extern int random_int(void);
3
4 void main(void)
5 {
6  int i = 1;
7  float fvalue = FLT_MAX;
8
9  i = i << 30; // i = 2**30
10 if (random_int())
11  i = 2 * (i - 1) + 2; // OVFL ERROR: 2**31 is an overflow
value for int32
12 if (random_int())
13  fvalue = 2 * fvalue + 1.0; // OVFL ERROR: float variable is
overflow
14 }
```

On a 32 bit architecture platform, the maximum integer value is $2^{31}-1$, thus 2^{31} will raise an overflow.

In the same manner, if *fvalue* represents the biggest float its double cannot be represented with same type and raises an overflow.

How Much is the Biggest Float in C?

There are occasions when it is important to understand when overflow may occur on a float value approaching its maximum value. Consider the following example.

```
void main(void)
{
    float x, y;
    x = 3.40282347e+38f; // is green
    y = (float) 3.40282347e+38; // OVFL red
}
```

There is a **red** error on the second assignment, but not the first. The real "biggest" value for a float is: 340282346638528859811704183484516925440.0 - MAXFLOAT - .

Now, rounding is not the same when casting a constant to a float, or a constant to a double:

- floats are rounded to the nearest lower value;
- doubles are rounded to the nearest higher value;
- 3.40282347e+38 is strictly bigger than 340282346638528859811704183484516925440 (named MAXFLOAT).
- In the case of the second assignment, the value is cast to a double first - by your compiler, using a temporary variable D1 -, then into a float - another temporary variable -, because of the cast. Float value is greater than MAXFLOAT, so the check is **red**.
- In the case of the first assignment, 3.40282347e+38f is directly cast into a float, which is less than MAXFLOAT

The solution to this problem is to use the "f" suffix to specify the variable directly as a float, rather than casting.

What is the Type of Constants/What is a Constant Overflow?

Consider the following example, which would cause an overflow.

```
int x = 0xFFFF; /* OVFL */
```

The type given to a constant is the first type which can accommodate its value, from the appropriate sequence shown below. (See “Predefined Target Processor Specifications” in the *Polyspace Products for C User’s Guide* for information about the size of a type depending on the target.)

| | |
|--------------|--|
| Decimals | int , long , unsigned long |
| Hexadecimals | Int, unsigned int, long, unsigned long |
| Floats | double |

For examples (assuming 16-bits target):

| | |
|--------|--------------|
| 5.8 | double |
| 6 | int |
| 65536 | long |
| 0x6 | int |
| 0xFFFF | unsigned int |
| 5.8F | float |
| 65536U | unsigned int |

The options `-ignore-constant-overflows` allow the user to bypass this limitation and consider the line:

```
int x = 0xFFFF; /* OVFL */ as int x = -1; instead of 65535, which does not fit into a 16-bit integer (from -32768 to 32767).
```

Left shift overflow on signed variables: OVFL

Overflows can be also be encountered in the case of left shifts on signed variables. In the following example, the higher order bit of `0x41021011`

(hexadecimal value of *1090654225*) has been lost, highlighting an overflow (integer promotion).

```

1
2 void main(void)
3 {
4   int i;
5
6   i = 1090654225 << 1; // OVFL ERROR: on left shift range
7 }

```

Float Underflow Versus Values Near Zero: OVFL

The definition of the word "underflow" differs between the ANSI standard and the ANSI/IEEE 754-1985 standard. According to the former definition, underflow occurs when a number is sufficiently negative for its type not to be capable of representing it. According to the latter, underflow describes the erroneous representation of a value close to zero due to the limits of its representation.

Polyspace verifications apply the former definition. The latter definition does not impose the raising of an exception as a result of an underflow. By default, processors supporting this standard permit the deactivation of such exceptions.

Consider the following example.

```

2 #define FLT_MAX 3.40282347e+38F // maximum representable
   float found in <float.h>
3 #define FLT_MIN 1.17549435e-38F // minimum normalised
   float found in <float.h>
4
5 void main(void)
6 {
7   float zer_float = FLT_MIN;
8   float min_float = -(FLT_MAX);
9
10  zer_float = zer_float * zer_float; // No check overflow
   near zero
11  min_float = min_float * min_float; // OVFL ERROR:
   underflow checked by verifier

```

```
12  
13 }
```

Scalar and Float Underflows: UNFL (Deprecated)

Note The UNFL check is deprecated in R2010a and later. The UNFL check no longer appears in Polyspace results. Instead of two separate UNFL and OVFL checks, a single OVFL check now appears.

These are checks to establish whether arithmetic expressions underflow. A scalar check is used with integer type, and a float check for floating point expressions. Consider the following example.

Float Underflows and Overflows: UOVFL (Deprecated)

Note The UOVFL check is deprecated in R2009a and later. The UOVFL check no longer appears in Polyspace results. Instead of a single UOVFL check, the results now display two checks, a UNFL and an OVFL.

The check UOVFL only concerns float variables. Polyspace verification shows an UOVFL when both overflow and underflow can occur on the same operation.

Scalar or Float Division by Zero: ZDV

This is a check to establish whether the right operand of a division (that is, the denominator) is different from 0[.0]. Consider the following example.

```
1 extern int random_value(void);  
2  
3 void zdvs(int p)  
4 {  
5     int i, j = 1;  
6     i = 1024 / (j-p); // ZDV ERROR: Scalar Division by Zero  
7 }  
8
```



```

9 void zdvf(float p)
10 {
11     float i,j = 1.0;
12     i = 1024.0 / (j-p); // ZDV ERROR: float Division by Zero
13 }
14
15 int main(void)
16 {
17     volatile int random;
18     if (random_value()) zdvs(1);
19     // NTC ERROR: because of ZDV ERROR
20     in ZDVS.
21     if (random_value()) zdvf(1.0);
22     // NTC ERROR: because of ZDV ERROR
23     in ZDVF.
24 }

```

Shift Amount in 0..31 (0..63):SHF

This is a check to establish whether a shift (left or right) is bigger than the size of the integral type operated upon (int or long int). The range of allowed shift depends on the target processor: 16 bits on *c-167*, 32 bits on *i386* for int, etc. Consider the following example.

```

1 extern int random_value(void);
2
3 void main(void)
4 {
5     volatile int x;
6     int k, l = 1024; // 32 bits on i386
7     unsigned int v, u = 1024;
8
9     if (x) k = l << 16;
10    if (x) k = l >> 16;
11
12    if (x) k = l << 32; // SHF ERROR
13    if (x) k = l >> 32; // SHF ERROR
14
15    if (x) v = u >> 32; // SHF ERROR
16    if (x) k = u << 32; // SHF ERROR
17

```

```
18 }
```

In this example, it is shown that the shift amount is greater than the integer size.

Left Operand of Left Shift is Negative: SHF

This is a check to establish whether the operand of a left shift is a signed number. Consider the following example.

```
1
2
3 void main(void)
4 {
5   int x = -200;
6   int y;
7
8   y = x << 1; // SHF ERROR: left operand must be positive
9
10 }
```

As an aside, note that the `-allow-negative-operand-in-shift` option used at launching time instructs Polyspace software to permit explicitly signed numbers on shift operations. Using the option in the example above would see the **red** check at line 8 transformed in a **green** one. Similarly, if the verification had included the expression `-2 << 2` at line 9, then that line would have been given a **green** check and `y` would assume a values of `-8`.

Function Pointer Must Point to a Valid Function: COR

This is a check to establish whether a function pointer points to a valid function, or to function with a valid prototype. Consider the following example.

```
1
2 typedef void (*Callback)(float *data);
3 typedef struct {
4   int a;
5   char name[20];
6   Callback func;
7 } funcS;
8
```

```
9 funcS myvar;
10 Callback cb;
11
12 void My_function(float *data)
13 {
14     *data = 2;
15 }
16
17 static void Struct_not_init_art_ptr_def(void)
18 {
19     cb = &My_function;
20 }
21
22 int main(void)
23 {
24     float fval=0;
25
26     cb = myvar.func;
27     cb(&fval); // COR ERROR: function pointer must point
                // to a valid function
28     return 0;
29 }
```

In the example above, `func` has a prototype in conformance with the declaration of `Callback`. Therefore, `func` is initialized to point to the `NULL` function through the global declaration of `funcS`. So a `NULL` pointer is assigned to the `cb` local variable.

Consider a second example.

```
1
2 #define MAX_MEMSEG 32764
3 typedef void (*ptrFunc)(int memseg);
4 ptrFunc initFlash = (ptrFunc)(0x003c);
5
6 void main(void)
7 {
8     int i;
9
10    for (i = 0 ; i < MAX_MEMSEG; i++) // NTL propagation
```

```
11 {
12   initFlash(i); // COR ERROR: function pointer must point to a
13   valid function
14 }
15 }
```

As Polyspace verification does not take the memory mapping of programs into account, it cannot ascertain whether `0x003` is the address of a function code segment or not (for instance, as far as Polyspace verification is concerned it could be a data segment). Thus a certain (red) error is raised.

Wrong Type for Argument: COR

This is a check to establish whether each argument passed to a function matches the prototype of that function. Consider the following example.

```
1
2 typedef struct {
3   float r;
4   float i;
5 } complex;
6
7 typedef int (*t_func)(complex*);
8
9 int foo_type(int *x)
10 {
11   if (*x%2 == 0) return 0;
12   else return 1;
13 }
14
15 void main(void)
16 {
17   t_func ptr_func;
18   int j,i = 0;
19
20   ptr_func = foo_type;
21   j = ptr_func(&i); // COR ERROR: wrong type of argument for #1
22 }
23
```

In this example, *ptr_func* is a pointer to a function which expects a pointer to a *complex* as input argument. However, the parameter used is a pointer to an *int*.

Wrong Number of Arguments: COR

This is a check to establish whether the number of arguments passed to a function matches the number of arguments in its prototype. Consider the following example.

```
1
2 typedef int (*t_func_2)(int);
3 typedef int (*t_func_2b)(int,int);
4
5 int foo_nb(int x)
6 {
7     if (x%2 == 0)
8         return 0;
9     else
10        return 1;
11 }
12
13
14 void main(void)
15 {
16     t_func_2b ptr_func;
17     int i = 0;
18
19     ptr_func = (t_func_2b)foo_nb;
20     i = ptr_func(1,2); // COR ERROR: the wrong number of arguments
21 }
22
```

In this example, *ptr_func* is a pointer to a function that takes two arguments but it has been initialized to point to a function that only takes one.

Wrong Return Type of a Function Pointer: COR

This is a check to establish whether the return type passed to a function pointer matches the declaration in its prototype. Consider the following example.

```
1
2 typedef int (*t_func_2)(int);
3 typedef double (*t_func_2b)(int);
4
5 int foo_nb(int x)
6 {
7     if (x%2 == 0)
8         return 0;
9     else
10        return 1;
11 }
12
13
14 void main(void)
15 {
16     t_func_2b ptr_func;
17     int i = 0;
18
19     ptr_func = (t_func_2b)foo_nb;
20     i = ptr_func(1,2); // COR ERROR: function pointer must
                        // point on a valid function
21                     // COR Warning: return type of function
                        // is INT but a FLOAT was expected
22 }
23
```

In this example, *ptr_func* is a pointer to a function that return a double but it has been initialized to point to a function that returns an int. The understanding of the red error is given in the orange associated COR message.

Wrong Return Type for Arithmetic Functions: COR

This is a check to establish whether that a wrong return type is used for an arithmetic function.

Using arithmetic functions without including `<math.h>` is compiler dependent in the real world because compiler could associate a integral return type to an implicit function.

However, as arithmetic functions are built-in in Polyspace software, you can face an inconsistency problem `<math.h>` is not explicitly included in the code file where an arithmetic function is used. All arithmetic function declared in `<math.h>` are concerned.

Consider the following examples:

Results without `<math.h>`:

```
1
2 int main(void) {
3
4 double x;
5 x = cos(2*3.1415); // COR ERROR: return type of
6 }                  function cos is INT 32 but a float 64 was expected
```

Results with `<math.h>`:

```
1 #include <math.h>
2 int main(void) {
3
4 double x;
5 x = cos(2*3.1415);
6 }
```

In the previous example without the definition of `<math.h>`, `cos` is declared without prototype and default return type is an `int32`.

Pointer Within Bounds: IDP

Check to establish whether a reference refers to a valid object (whether a dereference pointer is still within the bounds of the object it intended to point to).

Consider the following example.

```
1
2 #define TAILLE_TAB 1024
3 int tab[TAILLE_TAB];
4 int *p = tab;
5
6 void main(void)
7 {
8
9     int index;
10
11     for (index = 0; index < TAILLE_TAB ; index++, p++)
12     {
13         *p = 0;
14     }
15
16     *p = 1; // IDP ERROR: reference refers to an invalid object
17 }
```

In the example, the pointer *p* is initialized to point to the first element of the *tab* array at line 4. When the loop is exited, *p* points beyond the last element of the array.

Thus line 16 overwrites memory illegally.

Understanding Addressing

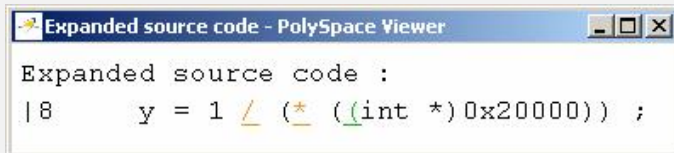
- “I Systematically Have an Orange Out of Bounds Access On My Hardware Register” on page 2-22
- “The NULL Pointer Case” on page 2-24
- “Comparing Address” on page 2-26

I Systematically Have an Orange Out of Bounds Access On My Hardware Register. Many code verifications exhibit **orange** out of bound checks with respect to accesses to absolute addresses and/or hardware registers.

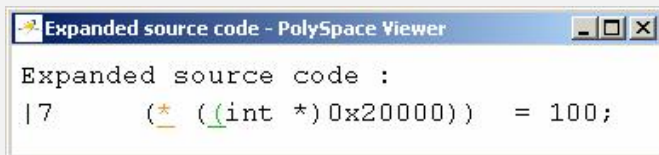
(Also refer to the discussion on Absolute Addressing)

Here is an example of what such code might look like:

```
#define X (* ((int *)0x20000))
X = 100;
y = 1 / X; // ZDV check is orange because
// X ~ [-2^31, 2^31-1] permanently.
// The pointer out of bounds check is orange because 0x20000
// may address anything of any length
// NIV check is orange on X as a consequence
```



```
Expanded source code - PolySpace Viewer
Expanded source code :
|8   y = 1 / (* ((int *)0x20000)) ;
```



```
Expanded source code - PolySpace Viewer
Expanded source code :
|7   (* ((int *)0x20000)) = 100;
```

```
3 void main (void)
4 {
5 int y;
6
7 X = 100;
8 y = 1 / X;
9
10 }
```

```
int *p = (int *)0x20000;
*p = 100;
y = 1 / *p; // ZDV check is orange because
// *p ~ [-2^31, 2^31-1] permanently
// The pointer out of bounds is orange because 0x20000
// may address anything of any length
// NIV check on *p is orange as a consequence
```

This can be addressed by defining registers as regular variables:

| Replace | By |
|-----------------------------|--|
| <code>#define X</code> | <code>int X;</code> |
| <code>int *p;</code> | <code>int _p;#define p (&_p)</code> <hr/> Note Check that the chosen variable name (p in this example) doesn't already exist <hr/> |
| <code>int *p;</code> | <code>volatile int _p;int *p = &_p;</code> |

See “Volatile Variables” for a discussion of an approach which will help avoid the **orange check** on the pointer dereference, but retains the representation of a “full range” variable.

The NULL Pointer Case.

Consider the NULL address:

```
#define NULL ((void *)0)
```

- It is illegal to dereference this NULL address;
- 0 **is not** treated as an absolute address.

Therefore, the following code produces a **red** (IDP) check:

```
*NULL = 100; // IDP: pointer is outside its bounds
```

Assuming these declarations:-

```
int *p = 0x5;
volatile int y;
```

and these definitions:-

```
#define NULL ((void *) 0)
#define RAM_MAX ((int *)0xffffffff)
```

consider the code snippets below.

```
While (p != (void *)0x1)
    p--; // terminates
```

0x1 is an absolute address, it can be reached and the loop terminates

```
for (p = NULL; p <= RAM_MAX; p++)
{
    *p = 0; // Red IDP: pointer is outside its bounds
}
```

At the first iteration of the loop p is a NULL pointer. Dereferencing a NULL pointer is forbidden.

```
While (p != NULL)
{
    p--;
    *p = 0; // Orange IDP: pointer may be outside its bounds
}
```

When p reaches the address 0x0, there is an attempt to considered it as an absolute address

In effect, it is an attempt to dereference a NULL pointer - which is forbidden.

Note In this case, the **check** is **orange** because the execution of the code here is OK (**green**) until 0x0 is reached (**red**)

The best way to address this issue depends on the purpose of the function.

- Thanks to the default behavior of Polyspace software, it is easy to automatically stub a function whose purpose is to copy data from/to RAM or to compute a checksum on RAM.
- If a function is supposed to copy calibration data, it should also be stubbed automatically.
- If the purpose of a function is to map EEPROM data to global variables, then a manually written stub is essential to ensure the assignment of the correct initialization values to them.

Comparing Address. Polyspace software only deals with the information referred to by a pointer, and not the physical location of a variable. Consequently it does not compare addresses of variables, and makes no assumption regarding where they are located in memory.

Consider the following two examples of Polyspace verification behavior:

```
int a,b;
if (&a > &b) // condition can be true and/or false
{ } // both branches are reachable
else
{ } // both branches are reachable
```

and

```
int x,z;
void main(void)
{ int i;
  x = 12;
  for (i=1; i<= 0xffffffff; i++)
  {
```

```

    *((int *)i) = 0;
}
z = 1 / x; // ZDV green check because Polyspace doesn't consider
           // any relationship between x and its address
}

```

“x” is aliased by no other variable. No pointer points to “x” in this example, so as far as the Polyspace verification is concerned, “x” remains constantly equal to 12.

Understanding Pointers

Polyspace software does not analyze anything which would require the physical address of a variable to be taken into account.

- Consider two variables x and y. Polyspace verification will not make a meaningful comparison of “&x” (address of x) and “&y”
- So, the Boolean (&x < &y) can be true or false as far as Polyspace verification is concerned.

However, Polyspace verification does keep track of the pointers that point to a particular variable.

- So, if ptr points to X, *ptr and X will be synonyms.

Address Alignment: the bitfield Example. Structure size depends on bit alignment.

Consider the following example, where an attempt is made to map a character to a bitfield.

```

struct reg {
    unsigned int a: 5;
    unsigned int b: 3;
};
int main()
{
    volatile unsigned char c;
    struct reg *r;
    r = (struct reg *) &c;
}

```

```
    if (r-> a == 10)
        return 1;
    return 0;
}
```

Consider a 32 bit target architecture (so int are 32 bits, i.e. 4 bytes). The size of a bit field is the size of the type of its elements. In the example above, the elements in the bit field are unsigned int, hence the size is 4 bytes. Since this is greater than 1, the structure reg cannot be contained in the char c.

This can be solved by using the unsigned char type for the elements in the bit field. The size of the bit field is then 1 byte and there is therefore no red error.

```
struct reg {
    unsigned char a: 5;
    unsigned char b: 3;
};
int main()
{
    volatile unsigned char c;
    struct reg *r;
    r = (struct reg *) &c;
    if (r-> a == 10)
        return 1;
    return 0;
}
```

Note You must also use the option `-allow-non-int-bitfield` to implement this solution, since this is an extension to the ANSI standard.

How Does malloc Work for Polyspace Verification? Polyspace verification accurately models malloc, such that both the possible return values of a null pointer and the requested amount of memory are taken into account.

Consider the following example.

```
void main(void)
{
```

```

char *p;
char *q;
p = malloc(120);
q = p;
*q = 'a'; // results in an orange dereference check
}

```

This code will avoid the orange dereference:

```

void main(void)
{
char *p;
char *q;
p = malloc(120);
q = p;
if (p!= NULL)
    *q = 'a'; // results in a green dereference check
}

```

Data Mapping into a Structure . It often happens that structured data are read as a char array. Before manipulating them it might be desirable to map those data into a structure that reflects their organization. In the following example an IDP warning (orange check) at line 22 suggests that the correctness of the code needs to be confirmed.

```

1
2
3 typedef struct
4 {
5     unsigned int MsgId;
6     union {
7         float fltv;
8         unsigned int intv;
9     } Msgbody;
10 } Message;
11
12 int random_int(void);
13 Message *get_msg(void);
14 void wait_idl(void);
15
16 void treatment_msg(char *msg)

```

```
17 {
18 Message *ptrMsg;
19
20 ptrMsg = (Message *)msg;
21 if (ptrMsg != NULL) {
22     if (ptrMsg->MsgId) { // IDP Warning: reference may not
refer to a valid object
23         // ...
24     }
25 }
26 }
27
28 int main (void) {
29
30     Message *msg;
31
32     while(random_int()) {
33         msg = get_msg();
34         if (msg) treatment_msg((char *)msg);
35         wait_idl();
36     }
37     return 0;
38 }
```

Mapping of a small structure into a bigger one. For example, suppose that p is a pointer to an object of type t_struct and it is initialized to point to an object of type t_struct_bis .

Now suppose that the size of t_struct_bis is less than the size of t_struct . Under these circumstances, it would be illegal to dereference p because it would be possible to access memory outside of t_struct_bis .

Consider the following example.

```
1 #include <malloc.h>
2
3 typedef struct {
4     int a;
5     union {
6         char c;
```



```

7  float f;
8  } b;
9  } t_struct;
10
11 void main(void)
12 {
13  t_struct *p;
14
15  // optimize memory usage
16  p = (t_struct *)malloc(sizeof(int)+sizeof(char));
17
18  p->a = 1; // IDP ERROR: not allowed to deference p
19
20 }

```

Partially allocated pointer (-size-in-bytes). According to the ANSI standard, the whole of a structure must be populated for that structure to be valid. In this case, the pointer is said to be fully allocated. A pointer is said to be partly allocated when only the first part of a structure is populated. In some development environments, that approach is tolerated despite the ANSI stance.

By default, Polyspace verification strictly conforms to the standard and checks for adherence to it. A more tolerant approach can be specified by using the `-size-in-bytes` option. So, depending on the `-size-in-bytes` option, when a partially allocated pointer is encountered during a Polyspace verification, the first elements of the allocated object may or may not be considered as valid.

First consider the following example. (A second example follows it to illustrate how this might apply to pointer arithmetic within a structure)

```

1  typedef struct _little { int a; int b; } LITTLE;
2  typedef struct _big { int a; int b; int c; } BIG;
3
4  int main(void)
5  {
6  BIG *p = malloc(sizeof(LITTLE));
7  volatile int y;

```

With `-size-in-bytes` option

```
9  if (p==(void *)0) return 0;
10 if(y) { p->a = 0; } // green
11 if(y) { p->b = 0; } // green
12 if(y) { p->c = 0; } // red
}
```

Default launching option

```
9  if(y) { p->a = 0 ; } // red
10 if(y) { p->b = 0 ; } // red
11 if(y) { p->c = 0 ; } // red
12
13 if (p==(void *)0)
14     return 0;
15 else
16     return 1; // dead code
17 return 1;
18 }
```

With the standard launching option, a pointer that has not been allocated to a complete structure is considered invalid, or NULL (as shown in the dead code).

Pointer to a structure field. According to the ANSI C standard, pointer arithmetic is to be independent of the size of the object (structure or array) to which the pointer points. By default, Polyspace verification strictly conforms to the standard and checks for adherence to it.

In some development environments an approach that does not recognize that requirement is tolerated, despite the ANSI stance. Under those circumstances, results are likely to include **red** pointer out of bounds **checks** unexpectedly.

A more tolerant approach can be specified at launch time. Consider the following examples.

```
char *p; // the size of the object pointed to is unknown,
// but arithmetic on this pointer is well defined.
// p = p + 5; will increment the location pointed to by
5 bytes (if the
size of a char is 1 byte)
```

```

int x; // assuming that an int is 4 bytes
p = &x; *p = 0; // the first byte of x
p++; *p = 0; // the second byte of x
p++; *p = 0; // the third byte of x
p++; *p = 0; // the fourth byte of x
p++; *p = 0; // an out of bound access

```

For structures, the same behavior can be applied.

```

struct { int a; int b; } x;
char *p = &x.a; // the pointed object is not the structure
but the field
*p = 0; // it is the first byte of x.a
p++; *p = 0; // it is the second byte of x.a
p++; *p = 0; // it is the third byte of x.a
p++; *p = 0; // it is the fourth byte of x.a
p++; *p = 0; // here is an out of bound access because
we are out of the field

```

If you wish to tolerate an approach which allows a pointer to go from one field to another, you can do so by using the `-size-in-bytes` option **together with** the `-allow-ptr-arith-on-struct` option. When a pointer points to a field in a structure, you will then be allowed to access other fields from this pointer. Note that as a consequence, any other "out of bound" accesses in the code will be ignored.

An alternative solution is to make your variable point to the structure rather than to the field, as follows:

```

struct { int a; int b; } x;
char *p = &x; // the pointed object is the structure
*p = 0; // we are modifying x.a (first byte)
p++; *p = 0; // we are modifying x.a (second byte)
p++; *p = 0; // we are modifying x.a (third byte)
p++; *p = 0; // we are modifying x.a (fourth byte)
p++; *p = 0; // we are modifying x.b (fifth byte)

```

A further alternative is to follow the ANSI C recommendation to use the `"offsetof()"` function, which jumps to the corresponding offset within the structure:-

```
#include <stddef.h>
typedef struct _m { int a; int b; } S;
S x;
char *p = (char *) &x + offsetof(S,b); // points to field b
```

I have a red when reading a field of one structure. Consider the following example.

```
5 typedef struct {
6   unsigned char c1;
7   unsigned char c2;
8 } my_struct;
9
10 int main(void)
11 {
12   my_struct v;
13   unsigned short x=0,y=0;
14
15   v.c1=9;
16   v.c2=15;
17   x = *((unsigned short *)&v.c1);
```

Just like the example in “Pointer to a structure field” on page 2-32, the object pointed to is the field in the structure, not the structure itself. Therefore, it is only possible to navigate inside this field. A short variable occupies more memory than a char, so it is a red pointer out of bounds.

This can be addressed by replacing

```
x = *((unsigned short *)&v.c1);
```

with

```
y = (v.c1 << sizeof(v.c2)*8 ) | v.c2;
```

This solution also ensures that the code is no longer target dependent.

Non Termination of Call or Loop

NTC and NTL are informative red (or orange) checks.

- They are the only red checks which can be filtered out as shown below
- They don't stop the verification
- As for other red checks, code found after them are gray (unreachable)
- These checks may only be red. There are no "orange" NTL or NTC checks.
- They can reveal a bug, or can simply just be informative

| | |
|-----|---|
| NTL | <p>In a Non Terminating Loop, the break condition is never met. Here are some examples.</p> <pre>while(1) { function_call(); } // informative NTL</pre> <p>The following may reveal a bug:</p> <pre>while(x>=0) {x++; } // where x is an unsigned int.</pre> <p>The following red NTL reveals a bug in the array access, flagged in orange:</p> <pre>for(i=0; i<=10; i++) my_array[i] = 10; // where int my_array[10]; applies.</pre> <p>In the following example, the first iteration of the loop is red, and therefore it is flagged as an NTL. The "i++" will be gray, because the first iteration crashed.</p> <pre>ptr = NULL; for(i=0; i<=100; i++) *ptr=0; //</pre> |
| NTC | <p>Suppose that a function calls f(), and that function call is flagged with a red NTC check. There could be five distinct explanations:</p> <ul style="list-style-type: none"> • "f" contains a red error; • "f" contains an NTL ; • "f" contains an NTC; • "f" contains an orange which is context dependant; that is, it is either red or green. For this particular call, it makes the function "f" crash. |

- “f” is a mathematical function, such as sqrt, acos which has always an invalid input parameter

Remember, additional information can be found when clicking on the NTC

Note A sqrt check is only colored if the input parameter is **never** valid. For instance, if the variable x may take any value between -5 and 5, then sqrt(x) has no color.

The list of constraints which cannot be satisfied (found by clicking on the NTC check) represents the variables that cause the red error inside the function. The (potentially) long list of variables can help to understand the cause of the red NTC, as it shows each condition causing the NTC

- where the variable has a given value; and
- where the variable is not initialized. (Perhaps the variable is initialized outside the set of files under verification?).

If a function is identified which is not expected to terminate (such as a loop or an exit procedure) then the -known-NTC function is an option. You will find all the NTCs and their consequences in the k-NTC facility in the Viewer, allowing you to filter them.

Non Termination of a Call: NTC

This is a check to establish whether a procedure call returns. It is not the case when the procedure contains an endless loop or a certain error, or if the procedure calls another procedure which does not terminate. In the latter instance, the status of this check is propagated to caller.

```
1
2
3 void foo(int x)
4 {
5   int y;
6   y = 1 / x; // Warning ZDV: its depends of the context
```

```
7 while(1) { // NTL ERROR: loop never terminates
8   if ( y != x) {
9     y = 1 / (y-x);
10  }
11 }
12 }
13
14 void main(void) {
15   volatile int _x;
16
17   if (_x)
18     foo(0); // NTC ERROR: Zero DiVision (ZDV) in foo
19   if (_x)
20     foo(2); // NTC ERROR: Non Termination Loop (NTL) in foo
21
22 }
23
```

In this example, the function *foo* is called twice in *main* and neither of these 2 calls ever terminates.

- 1 The first never returns because a division by zero occurs at line 6 (bad argument value),
- 2 The second never terminates because of an infinite loop (red NTL) at line 7.

Also with reference to the example and as an aside, note that by using either the `-context-sensitivity "foo"` option or the `-context-sensitivity-auto` option at launch time it would be possible for Polyspace verification to show explicitly that a ZDV error comes from the **first** call of *foo* in *main*.

Note An NTC check can only be **red** or uncolored, unless you use the `-context-sensitivity` option. If you use the `-context-sensitivity` option, NTC checks can also be orange.

Known Non-Termination of a Call: k-NTC

By using the `-known-NTC` option with a specified function at launch time it is possible to transform an NTC check to a k-NTC check. Like NTC checks, k-NTC checks are propagated to their callers. Functions designed not to terminate can then be filtered out through the use of the appropriate filter in the viewer.

Consider the following example, supposing that `-know-NTC "SysHalt"` option has been applied at launch time.

```
1
2 /* external get data function */
3 extern int get_data(int *ptr,void *data);
4 extern int printf (const char *, ...);
5
6 // known NTC function
7 void SysHalt(int value)
8 {
9   printf("Halt value %d",value);
10  while (1) ; // NTL ERROR: Loop Never Terminate
11 }
12
13 #define OK 1
14 int main(void)
15 {
16   int data, *ptr = NULL;
17   int status = OK;
18
19   // get next store
20   status = get_data(ptr,(void *)&data);
21   if (status != OK)
22     SysHalt(status); // k-NTC check: Call never
terminate
23
24   return(0);
25 }
```

In the example, the relevant NTC check is converted to a k-NTC one.

Non Termination of Loop: NTL

This is a check to establish whether a loop (for, do-while or while) terminates. Consider the following example:

```
1
2 // Function prototypes
3 void send_data(double data);
4 void update_alpha(double *a);
5
6 void main(void)
7 {
8     volatile double _acq;
9     double acq, filtered_acq, alpha;
10
11     // Init
12     filtered_acq = 0.0;
13     alpha = 0.85;
14
15     while (1) { //NTL ERROR: Non Termination Loop
16         // Acquisition
17         acq = _acq;
18         // Treatment
19         filtered_acq = acq + (1.0 - alpha) * filtered_acq;
20         // Action
21         send_data(filtered_acq);
22         update_alpha(&alpha);
23     }
24 }
```

In the example, the continuation condition is always true and the loop will never exit. Polyspace verification will raise an error in trivial examples such as this, and in much more complex circumstances.

Consider this second verification. When an error is found inside a for, do-while, or while loop, Polyspace will not continue to propagate it.

```
1
2 void main(void)
3 {
4     int i;
```

```
5 double twentyFloat[20];
6
7 for (i = 0; i <= 20; i++) {
  // NTL ERROR: propagation of OBAI ERROR
8  twentyFloat[i] = 0.0; // OBAI Warning: 20 verification with i
  in [0,19] and one ERROR with i = 20
9 }
10 }
```

At line 8 in this second example, the **red** OBAI related to the **21st** execution of the loop has yielded the **orange check**. The 20 first executions would be no problem, so this **orange** warning represents a combination of **red** and **green** checks.

In the following example, verification flags an NTL on the **while**.

```
int random(void);
unsigned int x;
void foo(void)
{
  x = random();
  while (x!=0) {
  }
  x--;
}
```

If $x=0$, the **while** loop is not executed and the program jumps to $x--$; . If x is not 0, the **while** loop is executed, and x is not modified in the loop, therefore the loop never terminates.

Note An NTL check can only be **red** or uncolored, unless you use the `-context-sensitivity` option. If you use the `-context-sensitivity` option, NTL checks can also be orange.

Tooltips for NTL Checks. Tooltips provide range information in the viewer, including the number of iterations for loops.

There are 2 possible situations:

- **Loops that terminate** – A tooltip gives the number of iterations of the loop. For example, for `(i=0; i<10; i++)`, a tooltip on the `for` keyword says `Number of iteration(s): 10`.
- **Non-terminating loops** — The NTL check contains information about the maximum number of iterations that can be done. This number is an overset of the real number of iterations (which may be lower).

For example:

- **Failure at a given iteration**, for `(i=0; i<10; i++) y = 2 / (i - 5);` — The NTL check on the `for` keyword says: `Number of iteration(s): 6`

This means that the loop fails at the 6th iteration, which can help you find the orange check that contains the failure.

- **Infinite loop** `x = 0; while (x >= 0) y = 2;` — The NTL check on the `for` keyword says: `Number of iteration(s): 0..?`

This means that the loop has an unknown number of iterations (up to an infinite number). It does not mean that the loop *is* an infinite loop, but that it *may* be an infinite loop. You would also get `0..?` on the loop `while (1) { if (random) break; }.`

Arithmetic Expressions: NTC

This is a check to establish whether standard arithmetic functions are used with valid arguments, as defined in the following:

- Argument of *sqrt* must be positive (ISO®/IEC 9899 section 7.5.5.2)
- Argument of *tan* must be different from $\pi/2$ modulo π (ISO/IEC 9899 section 7.5.2.7)
- Argument of *log* must be strictly positive (ISO/IEC 9899 section 7.5.4.4)
- Argument of *acos* and *asin* must be within $[-1..1]$ (ISO/IEC 9899 sections 7.5.2.1 and 7.5.2.2)
- Argument of *exp* must be less than or equal to 709 (ISO/IEC 9899 section 7.5.4.1)
- Argument of *atanh* must be within $] -1..1[$ (ISO/IEC 9899 section 7.12.5.3)

- Argument of *acosh* must be greater or equal to 1 (ISO/IEC 9899 section 7.12.5.1)

A domain error (such that *errno* returns *EDOM*) occurs if an input argument is outside the domain over which the mathematical function is defined. A range error occurs (such that *errno* returns *ERANGE*) if the result cannot be represented as a double value. In the latter case, the function returns 0 if the result is too small, or *HUGE_VAL* with the appropriate sign if it is too big.

Consider the following example

```
1
2 #include <math.h>
3 #include <assert.h>
4
5 extern int random_int(void);
6
7 int main(void)
8 {
9
10  volatile double dbl_random;
11  const double  dbl_one = 1.0;
12  const double  dbl_mone = -1.0;
13
14  double sp      = dbl_random;
15  double p       = dbl_random;
16  double sn      = dbl_random;
17  double n       = dbl_random;
18  double no_trig_val_neg = dbl_random;
19  double no_trig_val_pos = dbl_random;
20  double pun     = dbl_random;
21  double res;
22
23  // assert is used here to redefine range values of variables
24  assert(sp > 0.0);
25  assert(p >= 0.0);
26  assert(sn < 0.0);
27  assert(n <= 0.0);
28  assert(pun < 1.0);
29  assert(no_trig_val_neg < -1.0); assert(no_trig_val_pos > 1.0);
```

```
30
31 if (random_int()) res = sqrt(sn);          // NTC ERROR:
need argument positive
32 if (random_int()) res = asin(no_trig_val_neg); // NTC ERROR:
need argument in range [-1..1]
33 if (random_int()) res = asin(no_trig_val_pos); // NTC ERROR:
need argument in range [-1..1]
34 if (random_int()) res = acos(no_trig_val_pos); // NTC ERROR:
need argument in range [-1..1]
35 if (random_int()) res = acos(no_trig_val_neg); // NTC ERROR:
need argument in range [-1..1]
36 if (random_int()) res = tan(1.5707963267948966); // NTC ERROR:
need argument in range ]-pi/2..pi/2[
37 if (random_int()) res = log(n);          // NTC ERROR:
need argument strictly positive
38 if (random_int()) res = exp(710);        // NTC ERROR:
need argument less or equal to 709
39
40 // No information about asin or acos because of random value
41 if (random_int()) {
42     res = asin(dbl_random);
43     res = acos(dbl_random);
44 }
45
46 // hyperbolic functions are available in the float range
47 if (random_int()) {
48     res = cosh(710);
49     res = cosh(10.0);
50     assert (res < 1.0);
51 }
52 if (random_int()) res = sinh(710);
53 if (random_int()) {
54     res = tanh(1.0);
55     assert (res > -1.0 && res < 1.0);
56 }
57
58 // inverted hyperbolic functions
59 if (random_int()) res = acosh(pun);      // NTC ERROR:
Need argument >= 1
60 else res = acosh(1.0);
```

```
61 if (random_int()) res = atanh(no_trig_val_neg); // NTC ERROR:
Need argument in ]-1..1[
62 if (random_int()) res = atanh(no_trig_val_pos); // NTC ERROR:
Need argument in ]-1..1[
63 if (random_int()) res = atanh(dbl_mone); // NTC ERROR:
Need argument in ]-1..1[
64 if (random_int()) res = atanh(dbl_one); // NTC ERROR:
Need argument in ]-1..1[
65
66 return 0;
67 }
68
```

sqrt, *tan*, *asin*, *acos*, *exp* and *log* errors are derived directly from the mathematical definition of functions. Polyspace verification highlights any definite problems by means of an NTC to show that this is where execution would terminate. No NTC information is delivered when Polyspace cannot determine the exact value of the argument, (for *asin* and *acos* at lines 42 and 43). No range restriction is currently made for hyperbolic functions.

Caution Due to a lack of precision in some areas, Polyspace verification is not always able to indicate a **red** NTC check on mathematical functions even where a problem exists. In the following example involving a *sqrt* function, neither an orange nor a red check is shown on line16 even though the variable *val2* is negative.

By default it is important to consider each call to any mathematical functions as though it had been highlighted by an **orange check**, and could therefore lead to a runtime error.

```
1
2 #include <math.h>
3
4 extern int random_int(void);
5
6 int main(void)
7 {
8
```

```
9 double val1, val2;
10
11 int i;
12 val2 = 5.0;
13 for (i = 0 ; i < 10 ; i++) {
14     val2 = val2 - 1.0;
15 }
16 val1 = sqrt(val2); // No check on sqrt
17 return ((int)val1);
18 }
19
```

Unreachable Code: UNR

This is a check to establish whether different code snippets (assignments, returns, conditional branches and function calls) are dead, such that they can never be accessed during the normal execution of the software. Dead, or Unreachable, code is represented by means of a gray coding on every check, with supplementary UNR checks also being added.

Consider the following example.

```
1
2 #define True 1
3 #define False 0
4
5 typedef enum {
6     Intermediate, End, Wait, Init
7 } enumState;
8
9 // pure stub
10 int intermediate_state(int);
11 int random_int(void);
12
13 int State (enumState stateval)
14 {
15     volatile int random;
16     int i;
17     if (stateval == Init) return False;
18     return True;
19 }
```

```
20
21 int main (void)
22 {
23     int i, res_end;
24     enumState inter;
25
26     res_end = State(Init);
27     if (res_end == False) {
28         res_end = State(End);
29         inter = (enumState)intermediate_state(0);
30         if (res_end || inter == Wait) { // UNR code on inter
== Wait
31             inter = End;
32         }
33         // use of I not initialized
34         if (random_int()) {
35             inter = (enumState)intermediate_state(i); // NIV ERROR
36             if (inter == Intermediate) { // UNR code because
of NIV ERROR
37                 inter = End;
38             }
39         }
40     } else {
41         i = 1; // UNR code
42         inter = (enumState)intermediate_state(i); // UNR code
43     }
44     if (res_end) { // UNR code always reached, but no else
45         inter = End;
46     }
47
48     return res_end;
49 }
50
```

The example illustrates three possible reasons why code might be unreachable, and hence be colored **gray**:

- At line 30, the first part of a two part test is always true. The other part is never evaluated, following the standard definition of logical operator "||".

- The piece of code after a **red** error is never evaluated by Polyspace software. The call to the function on line 35 and the line following it are considered to be dead code. Correcting the red error and relaunching would allow the color to be revised.
- At line 27, the test is always true (`if {` part), and the first branch is always executed. Consequently there is dead code in the other branch (that is, in the `else {` part at lines 41 to 42).

In addition, at line 44, there is an `if` statement without an `else` clause. In this instance, because there is no `else` clause and `res_end` is *always* true, the `if` keyword is colored **gray**.

Inspection Points

You can create inspection points in the code that provide range information.

For example:

```
#pragma Inspection_Point <var1> <var2>
```

where *var1* and *var2* are scalar variables, instructs the Polyspace verification to provide range information for *var1* and *var2* at that point in the code. You see this information in a tooltip message when you place your cursor over *var1* or *var2*.

Approximations Used During Verification

- “Why Polyspace Verification Uses Approximations” on page 3-2
- “Approximations Made by Polyspace Verification” on page 3-4

Why Polyspace Verification Uses Approximations

| In this section... |
|---|
| “What is Static Verification” on page 3-2 |
| “Exhaustiveness” on page 3-3 |

What is Static Verification

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.

Polyspace verification works by approximating the software under verification, using safe and 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 needed.

Using the static verification approach, the variable 'i' is modelled by its variation domain. For instance the model of 'i' is that it belongs to the [0..999] static interval. (Depending on the complexity of the data, convex polyhedrons, integer lattices and more elaborated 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 variation domain 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 does have an exact solution, but that solution is generally not practical, as it would generally require the enumeration of all possible test cases. As a result, approximation is required.

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.

Approximations Made by Polyspace Verification

In this section...

“Volatile Variables” on page 3-4

“Structures with Volatile Fields” on page 3-4

“Absolute Addresses” on page 3-5

“Pointer Comparison” on page 3-5

“Shared Variables” on page 3-5

“Trigonometric Functions” on page 3-6

“Unions” on page 3-6

“Constant Pointer” on page 3-7

Volatile Variables

Volatile variables are potentially uninitialized and their content is always full range.

```
2 int volatile_test (void)
3 {
4   volatile int tmp;
5   return(tmp); // NIV orange: the variable content is full range
6   [-2^31;2^31-1]
6 }
```

In the case of a global variable the content would also be full range, but the NIV check would be **green**.

Structures with Volatile Fields

In this example, although only the b field is declared as volatile, in practice any read access to the “a” field will be full range and **orange**.

```
2 typedef struct {
3   int a;
4   volatile int b;
5 } Vol_Struct;
```

Absolute Addresses

Both reading from, and writing to, an absolute address leads to warning checks on the pointer dereference. An absolute address is considered as a volatile variable.

```
Val = *((char *) 0x0F00); // NIV and IDP orange: access to an
absolute address
```

Pointer Comparison

Polyspace verification is a static tool verifying source code. Memory management concerns dynamic considerations, and the characteristics of particular compilers and targets. Polyspace verification therefore doesn't consider where objects are actually implanted in memory

```
5 int *i, *j, k;
6 i = (int *) 0x0F00;
7 j = (int *) 0x0FF0;
8
9 if ( i < j ) // the condition can be true or false
10  k = 12; // this line is reachable
11 else
12  k = 23; // this line is reachable too.
```

Its the same situation if “i” and “j” points to real variable

```
6 i = & one_variable;
7 j = & another_one;
9 if ( i < j ) // the condition can still be true or false
```

Shared Variables

At the minimum, a shared variable contains a union of all ranges it can contain among the application. At the maximum, the variable will be full range.

```
12 void p_task1(void)
13 {
14  begin_cs();
15  X = 0;
16  if (X) {
17  Y = X; // Verified NIV, although it should be gray
```

```
18  assert (Y == 12); // Warning assert, although it should be gray
19  }
20  end_cs();
21  }
22
23  void p_task2(void)
24  {
25  begin_cs();
26  X = 12;
27  Y = X + 1; // Polyspace considers [Y==1] or [Y==13]
28  if (Y == 13)
29  Y = 14;
30  else
31  Y = X - 1 ; // this line should be gray
32  end_cs();
33  }
```

Trigonometric Functions

With trigonometric functions, such as sines and cosines, verification sometimes assumes that the return value is bound between the limits of that function, regardless of the parameter passed to it. Consider the following example, which uses `acos`, `sin` and `asin` functions.

```
7  double res;
8
9  res = sin(3.141592654);
10 assert(res == 0.0); // Range is [-1..1]
11
12 res = acos(0.0);
13 assert(res == 0.0); // Range always in [0..pi]
14
15 res = asin(0.0);
16 assert(res == 0.0); // Always gives [0.0]
```

Unions

In some situations, unions can help you construct efficient code. However, unions can cause issues for code verification, for example:

- **Padding** – Padding might be inserted at the end of an union.

- **Alignment** – Members of structures within a union might have different alignments.
- **Endianness** – Whether the most significant byte of a word could be stored at the lowest or highest memory address.
- **Bit-order** – Bits within bytes could have both different numbering and allocation to bit fields.

These issues can cause Polyspace verification to lose precision when structure unions are considered. In fact, these kinds of implementation are compiler dependant. Conversions from one type a union to another will cause a loss of precision on two checks:

- Is the other field initialized? **Orange NIV**
- What is the content of the other field? **Full range**

```
typedef union _u {
  int a;
  char b[4]; } my_union;
my_union X;

X.b[0] = 1; X.b[1] = 1; X.b[2] = 1; X.b[3] = 1;
if (X.A == 0x1111)
  else // both branches are reachable
```

Constant Pointer

To increase Polyspace precision where pointers are analyzed, replace

```
const int *p = &y;
```

with:

```
#define p (&y)
```

3 Approximations Used During Verification

Examples

Complete Examples

| In this section... |
|-----------------------------------|
| “Simple C Example” on page 4-2 |
| “Apache Example” on page 4-2 |
| “cxref Example” on page 4-3 |
| “T31 Example” on page 4-3 |
| “Dishwasher1 Example” on page 4-3 |
| “Satellite Example” on page 4-4 |

Simple C Example

```
polyspace-c \  
-prog myCproject \  
-O1 \  
-I /home/user/includes \  
-D SUN4 -D USE_FILES \  

```

Apache Example

Here is a script for verifying the code for Apache (after proper formatting). The source code is in C and the compilation is for a Sun™.

Note The use of O0 to reduce verification time.

```
polyspace-c \ \  
-target sparc \  
-prog Apache \  
-keep-all-files \  
-allow-undef-variables \  
-continue-with-red-error \  
-O0 \  
-D PST \  
-D __GNUC_MINOR__=6 -D SOLARIS2=270 -D USE_EXPAT \  
-D NO_DL_NEEDED \  

```

```

-I sources \
-I /usr/local/pst/include.sparc \
-I /usr/include \
-results-dir RESULTS

```

cxref Example

Here is another C launch command. The compilation is for Linux. Note the escape characters, allowing quoted strings to be used as compiler defines.

```

polyspace-c \
-OS-target linux \
-prog cxref \
-OO \
-I `pwd` \
-I sources \
-I <<PolySpace_Verifer_InstallPath>>/include/include.linux \
-D CXREF_CPP='\"/usr/local/gcc/bin/cpp\"' \
-D PAGE='\"A4\"' \
-results-dir RESULTS

```

T31 Example

Another simple C launcher. There are a couple of tasks and compilation is for an m68k.

```

polyspace-c \
-target m68k \
-entry-points task_callback_main,task_tcp_main,cdtask_depm_main,
task_receiver \
-to pass1 \
-prog T31 \
-OO \
-results-dir `pwd`/RESULTS_31 \
-keep-all-files

```

Dishwasher1 Example

Another C example. This one is for the c-167 and has tasks protected by critical section.

```

polyspace-c \
-target c-167 \

```

```
-entry-points periodic,pst_main \  
-D PST -D const= -D water= \  
-from scratch \  
-to pass4 \  
-critical-section-begin "critical_enter:cs1" \  
-critical-section-end "critical_exit:cs1" \  
-prog dishwasher1 \  
-I `pwd`/sources \  
-O0 \  
-keep-all-files \  
-results-dir RESULTS
```

Satellite Example

A C example with tasks and critical sections.

```
polyspace-c  
-target c-167 \  
-entry-points ctask0,ctask1,ctask2,ctask3,interrupts \  
-O2 \  
-keep-all-files \  
-from scratch \  
-critical-section-begin "DisableInterrupts:sc1" \  
-critical-section-end "EnableInterrupts:sc1" \  
-ignore-constant-overflows \  
-include `pwd`/sources/options.h \  
-to pass4 \  
-prog satellite \  
-I `pwd`/sources \  
-results-dir RESULTS
```