IBM XL C/C++ for Multicore Acceleration for Linux,
V9.0

Compiler Reference

SC23-8516-00

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V9.0

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Note!
Before using this information and the product it supports, be sure to read the general information under "Notices" on page 311.

First Edition

This edition applies to IBM XL C/C++ for Multicore Acceleration for Linux on System p, V9.0 and IBM XL C/C++ for Multicore Acceleration for Linux on x86 Systems, V9.0. (Programs 5724-T42 & 5724-T43)

Contents

About this document

This document contains reference information for the IBM® XL C/C++ for Multicore Acceleration for Linux® compiler. Although it provides information on compiling and linking applications written in C and C++, it is primarily intended as a reference for compiler command-line options, pragma directives, predefined macros, built-in functions, environment variables, and error messages and return codes.

Who should read this document

This document is for experienced C or C++ developers who have some familiarity with the XL C/C++ compilers or other command-line compilers on UNIX® operating systems. It assumes thorough knowledge of the C or C++ programming language, and basic knowledge of operating system commands. Although this document is intended as a reference guide, programmers new to XL C/C++ can still use this document to find information on the capabilities and features unique to the XL C/C++ compiler.

How to use this document

Unless indicated otherwise, all of the text in this reference pertains to both C and C++ languages. Where there are differences between languages, these are indicated through qualifying text and icons, as described in "Conventions used in this document" on page viii. Additionally, unless indicated otherwise, all of the text in this document pertains to compilation targeting both the PowerPC® Processor Unit (PPU) and Synergistic Processor Unit (SPU).

XL C/C++ provides separate invocation commands depending on whether you are compiling for the PPU or SPU. PPU-targeted compilation uses commands prefixed with **ppu**; SPU-targeted compilation uses commands prefixed with **spu**. In addition to these prefixes, other forms of the invocation commands are provided that use different default compiler settings (these are described in "Invoking the compiler" on page 1). However, for convenience, this document may use the invocation commands **xlc** and **xlc++** to describe the actions of the C and C++ compiler, respectively. Similarly, to refer to the GCC-option utilities, **ppugxlc**, **spugxlc**, **ppugxlc**++ and **spugxlc++**, this document may use the simplied forms **gxlc** and **gxlc++** only.

While this document covers information on configuring the compiler environment, and compiling and linking C or C++ applications using XL C/C++ compiler, it does not include the following topics:

- Compiler installation: see the *XL C/C++ Installation Guide*. for information on installing XL C/C++.
- The C or C++ programming languages: see the *XL C/C++ Language Reference* for information on the syntax, semantics, and IBM implementation of the C or C++ programming languages.
- Programming topics: see the *XL C/C++ Programming Guide* for detailed information on developing applications with XL C/C++, with a focus on program portability and optimization.

How this document is organized

Chapter 1, “Compiling and linking applications,” on page 1 discusses topics related to compilation tasks, including invoking the compiler, preprocessor, and linker; types of input and output files; different methods for setting include file path names and directory search sequences; different methods for specifying compiler options and resolving conflicting compiler options; how to reuse GNU C/C++ compiler options through the use of the compiler utilities **gxlc** and **gxlc++**; and compiler listings and messages.

Chapter 2, “Configuring compiler defaults,” on page 19 discusses topics related to setting up default compilation settings, including setting environment variables, customizing the configuration file, and customizing the **gxlc** and **gxlc++** option mappings.

Chapter 3, “Compiler options reference,” on page 27 begins with a summary of options according to functional category, which allows you to look up and link to options by function; and includes individual descriptions of each compiler option sorted alphabetically.

Chapter 4, “Compiler pragmas reference,” on page 231 begins with a summary of pragma directives according to functional category, which allows you to look up and link to pragmas by function; and includes individual descriptions of pragmas sorted alphabetically.

Chapter 5, “Compiler predefined macros,” on page 273 provides a list of compiler macros according to category.

Chapter 6, “Compiler built-in functions,” on page 285 contains individual descriptions of XL C/C++built-in functions for PowerPC architectures, categorized by their functionality.

Conventions used in this document

Typographical conventions

The following table explains the typographical conventions used in this document.

Table 1. Typographical conventions

Typeface	Indicates	Example
bold	Lowercase commands, executable names, compiler options and directives.	If you specify **-O3**, the compiler assumes **-qhot=level=0**. To prevent all HOT optimizations with **-O3**, you must specify **-qnohot**.
italics	Parameters or variables whose actual names or values are to be supplied by the user. Italics are also used to introduce new terms.	Make sure that you update the *size* parameter if you return more than the *size* requested.
underlining	The default setting of a parameter of a compiler option or directive.	nomaf | maf

Table 1. Typographical conventions (continued)

Typeface	Indicates	Example
`monospace`	Programming keywords and library functions, compiler built-in functions, examples of program code, command strings, or user-defined names.	If one or two cases of a `switch` statement are typically executed much more frequently than other cases, break out those cases by handling them separately before the `switch` statement.

Icons

All features described in this document apply to both C and C++ languages. Where a feature is exclusive to one language, or where functionality differs between languages, the following icons are used:

The text describes a feature that is supported in the C language only; or describes behavior that is specific to the C language.

The text describes a feature that is supported in the C++ language only; or describes behavior that is specific to the C++ language.

Syntax diagrams

Throughout this document, diagrams illustrate XL C/C++ syntax. This section will help you to interpret and use those diagrams.

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.

  The ▸▸— symbol indicates the beginning of a command, directive, or statement.

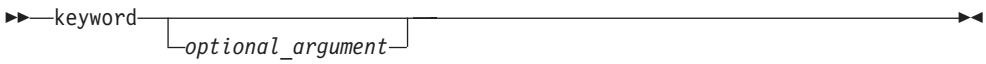
  The —▸ symbol indicates that the command, directive, or statement syntax is continued on the next line.

  The ▸— symbol indicates that a command, directive, or statement is continued from the previous line.

  The —▸◂ symbol indicates the end of a command, directive, or statement.

  Fragments, which are diagrams of syntactical units other than complete commands, directives, or statements, start with the |— symbol and end with the —| symbol.
- Required items are shown on the horizontal line (the main path):

- Optional items are shown below the main path:



- If you can choose from two or more items, they are shown vertically, in a stack.

  If you *must* choose one of the items, one item of the stack is shown on the main path.

If choosing one of the items is optional, the entire stack is shown below the main path.

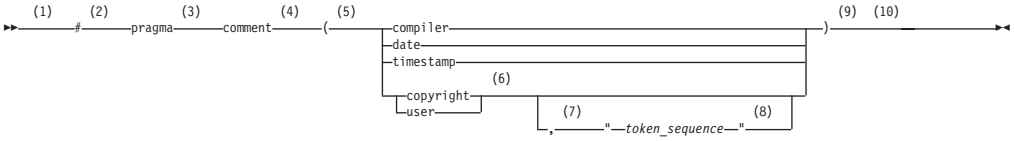
- An arrow returning to the left above the main line (a repeat arrow) indicates that you can make more than one choice from the stacked items or repeat an item. The separator character, if it is other than a blank, is also indicated:

- The item that is the default is shown above the main path.

- Keywords are shown in nonitalic letters and should be entered exactly as shown.
- Variables are shown in italicized lowercase letters. They represent user-supplied names or values.
- If punctuation marks, parentheses, arithmetic operators, or other such symbols are shown, you must enter them as part of the syntax.

Sample syntax diagram

The following syntax diagram example shows the syntax for the **#pragma comment** directive.



Notes:

1 This is the start of the syntax diagram.

2 The symbol # must appear first.

3 The keyword `pragma` must appear following the # symbol.

4 The name of the pragma `comment` must appear following the keyword `pragma`.

5 An opening parenthesis must be present.

6 The comment type must be entered only as one of the types indicated: `compiler`, `date`, `timestamp`, `copyright`, or `user`.

7 A comma must appear between the comment type `copyright` or `user`, and an optional character string.

8 A character string must follow the comma. The character string must be enclosed in double quotation marks.

9 A closing parenthesis is required.

10 This is the end of the syntax diagram.

The following examples of the **#pragma comment** directive are syntactically correct according to the diagram shown above:

```
#pragma comment(date)
#pragma comment(user)
#pragma comment(copyright,"This text will appear in the module")
```

Examples

The examples in this document, except where otherwise noted, are coded in a simple style that does not try to conserve storage, check for errors, achieve fast performance, or demonstrate all possible methods to achieve a specific result.

Related information

The following sections provide information on documentation related to XL C/C++:

IBM XL C/C++ publications

XL C/C++ provides product documentation in the following formats:

- Installable man pages

  Man pages are provided for the compiler invocations and all command-line utilities provided with the product. Instructions for installing and accessing the man pages are provided in the *XL C/C++ Installation Guide*.

- PDF documents

  PDF documents are located by default in the /opt/ibmcmp/xlc/cbe/9.0/doc/en_US/pdf/ directory.

  The following files comprise the full set of XL C/C++ product manuals:

Table 2. XL C/C++ PDF files

Document title	PDF file name	Description
IBM XL C/C++ for Multicore Acceleration for Linux, V9.0 Installation Guide, GC23-8520-00	install.pdf	Contains information for installing XL C/C++ and configuring your environment for basic compilation and program execution.
Getting Started with IBM XL C/C++ for Multicore Acceleration for Linux, V9.0, GC23-8518-00	getstart.pdf	Contains an introduction to the XL C/C++ product, with information on setting up and configuring your environment, compiling and linking programs, and troubleshooting compilation errors.
IBM XL C/C++ for Multicore Acceleration for Linux, V9.0 Compiler Reference, SC23-8516-00	compiler.pdf	Contains information about the various compiler options, pragmas, macros, environment variables, and built-in functions.

Table 2. XL C/C++ PDF files (continued)

Document title	PDF file name	Description
IBM XL C/C++ for Multicore Acceleration for Linux, V9.0 Language Reference, SC23-8519-00	langref.pdf	Contains information about the C and C++ programming languages, as supported by IBM, including language extensions for portability and conformance to non-proprietary standards.
IBM XL C/C++ for Multicore Acceleration for Linux, V9.0 Programming Guide, SC23-8517-00	proguide.pdf	Contains information on advanced programming topics, such as application porting, library development, application optimization, and the XL C/C++ high-performance libraries.

To read a PDF file, use the Adobe® Reader. If you do not have the Adobe Reader, you can download it (subject to license terms) from the Adobe Web site at http://www.adobe.com.

More documentation related to XL C/C++ including redbooks, white papers, tutorials, and other articles, is available on the Web at:

http://www.ibm.com/software/awdtools/xlcpp/library

Standards and specifications documents

XL C/C++ is designed to support the following standards and specifications. You can refer to these standards for precise definitions of some of the features found in this document.

- *Information Technology – Programming languages – C, ISO/IEC 9899:1990*, also known as *C89*.
- *Information Technology – Programming languages – C, ISO/IEC 9899:1999*, also known as *C99*.
- *Information Technology – Programming languages – C++, ISO/IEC 14882:1998*, also known as *C++98*.
- *Information Technology – Programming languages – C++, ISO/IEC 14882:2003(E)*, also known as *Standard C++*.
- *Information Technology – Programming languages – Extensions for the programming language C to support new character data types, ISO/IEC DTR 19769*. This draft technical report has been accepted by the C standards committee, and is available at http://www.open-std.org/JTC1/SC22/WG14/www/docs/n1040.pdf.
- *Draft Technical Report on C++ Library Extensions, ISO/IEC DTR 19768*. This draft technical report has been submitted to the C++ standards committee, and is available at http://www.open-std.org/JTC1/SC22/WG21/docs/papers/2005/n1836.pdf.
- *AltiVec Technology Programming Interface Manual*, Motorola Inc. This specification for vector data types, to support vector processing technology, is available at http://www.freescale.com/files/32bit/doc/ref_manual/ALTIVECPIM.pdf.

Other IBM publications

- *IBM C/C++ Language Extensions for Cell Broadband Engine Architecture*, available at http://www.ibm.com/developerworks/power/cell/documents.html
- Specifications, white papers, and other technical documents for the Cell Broadband Engine™ architecture are available at http://www.ibm.com/chips/techlib/techlib.nsf/products/Cell_Broadband_Engine.

- The Cell Broadband Engine resource center, at http://www.ibm.com/developerworks/power/cell, is the central repository for technical information, including articles, tutorials, programming guides, and educational resources.

Other publications

- *Using the GNU Compiler Collection* available at http://gcc.gnu.org/onlinedocs

How to send your comments

Your feedback is important in helping to provide accurate and high-quality information. If you have any comments about this document or any other XL C/C++ documentation, send your comments by e-mail to compinfo@ca.ibm.com.

Be sure to include the name of the document, the part number of the document, the version of XL C/C++, and, if applicable, the specific location of the text you are commenting on (for example, a page number or table number).

Chapter 1. Compiling and linking applications

By default, when you invoke the XL C/C++ compiler, all of the following phases of translation are performed:

- preprocessing of program source
- compiling and assembling into object files
- linking into an executable

These different translation phases are actually performed by separate executables, which are referred to as compiler *components*. However, you can use compiler options to perform only certain phases, such as preprocessing, or assembling. You can then reinvoke the compiler to resume processing of the intermediate output to a final executable.

The following sections describe how to invoke the XL C/C++ compiler to preprocess, compile and link source files and libraries:

Invoking the compiler

Different forms of the XL C/C++ compiler invocation commands support various levels of the C and C++ languages. In most cases, you should use the **xlc** command to compile your C source files, and the **xlc++** command to compile C++ source files. Use **xlc++** to link if you have both C and C++ object files. (For the Multicore Acceleration for Linux Processor platform, these commands are prefixed by **ppu** and **spu**, depending on whether you are targeting the PPU or SPU, respectively.)

You can use other forms of the command if your particular environment requires it. Table 3 on page 2 lists the different basic commands, with the "special" versions of each basic command. "Special" commands are described in Table 4 on page 3.

Note that for each invocation command, the compiler configuration file defines default option settings and, in some cases, macros; for information on the defaults implied by a particular invocation, see the /opt/ibmcmp/xlc/cbe/9.0/etc/vac.cfg file for your system.

Table 3. Compiler invocations

Basic invocations	Description	Equivalent special invocations
ppuxlc	Invokes the compiler for C source files and creates an executable that will run on the PPU. This command supports all of the ISO C99 standard features, and most IBM language extensions. This invocation is recommended for all applications targeting the PPU.	ppuxlc_r
spuxlc	Invokes the compiler for C source files and creates an executable that will run on the SPU. You must use this command for code you intend to run on the SPU.	
ppuc99	Invokes the compiler for C source files and creates an executable that will run on the PPU. This command supports all ANSI C89 features, and only the IBM language extensions related to vector processing. Use this invocation for strict conformance to the C99 standard.	ppuc99_r
ppuc89	Invokes the compiler for C source files and creates an executable that will run on the PPU. This command supports all ANSI C89 features, and only the IBM language extensions related to vector processing. Use this invocation for strict conformance to the C89 standard.	ppuc89_r
ppucc	Invokes the compiler for C source files and creates an executable that will run on the PPU. This command supports pre-ANSI C, and many common language extensions. You can use this command to compile legacy code that does not conform to standard C.	ppucc_r
ppugxlc	Invokes the compiler for C source files and creates an executable that will run on the PPU. This command accepts many common GNU C options, maps them to their XL C option equivalents, and then invokes **ppuxlc**. For more information, refer to "Reusing GNU C/C++ compiler options with **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++**" on page 10.	
spugxlc	Invokes the compiler for C source files and creates an executable that will run on the SPU. This command accepts many common GNU C options, maps them to their XL C option equivalents, and then invokes **spuxlc**. For more information, refer to "Reusing GNU C/C++ compiler options with **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++**" on page 10.	
ppuxlc++, ppuxlC	Invokes the compiler for C++ source files and creates an executable that will run on the PPU. If any of your source files are C++, you must use this invocation to link with the correct runtime libraries. Files with .c suffixes, assuming you have not used the **-+** compiler option, are compiled as C language source code.	ppuxlc++_r, ppuxlC_r
spuxlc++, spuxlC	Invokes the compiler for C++ source files and creates an executable that will run on the SPU. If any of your source files are C++, you must use this invocation to link with the correct runtime libraries. You must use this command for code you intend to run on the SPU. Files with .c suffixes, assuming you have not used the **-+** compiler option, are compiled as C language source code.	

Table 3. Compiler invocations (continued)

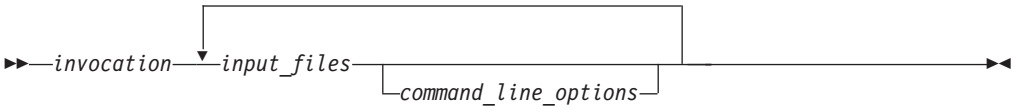
Basic invocations	Description	Equivalent special invocations
ppugxlc++, ppugxlC	Invokes the compiler for C++ files and creates an executable that will run on the PPU. This command accepts many common GNU C/C++ options, maps them to their XL C/C++ option equivalents, and then invokes **ppuxlc++**. For more information, refer to "Reusing GNU C/C++ compiler options with **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++**" on page 10.	
spugxlc++, spugxlC	Invokes the compiler for C++ files and creates an executable that will run on the SPU. This command accepts many common GNU C/C++ options, maps them to their XL C/C++ option equivalents, and then invokes **spuxlc++**. For more information, refer to "Reusing GNU C/C++ compiler options with **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++**" on page 10.	

Table 4. Suffixes for special invocations

_r-suffixed invocations	All **_r**-suffixed invocations allow for threadsafe compilation and you can use them to link the programs that use multi-threading. Use these commands if you want to create threaded applications.

Command-line syntax

You invoke the compiler using the following syntax, where *invocation* can be replaced with any valid XL C/C++ invocation command listed in Table 3 on page 2:



The parameters of the compiler invocation command can be the names of input files, compiler options, and linker options.

Your program can consist of several input files. All of these source files can be compiled at once using only one invocation of the compiler. Although more than one source file can be compiled using a single invocation of the compiler, you can specify only one set of compiler options on the command line per invocation. Each distinct set of command-line compiler options that you want to specify requires a separate invocation.

Compiler options perform a wide variety of functions, such as setting compiler characteristics, describing the object code and compiler output to be produced, and performing some preprocessor functions.

By default, the invocation command calls *both* the compiler and the linker. It passes linker options to the linker. Consequently, the invocation commands also accept all linker options. To compile without linking, use the **-c** compiler option. The **-c** option stops the compiler after compilation is completed and produces as output, an object file *file_name*.o for each *file_name.nnn* input source file, unless you use the

-o option to specify a different object file name. The linker is not invoked. You can link the object files later using the same invocation command, specifying the object files without the **-c** option.

Related information
- "Types of input files"

Types of input files

The compiler processes the source files in the order in which they appear. If the compiler cannot find a specified source file, it produces an error message and the compiler proceeds to the next specified file. However, the linker will not be run and temporary object files will be removed.

By default, the compiler preprocesses and compiles all the specified source files. Although you will usually want to use this default, you can use the compiler to preprocess the source file without compiling; see "Preprocessing" on page 11 for details.

You can input the following types of files to the XL C/C++ compiler:

C and C++ source files
These are files containing C or C++ source code.

To use the C compiler to compile a C language source file, the source file must have a .c (lowercase c) suffix, unless you compile with the **-qsourcetype=c** option.

To use the C++ compiler, the source file must have a .C (uppercase C), .cc, .cp, .cpp, .cxx, or .c++ suffix, unless you compile with the **-+** or **-qsourcetype=c++** option.

Preprocessed source files
Preprocessed source files have a .i suffix, for example, *file_name*.i. The compiler sends the preprocessed source file, *file_name*.i, to the compiler where it is preprocessed again in the same way as a .c or .C file. Preprocessed files are useful for checking macros and preprocessor directives.

Object files
Object files must have a .o suffix, for example, *file_name*.o. Object files, library files, and unstripped executable files serve as input to the linker. After compilation, the linker links all of the specified object files to create an executable file.

Assembler files
Assembler files must have a .s suffix, for example, *file_name*.s, unless you compile with the **-qsourcetype=assembler** option. Assembler files are assembled to create an object file.

Unpreprocessed assembler files
Unpreprocessed assembler files must have a .S suffix, for example, *file_name*.S, unless you compile with the **-qsourcetype=assembler-with-cpp** option. The compiler compiles all source files with a .S extension as if they are assembler language source files that need preprocessing.

Shared library files (PPU only)
Shared library files generally have a .a suffix, for example, *file_name*.a, but they can also have a .so suffix, for example, *file_name*.so.

Unstripped executable files
Executable and linking format (ELF) files that have not been stripped with the operating system **strip** command can be used as input to the compiler.

Related information
- Options summary by functional category: Input control

Types of output files

You can specify the following types of output files when invoking the XL C/C++ compiler:

Executable files
By default, executable files are named a.out. To name the executable file something else, use the **-o** *file_name* option with the invocation command. This option creates an executable file with the name you specify as *file_name*. The name you specify can be a relative or absolute path name for the executable file.

Object files
If you specify the **-c** option, an output object file, *file_name*.o, is produced for each input file. The linker is not invoked, and the object files are placed in your current directory. All processing stops at the completion of the compilation. The compiler gives object files a .o suffix, for example, *file_name*.o, unless you specify the **-o** *file_name* option, giving a different suffix or no suffix at all.

You can link the object files later into a single executable file by invoking the compiler.

Shared library files (PPU only)
If you specify the **-qmkshrobj** option, the compiler generates a single shared library file for all input files. The compiler names the output file a.out, unless you specify the **-o** *file_name* option, and give the file a .so suffix.

Assembler files
If you specify the **-S** option, an assembler file, *file_name*.s, is produced for each input file.

You can then assemble the assembler files into object files and link the object files by reinvoking the compiler.

Preprocessed source files
If you specify the **-P** option, a preprocessed source file, *file_name*.i, is produced for each input file.

You can then compile the preprocessed files into object files and link the object files by reinvoking the compiler.

Listing files
If you specify any of the listing-related options, such as **-qlist** or **-qsource**, a compiler listing file, *file_name*.lst, is produced for each input file. The listing file is placed in your current directory.

Target files
If you specify the **-M** or **-qmakedep** option, a target file suitable for inclusion in a makefile, *file_name*.d is produced for each input file.

Related information
- Options summary by functional category: Output control

Specifying compiler options

Compiler options perform a wide variety of functions, such as setting compiler characteristics, describing the object code and compiler output to be produced, and performing some preprocessor functions. You can specify compiler options in one or more of the following ways:

- On the command line
- In a custom configuration file, which is a file with a .cfg extension
- In your source program
- As system environment variables
- In a makefile

The compiler assumes default settings for most compiler options not explicitly set by you in the ways listed above.

When specifying compiler options, it is possible for option conflicts and incompatibilities to occur. XL C/C++ resolves most of these conflicts and incompatibilities in a consistent fashion, as follows:

In most cases, the compiler uses the following order in resolving conflicting or incompatible options:

1. Pragma statements in source code will override compiler options specified on the command line.
2. Compiler options specified on the command line will override compiler options specified as environment variables or in a configuration file. If conflicting or incompatible compiler options are specified in the same command line compiler invocation, the option appearing later in the invocation takes precedence.
3. Compiler options specified as environment variables will override compiler options specified in a configuration file.
4. Compiler options specified in a configuration file, command line or source program will override compiler default settings.

Option conflicts that do not follow this priority sequence are described in "Resolving conflicting compiler options" on page 9.

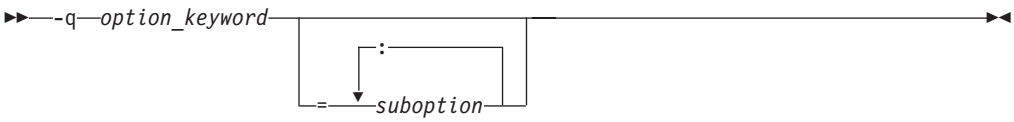
Specifying compiler options on the command line

Most options specified on the command line override both the default settings of the option and options set in the configuration file. Similarly, most options specified on the command line are in turn overridden by pragma directives, which provide you a means of setting compiler options right in the source file. Options that do not follow this scheme are listed in "Resolving conflicting compiler options" on page 9.

There are two kinds of command-line options:

- **-q***option_keyword* (compiler-specific)
- Flag options

-q options



Command-line options in the **-q***option_keyword* format are similar to on and off switches. For *most* **-q** options, if a given option is specified more than once, the last appearance of that option on the command line is the one recognized by the compiler. For example, **-qsource** turns on the source option to produce a compiler listing, and **-qnosource** turns off the source option so no source listing is produced. For example:

```
xlc -qnosource MyFirstProg.c -qsource MyNewProg.c
```

would produce a source listing for both `MyNewProg.c` and `MyFirstProg.c` because the last **source** option specified (**-qsource**) takes precedence.

You can have multiple **-q***option_keyword* instances in the same command line, but they must be separated by blanks. Option keywords can appear in either uppercase or lowercase, but you must specify the **-q** in lowercase. You can specify any **-q***option_keyword* before or after the file name. For example:

```
xlc -qLIST -qfloat=nomaf file.c
xlc file.c -qxref -qsource
```

You can also abbreviate many compiler options. For example, specifying **-qopt** is equivalent to specifying **-qoptimize** on the command line.

Some options have suboptions. You specify these with an equal sign following the **-q***option*. If the option permits more than one suboption, a colon (**:**) must separate each suboption from the next. For example:

```
xlc -qflag=w:e -qattr=full file.c
```

compiles the C source file `file.c` using the option **-qflag** to specify the severity level of messages to be reported. The **-qflag** suboption **w** (warning) sets the minimum level of severity to be reported on the listing, and suboption **e** (error) sets the minimum level of severity to be reported on the terminal. The **-qattr** with suboption **full** will produce an attribute listing of all identifiers in the program.

Flag options

XL C/C++ supports a number of common conventional flag options used on UNIX systems. Lowercase flags are different from their corresponding uppercase flags. For example, **-c** and **-C** are two different compiler options: **-c** specifies that the compiler should only preprocess and compile and not invoke the linker, while **-C** can be used with **-P** or **-E** to specify that user comments should be preserved.

XL C/C++ also supports flags directed to other programming tools and utilities (for example, the **ld** command). The compiler passes on those flags directed to **ld** at link time.

Some flag options have arguments that form part of the flag. For example:

```
xlc stem.c -F/home/tools/test3/new.cfg:xlc
```

where `new.cfg` is a custom configuration file.

You can specify flags that do not take arguments in one string. For example:

```
xlc -Ocv file.c
```

has the same effect as:

```
xlc -O -c -v file.c
```

and compiles the C source file `file.c` with optimization (**-O**) and reports on compiler progress (**-v**), but does not invoke the linker (**-c**).

A flag option that takes arguments can be specified as part of a single string, but you can only use one flag that takes arguments, and it must be the last option specified. For example, you can use the **-o** flag (to specify a name for the executable file) together with other flags, only if the **-o** option and its argument are specified last. For example:

```
xlc -Ovo test test.c
```

has the same effect as:

```
xlc -O -v -otest test.c
```

Most flag options are a single letter, but some are two letters. Note that specifying **-pg** (extended profiling) is not the same as specifying **-p -g** (**-p** for profiling, and **-g** for generating debug information). Take care not to specify two or more options in a single string if there is another option that uses that letter combination.

Specifying compiler options in a configuration file

The default configuration file (/opt/ibmcmp/xlc/cbe/9.0/etc/vac.cfg) defines values and compiler options for the compiler. The compiler refers to this file when compiling C or C++ programs. The configuration file is a plain text file. You can edit this file, or create an additional customized configuration file to support specific compilation requirements. For more information, see "Using custom compiler configuration files" on page 21.

Specifying compiler options in program source files

You can specify compiler options within your program source by using pragma directives. A pragma is an implementation-defined instruction to the compiler. For those options that have equivalent pragma directives, there are several ways to specify the syntax of the pragmas:

- Using **#pragma options** *option_name* syntax — Many command-line options allow you to use the **#pragma options** syntax, which takes the same name as the option, and suboptions with a syntax identical to that of the option. For example, if the command-line option is:

  ```
  -qhalt=w
  ```

  The pragma form is:

  ```
  #pragma options halt=w
  ```

  The descriptions for each individual option indicates whether this form of the pragma is supported; also, for a complete list of these, see "#pragma options" on page 255.
- Using **#pragma** *name* syntax — Some options also have corresponding pragma directives that use a pragma-specific syntax, which may include additional or slightly different suboptions. Throughout the section "Individual option

descriptions" on page 40, each option description indicates whether this form of the pragma is supported, and the syntax is provided.

- Using the standard C99 `_Pragma` operator — For options that support either forms of the pragma directives listed above, you can also use the C99 `_Pragma` operator syntax in both C and C++.

Complete details on pragma syntax are provided in "Pragma directive syntax" on page 231.

Other pragmas do not have equivalent command-line options; these are described in detail throughout Chapter 4, "Compiler pragmas reference," on page 231.

Options specified with pragma directives in program source files override all other option settings, except other pragma directives. The effect of specifying the same pragma directive more than once varies. See the description for each pragma for specific information.

Pragma settings can carry over into included files. To avoid potential unwanted side effects from pragma settings, you should consider resetting pragma settings at the point in your program source where the pragma-defined behavior is no longer required. Some pragma options offer **reset** or **pop** suboptions to help you do this. These suboptions are listed in the detailed descriptions of the pragmas to which they apply.

Resolving conflicting compiler options

In general, if more than one variation of the same option is specified (with the exception of **-qxref** and **-qattr**), the compiler uses the setting of the last one specified. Compiler options specified on the command line must appear in the order you want the compiler to process them.

Two exceptions to the rules of conflicting options are the **-I***directory* and **-L***directory* options, which have cumulative effects when they are specified more than once.

In most cases, the compiler uses the following order in resolving conflicting or incompatible options:

1. Pragma statements in source code override compiler options specified on the command line.
2. Compiler options specified on the command line override compiler options specified as environment variables or in a configuration file. If conflicting or incompatible compiler options are specified on the command line, the option appearing later on the command line takes precedence.
3. Compiler options specified as environment variables override compiler options specified in a configuration file.
4. Compiler options specified in a configuration file override compiler default settings.

Not all option conflicts are resolved using the above rules. The table below summarizes exceptions and how the compiler handles conflicts between them.

Option	Conflicting options	Resolution
-qalias=allptrs	-qalias=noansi	-qalias=noansi
-qalias=typeptr	-qalias=noansi	-qalias=noansi
-qhalt	Multiple severities specified by **-qhalt**	Lowest severity specified

Option	Conflicting options	Resolution
-qnoprint	-qxref, -qattr, -qsource, -qlistopt, -qlist	-qnoprint
-qfloat=rsqrt	-qnoignerrno	Last option specified
-qxref	-qxref=full	-qxref=full
-qattr	-qattr=full	-qattr=full
-qfloat=hsflt	-qfloat=spnans	-qfloat=hsflt
-E	-P, -o, -S	-E
-P	-c, -o, -S	-P
-#	-v	-#
-F	-B, -t, -W, -qpath	-B, -t, -W, -qpath
-qpath	-B, -t	-qpath
-S	-c	-S
-qnostdinc	-qc_stdinc, -qcpp_stdinc, -qgcc_c_stdinc, -qgcc_cpp_stdinc	-qnostdinc

Reusing GNU C/C++ compiler options with ppugxlc, ppugxlc++, spugxlc, and spugxlc++

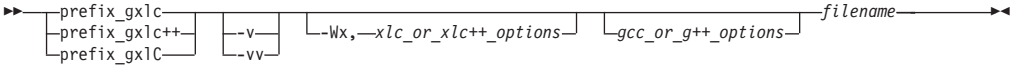
Each of the utilities accepts GNU C or C++ compiler options and translates them into comparable XL C/C++ options. Both utilities use the XL C/C++ options to create an **xlc** or **xlc++** invocation command, which they then use to invoke the compiler. These utilities are provided to facilitate the reuse of make files created for applications previously developed with GNU C/C++. However, to fully exploit the capabilities of XL C/C++, it is recommended that you use the XL C/C++ invocation commands and their associated options.

The actions of **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++** are controlled by the configuration file /opt/ibmcmp/xlc/cbe/9.0/etc/gxlc.cfg. The GNU C/C++ options that have an XL C or XL C++ counterpart are shown in this file. Not every GNU option has a corresponding XL C/C++ option. **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++** return warnings for input options that were not translated.

The **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++** option mappings are modifiable. For information on adding to or editing the **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++** configuration file, see "Configuring the **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** option mapping" on page 24.

ppugxlc, ppugxlc++, spugxlc, or spugxlc++ syntax

The following diagram shows the **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** syntax:



where:

*prefix_* Can be *ppu* or *spu*.

filename
Is the name of the file to be compiled.

-v Allows you to verify the command that will be used to invoke XL C/C++.

The utility displays the XL C/C++ invocation command that it has created, before using it to invoke the compiler.

-vv Allows you to run a simulation. The utility displays the XL C/C++ invocation command that it has created, but does not invoke the compiler.

-Wx,*xlc_or_xlc++_ options*
Sends the given XL C/C++ options directly to the **ppuxlc**, **ppuxlc++**, **spuxlc**, or **spuxlc++** invocation command. The utility adds the given options to the XL C/C++ invocation it is creating, without attempting to translate them. Use this option with known XL C/C++ options to improve the performance of the utility. Multiple *xlc_or_xlc++_ options* are delimited by a comma.

gcc_or_g++_options
Are the GNU C/C++ options that are to be translated to XL C/C++ options. The utility emits a warning for any option it cannot translate. The GNU C/C++ options that are currently recognized by **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** are in the configuration file gxlc.cfg. Multiple *gcc_or_g++_options* are delimited by the space character.

Example

To use the GCC **-fstrict-aliasing** option to compile the C version of the Hello World program, you can use:

```
ppugxlc -fstrict-aliasing hello.c
```

which translates into:

```
ppuxlc -qalias=ansi hello.c
```

This command is then used to invoke the XL C compiler.

Related information
- "Configuring the **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** option mapping" on page 24

Preprocessing

Preprocessing manipulates the text of a source file, usually as a first phase of translation that is initiated by a compiler invocation. Common tasks accomplished by preprocessing are macro substitution, testing for conditional compilation directives, and file inclusion.

You can invoke the preprocessor separately to process text without compiling. The output is an intermediate file, which can be input for subsequent translation. Preprocessing without compilation can be useful as a debugging aid because it provides a way to see the result of include directives, conditional compilation directives, and complex macro expansions.

The following table lists the options that direct the operation of the preprocessor.

Option	Description
-E	Preprocesses the source files and writes the output to standard output. By default, `#line` directives are generated.

Option	Description
-P	Preprocesses the source files and creates an intermediary file with a .i file name suffix for each source file. By default, `#line` directives are not generated.
-qppline	Toggles on and off the generation of `#line` directives for the **-E** and **-P** options.
-C, -C!	Preserves comments in preprocessed output.
-D	Defines a macro name from the command line, as if in a `#define` directive.
-U	Undefines a macro name defined by the compiler or by the **-D** option.

Directory search sequence for include files

XL C/C++ supports the following types of include files:

- Header files supplied by the compiler (referred to throughout this document as *XL C/C++ headers*)
- Header files mandated by the C and C++ standards (referred to throughout this document as *system headers*)
- Header files supplied by the operating system (also referred to throughout this document as *system headers*)
- User-defined header files

You can use any of the following methods to include any type of header file:

- Use the standard `#include <file_name>` preprocessor directive in the including source file.
- Use the standard `#include "file_name"` preprocessor directive in the including source file.
- Use the **-qinclude** compiler option.

If you specify the header file using a full (absolute) path name, you can use these methods interchangeably, regardless of the type of header file you want to include. However, if you specify the header file using a *relative* path name, the compiler uses a different directory search order for locating the file depending on the method used to include the file.

Furthermore, the **-qidirfirst** and **-qstdinc** compiler options can affect this search order. The following summarizes the search order used by the compiler to locate header files depending on the mechanism used to include the files and on the compiler options that are in effect:

1. Header files included with **-qinclude** only: The compiler searches the current (working) directory from which the compiler is invoked.[1]
2. Header files included with **-qinclude** or `#include "file_name"`: The compiler searches the directory in which the including file is located.[1]
3. All header files: The compiler searches each directory specified by the **-I** compiler option, in the order that it appears on the command line.
4. All header files: C The compiler searches the standard directory for the XL C headers. The default directory for these headers is specified in the compiler configuration file. This is normally /opt/ibmcmp/xlc/cbe/9.0/include/, but the search path can be changed with the **-qc_stdinc** compiler option. C++ The compiler searches the standard directory for the XL C++ headers. The default directory for these headers is specified in the compiler

configuration file. This is normally /opt/ibmcmp/xlc/cbe/9.0//include/, but the search path can be changed with the **-qcpp_stdinc** compiler option.[2]

5. All header files: C The compiler searches the standard directory for the system headers. The default directory for these headers is specified in the compiler configuration file. This is normally /opt/ibmcmp/xlc/cbe/9.0/include/, but the search path can be changed with the **-qgcc_c_stdinc** option.
   C++ The compiler searches the standard directory for the system headers. The default directory for these headers is specified in the compiler configuration file. This is normally /opt/ibmcmp/xlc/cbe/9.0//include/ but the search path can be changed with the **-qgcc_cpp_stdinc** option.[2]

Notes:

1. If the **-qidirfirst** compiler option is in effect, step 3 is performed before steps 1 and 2.
2. If the **-qnostdinc** compiler option is in effect steps 4 and 5 are omitted.

Related information

- "-I" on page 105
- "-qc_stdinc (C only)" on page 67
- "-qcpp_stdinc (C++ only)" on page 68
- "-qgcc_c_stdinc (C only)" on page 97
- "-qgcc_cpp_stdinc (C++ only)" on page 98
- "-qidirfirst" on page 106
- "-qinclude" on page 109
- "-qstdinc" on page 196

Linking

The linker links specified object files to create one executable file. Invoking the compiler with one of the invocation commands automatically calls the linker unless you specify one of the following compiler options: **-E**, **-P**, **-c**, **-S**, **-qsyntaxonly** or **-#**.

Input files

Object files, unstripped executable files, and library files serve as input to the linker. Object files must have a .o suffix, for example, *filename*.o. Static library file names have an .a suffix, for example, *filename*.a. Dynamic library file names typically have a .so suffix, for example, *filename*.so.

Output files

The linker generates an *executable file* and places it in your current directory. The default name for an executable file is a.out. To name the executable file explicitly, use the **-o** file_name option with the compiler invocation command, where *file_name* is the name you want to give to the executable file. For example, to compile `myfile.c` and generate an executable file called `myfile`, enter:

```
ppuxlc myfile.c -o myfile
```

If you use the **-qmkshrobj** option to create a shared library, the default name of the shared object created is a.out. You can use the **-o** option to rename the file and give it a .so suffix.

You can invoke the linker explicitly with the **ppu-ld** or **spu-ld** command. However, the compiler invocation commands set several linker options, and link some standard files into the executable output by default. In most cases, it is better to

use one of the compiler invocation commands to link your object files. For a complete list of options available for linking, see “Linking” on page 38.

Related information
- “-qmkshrobj (PPU only)” on page 156

Order of linking

The compiler links libraries in the following order:

1. System startup libraries
2. User .o files and libraries
3. XL C/C++ libraries
4. C++ standard libraries
5. C standard libraries

Related information
- “Linking” on page 38

Redistributable libraries

If you build your application using XL C/C++, it may use one or more of the following redistributable libraries. If you ship the application, ensure that the users of the application have the packages containing the libraries. To make sure the required libraries are available to users, one of the following can be done:

- You can ship the packages that contain the redistributable libraries with the application. The packages are stored under the rpms/ directory under the appropriate Linux distribution directory on the installation CD.
- The user can download the packages that contain the redistributable libraries from the XL C/C++ support Web site at:

  http://www.ibm.com/software/awdtools/xlcpp/support/

For information on the licensing requirements related to the distribution of these packages refer to LicAgree.pdf on the CD.

Table 5. Redistributable libraries

Package name	Libraries (and default installation path)	Description
cell-xlc-rte	opt/ibmcmp/xlc/cbe/V9.0/opt.ibmcmp.lib/libibmc++.so.1 /opt/ibmcmp/xlc/cbe/V9.0/opt.ibmcmp.lib64/libibmc++.so.1	XL C++ runtime libraries

Compiler messages and listings

The following sections discuss the various methods of reporting provided by the compiler after compilation:

- “Compiler messages” on page 15
- “Compiler return codes” on page 17
- “Compiler listings” on page 17

Compiler messages

When the compiler encounters a programming error while compiling a C or C++ source program, it issues a diagnostic message to the standard error device and, if you compile with the **-qsource** option, to a listing file. Note that messages are specific to the C or C++ language.

C If you specify the compiler option **-qsrcmsg** and the error is applicable to a particular line of code, the reconstructed source line or partial source line is included with the error message. A reconstructed source line is a preprocessed source line that has all the macros expanded.

You can control the diagnostic messages issued, according to their severity, using either the **-qflag** option or the **-w** option. To get additional informational messages about potential problems in your program, use the **-qinfo** option.

Related information
- "-qsource" on page 190
- "-qsrcmsg (C only)" on page 193
- "-qflag" on page 85
- "-w" on page 224
- "-qinfo" on page 110

Compiler message format

Diagnostic messages have the following format:

"*file*", line *line_number.column_number*: 15*dd-number* (*severity*) *text*.

where:

file Is the name of the C or C++ source file with the error.

line_number
Is the source code line number where the error was found.

column_number
Is the source code column number where the error was found.

15 Is the compiler product identifier.

dd is a two-digit code indicating the compiler component that issued the message. *dd* can have the following values:

00 - code generating or optimizing message

01 - compiler services message

05 - message specific to the C compiler

06 - message specific to the C compiler

40 - message specific to the C++ compiler

86 - message specific to interprocedural analysis (IPA)

number
Is the message number.

severity
Is a letter representing the severity of the error. See "Message severity levels and compiler response" on page 16 for a description of these.

text
Is a message describing the error.

C If you compile with **-qsrcmsg**, diagnostic messages have the following format:

```
x - 15dd-nnn(severity) text.
```

where *x* is a letter referring to a finger in the finger line.

Message severity levels and compiler response

XL C/C++ uses a multi-level classification scheme for diagnostic messages. Each level of severity is associated with a compiler response. The following table provides a key to the abbreviations for the severity levels and the associated default compiler response. Note that you can adjust the default compiler response by using any of the following options:

- **-qhalt** allows you to halt the compilation phase at a lower severity level than the default
- **-qmaxerr** allows you to halt the compilation phase as soon as a specific number of errors at a specific severity level is reached
- C++ **-qhaltonmsg** allows you to halt the compilation phase as soon as a specific error is encountered

Table 6. Compiler message severity levels

Letter	Severity	Compiler response
I	Informational	Compilation continues and object code is generated. The message reports conditions found during compilation.
W	Warning	Compilation continues and object code is generated. The message reports valid but possibly unintended conditions.
C E	Error	Compilation continues and object code is generated. Error conditions exist that the compiler can correct, but the program might not produce the expected results.
S	Severe error	Compilation continues, but object code is not generated. Error conditions exist that the compiler cannot correct: • If the message indicates a resource limit (for example, file system full or paging space full), provide additional resources and recompile. • If the message indicates that different compiler options are needed, recompile using them. • Check for and correct any other errors reported prior to the severe error. • If the message indicates an internal compiler error, the message should be reported to your IBM service representative.
C U	Unrecoverable error	The compiler halts. An internal compiler error has occurred. The message should be reported to your IBM service representative.

Related information

- "-qhalt" on page 100
- "-qmaxerr" on page 151
- "-qhaltonmsg (C++ only)" on page 102
- Options summary by functional category: Listings and messages

Compiler return codes

At the end of compilation, the compiler sets the return code to zero under any of the following conditions:

- No messages are issued.
- The highest severity level of all errors diagnosed is less than the setting of the **-qhalt** compiler option, and the number of errors did not reach the limit set by the **-qmaxerr** compiler option.
- C++ No message specified by the **-qhaltonmsg** compiler option is issued.

Otherwise, the compiler sets the return code to one of the following values:

Return code	Error type
1	Any error with a severity level higher than the setting of the **-qhalt** compiler option has been detected.
40	An option error or an unrecoverable error has been detected.
41	A configuration file error has been detected.
249	A no-files-specified error has been detected.
250	An out-of-memory error has been detected. The compiler cannot allocate any more memory for its use.
251	A signal-received error has been detected. That is, an unrecoverable error or interrupt signal has occurred.
252	A file-not-found error has been detected.
253	An input/output error has been detected: files cannot be read or written to.
254	A fork error has been detected. A new process cannot be created.
255	An error has been detected while the process was running.

Note: Return codes may also be displayed for runtime errors.

ppugxlc, ppugxlc++, spugxlc, and spugxlc++ return codes

Like other invocation commands, **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++** return output, such as listings, diagnostic messages related to the compilation, warnings related to unsuccessful translation of GNU options, and return codes. If **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** cannot successfully call the compiler, it sets the return code to one of the following values:

40 A **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** option error or unrecoverable error has been detected.

255 An error has been detected while the process was running.

Compiler listings

A listing is a compiler output file (with a .lst suffix) that contains information about a particular compilation. As a debugging aid, a compiler listing is useful for determining what has gone wrong in a compilation. For example, any diagnostic messages emitted during compilation are written to the listing.

To produce a listing, you can compile with any of the following options, which provide different types of information:

- -qsource
- -qlistopt
- -qattr

- -qxref
- -qlist

When any of these options is in effect, a listing file *filename*.lst is saved in the current directory for every input file named in the compilation.

Listing information is organized in sections. A listing contains a header section and a combination of other sections, depending on other options in effect. The contents of these sections are described as follows.

Header section
Lists the compiler name, version, and release, as well as the source file name and the date and time of the compilation.

Source section
If you use the **-qsource** option, lists the input source code with line numbers. If there is an error at a line, the associated error message appears after the source line. Lines containing macros have additional lines showing the macro expansion. By default, this section only lists the main source file. Use the **-qshowinc** option to expand all header files as well.

Options section
Lists the non-default options that were in effect during the compilation. To list all options in effect, specify the **-qlistopt** option.

Attribute and cross-reference listing section
If you use the **-qattr** or **-qxref** options, provides information about the variables used in the compilation unit, such as type, storage duration, scope, and where they are defined and referenced. Each of these options provides different information on the identifiers used in the compilation.

File table section
Lists the file name and number for each main source file and include file. Each file is associated with a file number, starting with the main source file, which is assigned file number 0. For each file, the listing shows from which file and line the file was included. If the **-qshowinc** option is also in effect, each source line in the source section will have a file number to indicate which file the line came from.

Compilation epilogue section
Displays a summary of the diagnostic messages by severity level, the number of source lines read, and whether or not the compilation was successful.

Object or assembly section
If you use the **-qlist** option, lists the object or assembly code generated by the compiler for the PPU or lists the object code generated by the compiler for the SPU. This section is useful for diagnosing execution time problems, if you suspect the program is not performing as expected due to code generation error.

Related information
- Summary of command line options: Listings and messages

Chapter 2. Configuring compiler defaults

When you compile an application with XL C/C++, the compiler uses default settings that are determined in a number of ways:

- Internally defined settings. These settings are predefined by the compiler and you cannot change them.
- Settings defined by system environment variables. Certain environment variables are required by the compiler; others are optional. You may have already set some of the basic environment variables during the installation process (for more information, see the *XL C/C++ Installation Guide*). "Setting environment variables" provides a complete list of the required and optional environment variables you can set or reset after installing the compiler.
- Settings defined in the compiler configuration file, /opt/ibmcmp/xlc/cbe/9.0/etc/vac.cfg. The compiler requires many settings that are determined by its configuration file. Normally, the configuration file is automatically generated during the installation procedure (for more information, see the *XL C/C++ Installation Guide*). However, you can customize this file after installation, to specify additional compiler options, default option settings, library search paths, and so on. Information on customizing the configuration file is provided in "Using custom compiler configuration files" on page 21.
- Settings defined by the GCC options configuration file. If you are using **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** utility to map GCC options, the default option mappings are defined in the /opt/ibmcmp/xlc/cbe/9.0/etc/gxlc.cfg file. You can customize this file to suit your requirements; for more information, see "Configuring the **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** option mapping" on page 24.

Setting environment variables

To set environment variables in Bourne, Korn, and BASH shells, use the following commands:

```
variable=value
export variable
```

where *variable* is the name of the environment variable, and *value* is the value you assign to the variable.

To set environment variables in the C shell, use the following command:

```
setenv variable value
```

where *variable* is the name of the environment variable, and *value* is the value you assign to the variable.

To set the variables so that all users have access to them, in Bourne, Korn, and BASH shells, add the commands to the file /etc/profile. To set them for a specific user only, add the commands to the file .profile in the user's home directory. In C shell, add the commands to the file /etc/csh.cshrc. To set them for a specific user only, add the commands to the file .cshrc in the user's home directory. The environment variables are set each time the user logs in.

The following sections discuss the environment variables you can set for XL C/C++ and applications you have compiled with it:

- “Compile-time and link-time environment variables”
- “Runtime environment variables”

Compile-time and link-time environment variables

The following environment variables are used by the compiler when you are compiling and linking your code. Many are built into the Linux operating system.All of these variables are optional.

LD_RUN_PATH
Specifies search paths for dynamically loaded libraries, equivalent to using the **-R** link-time option. The shared-library locations named by the environment variable are embedded into the executable, so the dynamic linker can locate the libraries at application run time. For more information about this environment variable, see your operating system documentation. See also “-R” on page 179.

PATH Specifies the directory search path for the executable files of the compiler. Executables are in /opt/ibmcmp/xlc/cbe/9.0/bin/ if installed to the default location. For information on setting the PATH, see "Setting the PATH environment variable to include the path to the XL C/C++ invocations" in the *XL C/C++ Installation Guide*.

TMPDIR
Optionally specifies the directory in which temporary files are created during compilation. The default location, /tmp/, may be inadequate at high levels of optimization, where paging and temporary files can require significant amounts of disk space, so you can use this environment variable to specify an alternate directory.

XLC_USR_CONFIG
Specifies the location of a custom configuration file to be used by the compiler. The file name must be given with its absolute path. The compiler will first process the definitions in this file before processing those in the default system configuration file, or those in a customized file specified by the **-F** option; for more information, see “Using custom compiler configuration files” on page 21.

Runtime environment variables

The following environment variables are used by the system loader or by your application when it is executed. All of these variables are optional.

LD_LIBRARY_PATH
Specifies an alternate directory search path for dynamically linked libraries at application run time. If shared libraries required by your application have been moved to an alternate directory that was not specified at link time, and you do not want to relink the executable, you can set this environment variable to allow the dynamic linker to locate them at run time. For more information about this environment variable, see your operating system documentation.

PDFDIR
Optionally specifies the directory in which profiling information is saved when you run an application that you have compiled with the **-qpdf1** option. The default value is unset, and the compiler places the profile data file in the current working directory. When you recompile or relink your application with **-qpdf2**, the compiler uses the data saved in this directory to optimize the application. It is recommended that you set this variable to

an absolute path if you will be using profile-directed feedback. See "-qpdf1, -qpdf2 (PPU only)" on page 167 for more information.

Using custom compiler configuration files

XL C/C++ generates a default configuration file /opt/ibmcmp/xlc/cbe/9.0/etc/vac.cfg at installation time. (See the *XL C/C++ Installation Guide* for more information on the various tools you can use to generate the configuration file during installation.) The configuration file specifies information that the compiler uses when you invoke it.

If you are running on a single-user system, or if you already have a compilation environment with compilation scripts or makefiles, you may want to leave the default configuration file as it is.

Otherwise, especially if you want many users to be able to choose among several sets of compiler options, you may want to use custom configuration files for specific needs. For example, you might want to enable **-qlist** by default for compilations using the **xlc** compiler invocation command. Rather than a user being required to specify this option on the command line for every compilation, it would automatically be in effect every time the compiler is invoked with the **xlc** command.

You have several options for customizing configuration files:

- You can directly edit the default configuration file. In this case, the customized options will apply for all users for all compilations. The disadvantage of this option is that you will need to reapply your customizations to the new default configuration file that is provided every time you install a compiler update.
- You can use the default configuration file as the basis of customized copies that you specify at compile time with the **-F** option. In this case, the custom file overrides the default file on a per-compilation basis. Again, the disadvantage of this option is that you will need to reapply your customizations to the new default configuration file that is provided every time you install a compiler update.
- You can create custom, or user-defined, configuration files that are specified at compile time with the XLC_USR_CONFIG environment variable. In this case, the custom user-defined files complement, rather than override, the default configuration file, and they can be specified on a per-compilation or global basis. The advantage of this option is that you do not need to modify your existing, custom configuration files when a new system configuration file is installed during an update installation. Procedures for creating custom, user-defined configuration files are provided below.

Related information:

- "-F" on page 83
- "Compile-time and link-time environment variables" on page 20

Creating custom configuration files

If you use the XLC_USR_CONFIG environment variable to instruct the compiler to use a custom user-defined configuration file, the compiler will examine and process the settings in that user-defined configuration file before looking at the settings in the default system configuration file.

To create a custom user-defined configuration file, you add stanzas which specify multiple levels of the **use** attribute. The user-defined configuration file can reference definitions specified elsewhere in the same file, as well as those specified in the system configuration file. For a given compilation, when the compiler looks for a given stanza, it searches from the beginning of the user-defined configuration file and then follows any other stanza named in the use attribute, including those specified in the system configuration file.

If the stanza named in the **use** attribute has a name different from the stanza currently being processed, then the search for the use stanza starts from the beginning of the user-defined configuration file. This is the case for stanzas A, C, and D in the example shown below. However, if the stanza in the **use** attribute has the same name as the stanza currently being processed, as is the case of the two B stanzas in the example, then the search for the **use** stanza starts from the location of the current stanza.

The following example shows how you can use multiple levels for the **use** attribute. This example uses the **options** attribute to help show how the **use** attribute works, but any other attribute, such as **libraries** could also be used.

```
A: use =DEFLT
    options=<set of options A>
B: use =B
    options=<set of options B1>
B: use =D
    options=<set of options B2>
C: use =A
    options=<set of options C>
D: use =A
    options=<set of options D>
DEFLT:
    options=<set of options Z>
```

Figure 1. Sample configuration file

In this example:

- stanza A uses option sets *A* and *Z*
- stanza B uses option sets *B1*, *B2*, *D*, *A*, and *Z*
- stanza C uses option sets *C*, *A*, and *Z*
- stanza D uses option sets *D*, *A*, and *Z*

Attributes are processed in the same order as the stanzas. The order in which the options are specified is important for option resolution. Ordinarily, if an option is specified more than once, the last specified instance of that option wins.

By default, values defined in a stanza in a configuration file are added to the list of values specified in previously processed stanzas. For example, assume that the XLC_USR_CONFIG environment variable is set to point to the user-defined configuration file at ~/userconfig1. With the user-defined and default configuration files shown in the example below, the compiler will reference the **xlc** stanza in the user-defined configuration file and use the option sets specified in the configuration files in the following order: *A1*, *A*, *D*, and *C*.

```
xlc:  use=xlc
    options= <A1>

DEFLT: use=DEFLT
    options=<D>
```

Figure 2. Custom user-defined configuration file ~/userconfig1

```
xlc:  use=DEFLT
    options=<A>

DEFLT:
    options=<C>
```

Figure 3. Default configuration file vac.cfg

Overriding the default order of attribute values

You can override the default order of attribute values by changing the assignment operator(=) for any attribute in the configuration file.

Table 7. Assignment operators and attribute ordering

Assignment Operator	Description
-=	Prepend the following values before any values determined by the default search order.
:=	Replace any values determined by the default search order with the following values.
+=	Append the following values after any values determined by the default search order.

For example, assume that the XLC_USR_CONFIG environment variable is set to point to the custom user-defined configuration file at ~/userconfig2.

```
xlc_prepend: use=xlc
    options-=<B1>

xlc_replace:use=xlc
    options:=<B2>

xlc_append:use=xlc
    options+=<B3>

DEFLT: use=DEFLT
    options=<D>
```

Figure 4. Custom user-defined configuration file ~/userconfig2

```
xlc: use=DEFLT
    options=<B>

DEFLT:
    options=<C>
```

Figure 5. Default configuration file vac.cfg

The stanzas in the configuration files shown above will use the following option sets, in the following orders:

1. stanza xlc uses *B*, *D*, and *C*
2. stanza xlc_prepend uses *B1*, *B*, *D*, and *C*
3. stanza xlc_replace uses *B2*
4. stanza xlc_append uses *B*, *D*, *C*, and *B3*

You can also use assignment operators to specify an attribute more than once. For example:

```
xlc:
    use=xlc
    options-=-Isome_include_path
    options+=some options
```

Figure 6. Using additional assignment operations

Examples of stanzas in custom configuration files

`DEFLT: use=DEFLT` `options = -g`	This example specifies that the **-g** option is to be used in all compilations.

`xlc: use=xlc`
`options+=-qlist`
`xlc_r: use=xlc_r`
`options+=-qlist`
	This example specifies that **-qlist** be used for any compilation invoked by the **xlc** and **xlc_r** commands. This **-qlist** specification overrides the default setting of **-qlist** specified in the system configuration file.

`DEFLT: use=DEFLT` `libraries=-L/home/user/lib,-lmylib`	This example specifies that all compilations should link with /home/user/lib/libmylib.a.

Configuring the ppugxlc, ppugxlc++, spugxlc, or spugxlc++ option mapping

The **ppugxlc**, **ppugxlc++**, **spugxlc**, and **spugxlc++** utilities use the configuration file /opt/ibmcmp/xlc/cbe/9.0/etc/gxlc.cfg to translate GNU C and C++ options to XL C/C++ options. Each entry in gxlc.cfg describes how the utility should map a GNU C or C++ option to an XL C/C++ option and how to process it.

An entry consists of a string of flags for the processing instructions, a string for the GNU C/C++ option, and a string for the XL C/C++ option. The three fields must be separated by white space. If an entry contains only the first two fields and the XL C/C++ option string is omitted, the GNU C option in the second field will be recognized by **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** and silently ignored.

The # character is used to insert comments in the configuration file. A comment can be placed on its own line, or at the end of an entry.

The following syntax is used for an entry in `gxlc.cfg`:

abcd *"gcc_or_g++_option"* *"xlc_or_xlc++_option"*

where:

a Lets you disable the option by adding **no-** as a prefix. The value is either **y** for yes, or **n** for no. For example, if the flag is set to **y**, then **finline** can be disabled as **fno-inline**, and the entry is:

```
ynn*        "-finline"                  "-qinline"
```

If given **-fno-inline**, then the utility will translate it to **-qnoinline**.

b Informs the utility that the XL C/C++ option has an associated value. The value is either **y** for yes, or **n** for no. For example, if option **-fmyvalue=***n* maps to **-qmyvalue=***n*, then the flag is set to `y`, and the entry is:

```
nyn*        "-fmyvalue"             "-qmyvalue"
```

The utility will then expect a value for these options.

c Controls the processing of the options. The value can be any of the following:

n Tells the utility to process the option listed in the *gcc_or_g++_option* field

i Tells the utility to ignore the option listed in the *gcc_or_g++_option* field. The utility will generate a message that this has been done, and continue processing the given options.

e Tells the utility to halt processing if the option listed in the *gcc_or_g++_option* field is encountered. The utility will also generate an error message.

For example, the GCC option `-I-` is not supported and must be ignored by **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++**. In this case, the flag is set to `i`, and the entry is:

```
nni*        "-I-"
```

If the utility encounters this option as input, it will not process it and will generate a warning.

d Lets **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** include or ignore an option based on the type of compiler. The value can be any of the following:

c Tells the utility to translate the option only for C.

x Tells the utility to translate the option only for C++.

***** Tells **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** to translate the option for C and C++.

For example, **-fwritable-strings** is supported by both compilers, and maps to **-qnoro**. The entry is:

```
nnn*        "-fwritable-strings"        "-qnoro"
```

"*gcc_or_g++_option*"
Is a string representing a GNU C/C++ option. This field is required and must appear in double quotation marks.

"*xlc__or_xlc++_option*"
Is a string representing an XL C/C++ option. This field is optional, and, if present, must appear in double quotation marks. If left blank, the utility ignores the *gcc_or_g++_option* in that entry.

It is possible to create an entry that will map a range of options. This is accomplished by using the asterisk (*) as a wildcard. For example, the GCC **-D** option requires a user-defined name and can take an optional value. It is possible to have the following series of options:

```
-DCOUNT1=100
-DCOUNT2=200
-DCOUNT3=300
-DCOUNT4=400
```

Instead of creating an entry for each version of this option, the single entry is:

```
nnn*        "-D*"                       "-D*"
```

where the asterisk will be replaced by any string following the **-D** option.

Conversely, you can use the asterisk to exclude a range of options. For example, if you want **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** to ignore all the **-std** options, then the entry would be:

```
nni*       "-std*"
```

When the asterisk is used in an option definition, option flags *a* and *b* are not applicable to these entries.

The character **%** is used with a GNU C/C++ option to signify that the option has associated parameters. This is used to insure that **ppugxlc**, **ppugxlc++**, **spugxlc**, or **spugxlc++** will ignore the parameters associated with an option that is ignored. For example, the **-isystem** option is not supported and uses a parameter. Both must be ignored by the application. In this case, the entry is:

```
nni*        "-isystem %"
```

For a complete list of GNU C and C++ and XL C/C++ option mappings, refer to:

http://www.ibm.com/support/docview.wss?rs=2239&context=SSJT9L&uid=swg27010369

Related information

- The GNU Compiler Collection online documentation at http://gcc.gnu.org/onlinedocs/

Chapter 3. Compiler options reference

This chapter contains a summary view of the options available in XL C/C++ by functional category, followed by detailed descriptions of the individual options.

Summary of compiler options by functional category

The XL C/C++ options available are grouped into the following categories:

- Output control
- Input control
- Language element control
- Template control (C++ only)
- Floating-point and integer control
- Error checking and debugging
- Listings, messages, and compiler information
- Optimization and tuning
- Object code control
- Linking
- Portability and migration
- Compiler customization

If the option supports an equivalent pragma directive, this is indicated. To get detailed information on any option listed, see the full description page for that option.

Output control

The options in this category control the type of file output the compiler produces, as well as the locations of the output. These are the basic options that determine the compiler components that will be invoked, the preprocessing, compilation, and linking steps that will (or will not) be taken, and the kind of output to be generated.

Table 8. Compiler output options

Option name	Equivalent pragma name	Description
-c	None.	Prevents the completed object from being sent to the linker. With this option, the output is a .o file for each source file.
-C, -C!	None.	When used in conjunction with the **-E** or **-P** options, preserves or removes comments in preprocessed output.
-E	None.	Preprocesses the source files named in the compiler invocation, without compiling, and writes the output to the standard output.
-qmakedep, -M	None.	Creates an output file containing targets suitable for inclusion in a description file for the **make** command.

Table 8. Compiler output options (continued)

Option name	Equivalent pragma name	Description
-MF	None.	Specifies the target for the output generated by the **-qmakedep** or **-M** options.
-qmkshrobj (PPU only)	None.	Creates a shared object from generated object files.
-o	None.	Specifies a name for the output object, assembler, or executable file.
-P	None.	Preprocesses the source files named in the compiler invocation, without compiling, and creates an output preprocessed file for each input file.
-S	None.	Generates an assembler language file for each source file.

Input control

The options in this category specify the type and location of your source files.

Table 9. Compiler input options

Option name	Equivalent pragma name	Description
-+ (plus sign) (C++ only)	None.	Compiles any file as a C++ language file.
-qcinc (C++ only)	None.	Places an `extern "C" { }` wrapper around the contents of include files located in a specified directory.
-I	None.	Adds a directory to the search path for include files.
-qidirfirst	#pragma options idirfirst	Specifies whether the compiler searches for user include files in directories specified by the **-I** option *before* or *after* searching any other directories.
-qinclude	None.	Specifies additional header files to be included in a compilation unit, as though the files were named in an `#include` statement in the source file.
-qsourcetype	None.	Instructs the compiler to treat all recognized source files as a specified source type, regardless of the actual file name suffix.
-qstdinc	#pragma options stdinc	Specifies whether the standard include directories are included in the search paths for system and user header files.

Language element control

The options in this category allow you to specify the characteristics of the source code. You can also use these options to enforce or relax language restrictions and enable or disable language extensions.

Table 10. Language element control options

Option name	Equivalent pragma name	Description
-qaltivec	None	Enables compiler support for vector data types and operators.
-qasm	None	Controls the interpretation of and subsequent generation of code for assembler language extensions.
-qcpluscmt (C only)	None.	Enables recognition of C++-style comments in C source files.
-D	None.	Defines a macro as in a `#define` preprocessor directive.
-qdigraph	#pragma options digraph	Enables recognition of digraph key combinations or keywords to represent characters not found on some keyboards.
-qdollar	#pragma options dollar	Allows the dollar-sign ($) symbol to be used in the names of identifiers.
-qignprag	#pragma options ignprag	Instructs the compiler to ignore certain pragma statements.
-qkeyword	None.	Controls whether the specified name is treated as a keyword or as an identifier whenever it appears in your program source.
-qlanglvl	C #pragma options langlvl, #pragma langlvl	Determines whether source code and compiler options should be checked for conformance to a specific language standard, or subset or superset of a standard.
-qlonglong	#pragma options long long	Allows IBM `long long` integer types in your program.
-qmbcs, -qdbcs	#pragma options mbcs, #pragma options dbcs	Enables support for multibyte character sets (MBCS) and Unicode characters in your source code.
-qstaticinline (C++ only)	None.	Controls whether inline functions are treated as having `static` or `extern` linkage.
-qtabsize	None.	Sets the default tab length, for the purposes of reporting the column number in error messages.
-qtrigraph	None.	Enables the recognition of trigraph key combinations to represent characters not found on some keyboards.
-U	None.	Undefines a macro defined by the compiler or by the **-D** compiler option.
-qutf	None.	Enables recognition of UTF literal syntax.

Template control (C++ only)

You can use these options to control how the C++ compiler handles templates.

Table 11. C++ template options

Option name	Equivalent pragma name	Description
-qtempinc (C++ only)	None.	Generates separate template include files for template functions and class declarations, and places these files in a directory which can be optionally specified.
-qtemplatedepth (C++ only)	None.	Specifies the maximum number of recursively instantiated template specializations that will be processed by the compiler.
-qtemplaterecompile (C++ only)	None.	Helps manage dependencies between compilation units that have been compiled using the **-qtemplateregistry** compiler option.
-qtemplateregistry (C++ only)	None.	Maintains records of all templates as they are encountered in the source and ensures that only one instantiation of each template is made.
-qtempmax (C++ only)	None.	Specifies the maximum number of template include files to be generated by the **-qtempinc** option for each header file.
-qtmplinst (C++ only)	None.	Manages the implicit instantiation of templates.
-qtmplparse (C++ only)	None.	Controls whether parsing and semantic checking are applied to template definitions.

Floating-point and integer control

Specifying the details of how your applications perform calculations can allow you to take better advantage of your system's floating-point performance and precision, including how to direct rounding. However, keep in mind that strictly adhering to IEEE floating-point specifications can impact the performance of your application. Using the options in the following table, you can control trade-offs between floating-point performance and adherence to IEEE standards.

Table 12. Floating-point and integer control options

Option name	Equivalent pragma name	Description
-qbitfields	None.	Specifies whether bit fields are signed or unsigned.
-qchars	#pragma options chars, #pragma chars	Determines whether all variables of type `char` are treated as either `signed` or `unsigned`.
-qenum	#pragma options enum, #pragma enum	Specifies the amount of storage occupied by enumerations.

Table 12. Floating-point and integer control options (continued)

Option name	Equivalent pragma name	Description
-qfloat	#pragma options float	Selects different strategies for speeding up or improving the accuracy of floating-point calculations.
-qlonglit (PPU only)	None.	In 64-bit mode, promotes literals with implicit type of `int` to `long`.
-y	None.	Specifies the rounding mode for the compiler to use when evaluating constant floating-point expressions at compile time.

Object code control

These options affect the characteristics of the object code, preprocessed code, or other output generated by the compiler.

Table 13. Object code control options

Option name	Equivalent pragma name	Description
-q32, -q64 (PPU only)	None.	Selects either 32-bit or 64-bit compiler mode.
-qalloca, -ma (C only)	#pragma alloca	Provides an inline definition of system function `alloca` when it is called from source code that does not include the `alloca.h` header.
-qcommon	None.	Controls where uninitialized global variables are allocated.
-qeh (C++ only) (PPU only)	None.	Controls whether exception handling is enabled in the module being compiled.
-qkeepinlines (C++ only)	None.	Keeps or discards definitions for unreferenced `extern` inline functions.
-qpic	None.	Generates Position-Independent Code suitable for use in shared libraries.
-qppline	None.	When used in conjunction with the **-E** or **-P** options, enables or disables the generation of `#line` directives.
-qpriority (C++ only)	#pragma options priority, #pragma priority	Specifies the priority level for the initialization of static objects.
-qproto (C only)	#pragma options proto	Specifies the linkage conventions for passing floating-point arguments to functions that have not been prototyped.
-r	None.	Produces a relocatable object, even though the file contains unresolved symbols.

Table 13. Object code control options (continued)

Option name	Equivalent pragma name	Description
-qreserved_reg	None.	Indicates that the given list of registers cannot be used during the compilation except as a stack pointer, frame pointer or in some other fixed role.
-qro (PPU only)	#pragma options ro, #pragma strings	Specifies the storage type for string literals.
-qroconst (PPU only)	#pragma options roconst	Specifies the storage location for constant values.
-qrtti (C++ only) (PPU only)	None.	Generates runtime type identification (RTTI) information for exception handling and for use by the `typeid` and `dynamic_cast` operators.
-s	None.	Strips the symbol table, line number information, and relocation information from the output file.
-qsaveopt	None.	Saves the command-line options used for compiling a source file, the version and level of each compiler component invoked during compilation, and other information to the corresponding object file.
-qstatsym	None.	Adds user-defined, nonexternal names that have a persistent storage class, such as initialized and uninitialized static variables, to the symbol table of the object file.
-qtbtable (PPU only)	#pragma options tbtable	Controls the amount of debugging traceback information that is included in the object files.
-qthreaded (PPU only)	None.	Indicates to the compiler whether it must generate threadsafe code.
-qtls (PPU only)	None.	Enables recognition of the `__thread` storage class specifier, which designates variables that are to be allocated thread-local storage; and specifies the thread-local storage model to be used.
-qxcall	None.	Generates code to treat static functions within a compilation unit as if they were external functions.

Error checking and debugging

The options in this category allow you to detect and correct problems in your source code. In some cases, these options can alter your object code, increase your

compile time, or introduce runtime checking that can slow down the execution of your application. The option descriptions indicate how extra checking can impact performance.

To control the amount and type of information you receive regarding the behavior and performance of your application, consult the options in "Listings, messages, and compiler information" on page 34.

For information on debugging optimized code, see the *XL C/C++ Programming Guide*.

Table 14. Error checking and debugging options

Option name	Equivalent pragma name	Description
-# (pound sign)	None.	Previews the compilation steps specified on the command line, without actually invoking any compiler components.
-qcheck	#pragma options check	Generates code that performs certain types of runtime checking.
-qflttrap (PPU only)	#pragma options flttrap	Determines the types of floating-point exception conditions to be detected at run time
-qformat	None.	Warns of possible problems with string input and output format specifications.
-qfullpath	#pragma options fullpath	When used with the **-g** option, this option records the full, or absolute, path names of source and include files in object files compiled with debugging information, so that debugging tools can correctly locate the source files.
-g	None.	Generates debug information for use by a symbolic debugger.
-qhalt	#pragma options halt	Stops compilation before producing any object, executable, or assembler source files if the maximum severity of compile-time messages equals or exceeds the severity you specify.
-qhaltonmsg (C++ only)	None.	Stops compilation before producing any object, executable, or assembler source files if a specified error message is generated.
-qinfo	#pragma options info, #pragma info	Produces or suppresses groups of informational messages.
-qinitauto	#pragma options initauto	Initializes uninitialized automatic variables to a specific value, for debugging purposes.
-qkeepparm	None.	When used with **-O2** or higher optimization, specifies whether function parameters are stored on the stack.

Table 14. Error checking and debugging options (continued)

Option name	Equivalent pragma name	Description
-qlinedebug	None.	Generates only line number and source file name information for a debugger.
-qmaxerr	None.	Halts compilation when a specified number of errors of a specified severity level or higher is reached.
"-qnewcheck (C++ only)" on page 157	None.	Specifies whether the compiler inserts a check to determine whether a null pointer has been returned by a call to a version of `operator new` or `operator new[]` with a non-empty `throw` specification.
-qoptdebug	None.	When used with high levels of optimization, produces files containing optimized pseudocode that can be read by a debugger.
-qsyntaxonly (C only)	None.	Performs syntax checking without generating an object file.
-qwarn64 (PPU only)	None.	Enables checking for possible data conversion problems between 32-bit and 64-bit compiler modes.

Listings, messages, and compiler information

The options in this category allow you control over the listing file, as well as how and when to display compiler messages. You can use these options in conjunction with those described in "Error checking and debugging" on page 32 to provide a more robust overview of your application when checking for errors and unexpected behavior.

Table 15. Listings and messages options

Option name	Equivalent pragma name	Description
-qattr	#pragma options attr	Produces a compiler listing that includes the attribute component of the attribute and cross-reference section of the listing.
-qdump_class_hierarchy (C++ only)	None.	Dumps a representation of the hierarchy and virtual function table layout of each class object to a file.
-qflag	#pragma options flag, C++ #pragma report (C++ only)	Limits the diagnostic messages to those of a specified severity level or higher.
-qlist	#pragma options list	Produces a compiler listing file that includes an object or assembly listing.
-qlistopt	None.	Produces a compiler listing file that includes all options in effect at the time of compiler invocation.

Table 15. Listings and messages options (continued)

Option name	Equivalent pragma name	Description
-qphsinfo	None.	Reports the time taken in each compilation phase to standard output.
-qprint	None.	Enables or suppresses listings.
-qreport	None.	Produces listing files that show how sections of code have been optimized.
-qshowinc	#pragma options showinc	When used with **-qsource** option to generate a listing file, selectively shows user or system header files in the source section of the listing file.
-qsource	#pragma options source	Produces a compiler listing file that includes the source section of the listing and provides additional source information when printing error messages.
-qsrcmsg (C only)	None.	Adds the corresponding source code lines to diagnostic messages generated by the compiler.
-qsuppress	None.	Prevents specific informational or warning messages from being displayed or added to the listing file, if one is generated.
-v, -V	None.	Reports the progress of compilation, by naming the programs being invoked and the options being specified to each program.
-qversion	None.	Displays the version and release of the compiler being invoked.
-w	None.	Suppresses informational, language-level and warning messages.
-qxref	#pragma options xref	Produces a compiler listing that includes the cross-reference component of the attribute and cross-reference section of the listing.

Optimization and tuning

The options in this category allow you to control the optimization and tuning process, which can improve the performance of your application at run time.

Remember that not all options benefit all applications. Trade-offs sometimes occur between an increase in compile time, a reduction in debugging capability, and the improvements that optimization can provide.

In addition to the option descriptions in this section, consult the *XL C/C++ Programming Guide* for a details on the optimization and tuning process as well as writing optimization friendly source code.

Table 16. Optimization and tuning options

Option name	Equivalent pragma name	Description
-qaggrcopy	None.	Enables destructive copy operations for structures and unions.
-qalias	None.	Indicates whether a program contains certain categories of aliasing or does not conform to C/C++ standard aliasing rules. The compiler limits the scope of some optimizations when there is a possibility that different names are aliases for the same storage location..
-qarch	None.	Specifies the processor architecture for which the code (instructions) should be generated.
-qcache (PPU only)	None.	When specified with **-O4**, **-O5**, or **-qipa**, specifies the cache configuration for a specific execution machine.
-qcompact	#pragma options compact	Avoids optimizations that increase code size.
-qdataimported, -qdatalocal, -qtocdata (PPU only)	None.	Marks data as local or imported in 64-bit compilations.
-qdirectstorage	None.	Informs the compiler that a given compilation unit may reference write-through-enabled or cache-inhibited storage.
-qenablevmx (PPU only)	None.	Enables generation of vector instructions.
-qhot	#pragma nosimd, #pragma novector	Performs high-order loop analysis and transformations (HOT) during optimization.
-qignerrno	#pragma options ignerrno	Allows the compiler to perform optimizations that assume `errno` is not modified by system calls.
-qipa	None.	Enables or customizes a class of optimizations known as interprocedural analysis (IPA).
-qisolated_call	#pragma options isolated_call, #pragma isolated_call	Specifies functions in the source file that have no side effects other than those implied by their parameters.
-qlibansi	#pragma options libansi	Assumes that all functions with the name of an ANSI C library function are in fact the system functions.
-qmaxmem	#pragma options maxmem	Limits the amount of memory that the compiler allocates while performing specific, memory-intensive optimizations to the specified number of kilobytes.

Table 16. Optimization and tuning options (continued)

Option name	Equivalent pragma name	Description
-qminimaltoc (PPU only)	None.	Controls the generation of the table of contents (TOC), which the compiler creates for an executable file in 64-bit compilation mode.
-O, -qoptimize	#pragma options optimize	Specifies whether to optimize code during compilation and, if so, at which level.
-p, -pg, -qprofile (PPU only)	None.	Prepares the object files produced by the compiler for profiling.
-qpdf1, -qpdf2 (PPU only)	None.	Tunes optimizations through *profile-directed feedback* (PDF), where results from sample program execution are used to improve optimization near conditional branches and in frequently executed code sections.
-qprefetch (PPU only)	None.	Inserts prefetch instructions automatically where there are opportunities to improve code performance.
-qprocimported, -qproclocal, -qprocunknown (PPU only)	#pragma options procimported, #pragma options proclocal, #pragma options procunkown	Marks functions as local, imported, or unknown in 64-bit compilations.
-Q, -qinline	None.	Attempts to inline functions instead of generating calls to those functions, for improved performance.
-qsmallstack	None.	Reduces the size of the stack frame.
-qstrict	#pragma options strict	Ensures that optimizations done by default at optimization levels **-O3** and higher, and, optionally at **-O2**, do not alter the semantics of a program.
-qstrict_induction	None.	Prevents the compiler from performing induction (loop counter) variable optimizations. These optimizations may be unsafe (may alter the semantics of your program) when there are integer overflow operations involving the induction variables.
-qtune	#pragma options tune	Tunes instruction selection, scheduling, and other architecture-dependent performance enhancements to run best on a specific hardware architecture.
-qunroll	#pragma options unroll, #pragma unroll	Controls loop unrolling, for improved performance.
-qunwind	None.	Specifies whether the call stack can be unwound by code looking through the saved registers on the stack.

Linking

Though linking occurs automatically, the options in this category allow you to direct input and output to the linker, controlling how the linker processes your object files.

Table 17. Linking options

Option name	Equivalent pragma name	Description
-qbigdata	None.	Allows initialized data to be larger than 16 MB in size.
-qcrt	None.	Specifies whether system startup files are to be linked.
-e	None.	When used together with the **-qmkshrobj**, specifies an entry point for a shared object.
-L	None.	At link time, searches the directory path for library files specified by the **-l** option.
-l	None.	Searches for the specified library file, lib*key*.so, and then lib*key*.a for dynamic linking, or just for lib*key*.a for static linking.
-qlib	None.	Specifies whether standard system libraries and XL C/C++ libraries are to be linked.
-R	None.	At link time, writes search paths for shared libraries into the executable, so that these directories are searched at program run time for any required shared libraries.
-qstaticlink	None.	Controls how shared and non-shared runtime libraries are linked into an application.
-qstdmain (SPU only)	None.	Links your SPU program with the startup routines required to use C99-style main function arguments.

Portability and migration

The options in this category can help you maintain application behavior compatibility on past, current, and future hardware, operating systems and compilers, or help move your applications to an XL compiler with minimal change.

Table 18. Portability and migration options

Option name	Equivalent pragma name	Description
-qabi_version (C++ only)	None.	Specifies the version of the C++ application binary interface (ABI) version used during compilation. This option is provided for compatibility with different levels of GNU C++.

Table 18. Portability and migration options (continued)

Option name	Equivalent pragma name	Description
-qalign	#pragma options align, #pragma align	Specifies the alignment of data objects in storage, which avoids performance problems with misaligned data.
-qgenproto (C only)	None.	Produces prototype declarations from K&R function definitions or function definitions with empty parentheses, and displays them to standard output.
-qupconv (C only)	#pragma options upconv	Specifies whether the `unsigned` specification is preserved when integral promotions are performed.

Compiler customization

The options in this category allow you to specify alternate locations for compiler components, configuration files, standard include directories, and internal compiler operation. You should only need to use these options in specialized installation or testing scenarios.

Table 19. Compiler customization options

Option name	Equivalent pragma name	Description
-qasm_as (PPU only)	None.	Specifies the path and flags used to invoke the assembler in order to handle assembler code in an `asm` assembly statement.
-B	None.	Determines substitute path names for XL C/C++ executables such as the compiler, assembler, linker, and preprocessor.
-qcomplexgccincl	#pragma complexgcc	Specifies whether to use GCC parameter-passing conventions for complex data types (equivalent to enabling **-qfloat=complexgcc**) for selected include files only.
-qc_stdinc (C only)	None.	Changes the standard search location for the XL C header files.
-qcpp_stdinc (C++ only)	None.	Changes the standard search location for the XL C++ header files.
-F	None.	Names an alternative configuration file or stanza for the compiler.
-qgcc_c_stdinc (C only)	None.	Changes the standard search location for the GNU C system header files.
-qgcc_cpp_stdinc (C++ only)	None.	Changes the standard search location for the GNU C++ system header files.
-qpath	None.	Determines substitute path names for XL C/C++ executables such as the compiler, assembler, linker, and preprocessor.

Table 19. Compiler customization options (continued)

Option name	Equivalent pragma name	Description
-qspill	#pragma options spill	Specifies the size (in bytes) of the register spill space, the internal program storage areas used by the optimizer for register spills to storage.
-t	None.	Applies the prefix specified by the **-B** option to the designated components.
-W	None.	Passes the listed options to a component that is executed during compilation.

Individual option descriptions

This section contains descriptions of the individual compiler options available in XL C/C++.

For each option, the following information is provided:

Category
The functional category to which the option belongs is listed here.

Pragma equivalent
Many compiler options allow you to use an equivalent pragma directive to apply the option's functionality within the source code, limiting the scope of the option's application to a single source file, or even selected sections of code. Where an option supports the **#pragma options** *option_name* and/or **#pragma** *name* form of the directive, this is indicated.

Purpose
This section provides a brief description of the effect of the option (and equivalent pragmas), and why you might want to use it.

Syntax
This section provides the syntax for the option, and where an equivalent **#pragma** *name* is supported, the specific syntax for the pragma. Syntax for **#pragma options** *option_name* forms of the pragma is not provided, as this is normally identical to that of the option. Note that you can also use the C99-style `_Pragma` operator form of any pragma; although this syntax is not provided in the option descriptions. For complete details on pragma syntax, see "Pragma directive syntax" on page 231

Defaults
In most cases, the default option setting is clearly indicated in the syntax diagram. However, for many options, there are multiple default settings, depending on other compiler options in effect. This section indicates the different defaults that may apply.

Parameters
This section describes the suboptions that are available for the option and pragma equivalents, where applicable. For suboptions that are specific to the command-line option or to the pragma directive, this is indicated in the descriptions.

Usage This section describes any rules or usage considerations you should be aware of when using the option. These can include restrictions on the option's applicability, valid placement of pragma directives, precedence rules for multiple option specifications, and so on.

Predefined macros

Many compiler options set macros that are protected (that is, cannot be undefined or redefined by the user). Where applicable, any macros that are predefined by the option, and the values to which they are defined, are listed in this section. A reference list of these macros (as well as others that are defined independently of option setting) is provided in Chapter 5, "Compiler predefined macros," on page 273

Examples

Where appropriate, examples of the command-line syntax and pragma directive use are provided in this section.

-+ (plus sign) (C++ only)

Category

Input control

Pragma equivalent

None.

Purpose

Compiles any file as a C++ language file.

This option is equivalent to the **-qsourcetype=c++** option.

Syntax

Usage

You can use **-+** to compile a file with any suffix other than .a, .o, .so, .S or .s. If you do not use the **-+** option, files must have a suffix of .C (uppercase C), .cc, .cp, .cpp, .cxx, or .c++ to be compiled as a C++ file. If you compile files with suffix .c (lowercase c) without specifying **-+**, the files are compiled as a C language file.

The **-+** option should not be used together with the **-qsourcetype** option.

Predefined macros

None.

Examples

To compile the file `myprogram.cplspls` as a C++ source file, enter:

```
ppuxlc++ -+ myprogram.cplspls
```

Related information

- "-qsourcetype" on page 191

-# (pound sign)

Category

Error checking and debugging

Pragma equivalent

None.

Purpose
Previews the compilation steps specified on the command line, without actually invoking any compiler components.

When this option is enabled, information is written to standard output, showing the names of the programs within the preprocessor, compiler, and linker that would be invoked, and the default options that would be specified for each program. The preprocessor, compiler, and linker are not invoked.

Syntax

Usage
You can use this command to determine the commands and files that will be involved in a particular compilation. It avoids the overhead of compiling the source code and overwriting any existing files, such as .lst files.

This option displays the same information as **-v**, but does not invoke the compiler. The **-#** option overrides the **-v** option.

Predefined macros
None.

Examples
To preview the steps for the compilation of the source file `myprogram.c`, enter:

```
invocation myprogram.c -#
```

Related information
- "-v, -V" on page 220

-q32, -q64 (PPU only)

Category
Object code control

Pragma equivalent
None.

Purpose
Selects either 32-bit or 64-bit compiler mode.

Syntax

Defaults
-q32

Predefined macros
__64BIT__ is defined to 1 when **-q64** is in effect; otherwise, it is undefined.

-qabi_version (C++ only)

Category
Portability and migration

Pragma equivalent
None.

Purpose
Specifies the version of the C++ application binary interface (ABI) version used during compilation. This option is provided for compatibility with different levels of GNU C++.

Syntax

Defaults
-qabi_version=2

Parameters

1 Specifies the same C++ ABI behavior as in GNU C++ 3.2.

2 Specifies the same C++ ABI behavior as in GNU C++ 3.4.

Predefined macros
None.

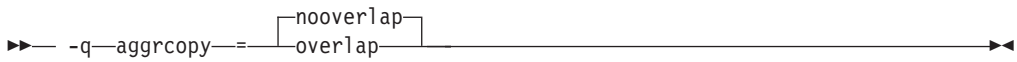
-qaggrcopy

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Enables destructive copy operations for structures and unions.

Syntax



Defaults
-qaggrcopy=nooverlap

Parameters

overlap | nooverlap
nooverlap assumes that the source and destination for structure and union assignments do not overlap, allowing the compiler to generate faster code. **overlap** inhibits these optimizations.

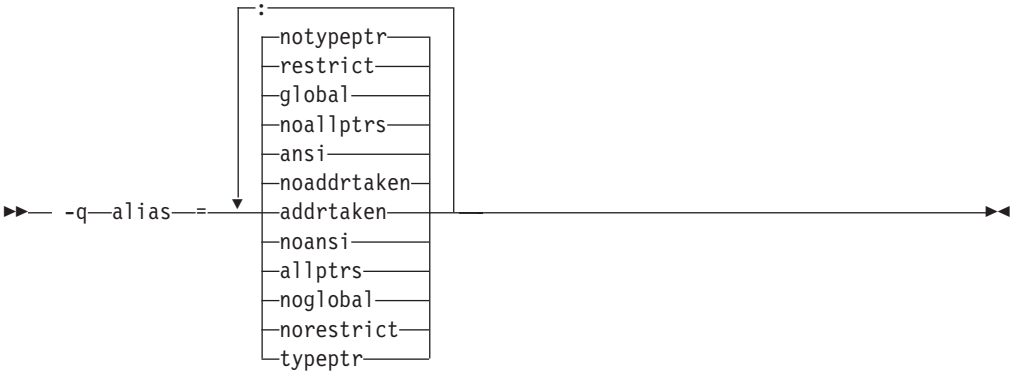
Predefined macros
None.

-qalias

Category
Optimization and tuning

Pragma equivalent
None

Purpose
Indicates whether a program contains certain categories of aliasing or does not conform to C/C++ standard aliasing rules. The compiler limits the scope of some optimizations when there is a possibility that different names are aliases for the same storage location.

Syntax


Defaults
- C++ -qalias=noaddrtaken:noallptrs:ansi:global:restrict:notypeptr
- C **-qalias=noaddrtaken:noallptrs:ansi:global:restrict:notypeptr** for all invocation commands except **cc**.
  -qalias=noaddrtaken:noallptrs:noansi:global:restrict:notypeptr for the **cc** invocation command.

Parameters
addrtaken | noaddrtaken
When **addrtaken** is in effect, variables are disjoint from pointers unless their address is taken. Any class of variable for which an address has *not* been recorded in the compilation unit will be considered disjoint from indirect access through pointers.

When **noaddrtaken** is specified, the compiler generates aliasing based on the aliasing rules that are in effect.

allptrs | noallptrs
When **allptrs** is in effect, pointers are never aliased (this also implies **-qalias=typeptr**). Specifying **allptrs** is an assertion to the compiler that no two pointers point to the same storage location. These suboptions are only valid if **ansi** is also specified.

ansi | **noansi**
When **ansi** is in effect, type-based aliasing is used during optimization, which restricts the lvalues that can be safely used to access a data object. The optimizer assumes that pointers can *only* point to an object of the same type. This suboption has no effect unless you also specify an optimization option.

When **noansi** is in effect, the optimizer makes worst case aliasing assumptions. It assumes that a pointer of a given type can point to an external object or any object whose address is already taken, regardless of type.

global | **noglobal**
When **global** is in effect, type-based aliasing rules are enabled during IPA link-time optimization across compilation units. Both **-qipa** and **-qalias=ansi** must be enabled for **-qalias=global** to have an effect. Specifying **noglobal** disables type-based aliasing rules.

-qlias=global produces better performance at higher optimization levels and also better link-time performance. If you use **-qalias=global**, it is recommended that you compile as much as possible of the application with the same version of the compiler to maximize the effect of the suboption on performance.

restrict | **norestrict**
When **restrict** is in effect, optimizations for pointers qualified with the `restrict` keyword are enabled. Specifying **norestrict** disables optimizations for `restrict`-qualified pointers.

-qalias=restrict is independent from other **-qalias** suboptions. Using the **-qalias=restrict** option will usually result in performance improvements for code that uses `restrict`-qualified pointers. Note, however, that using **-qalias=restrict** requires that restricted pointers be used correctly; if they are not, compile-time and runtime failures may result. You can use **norestrict** to preserve compatibility with code compiled with versions of the compiler previous to V9.0.

typeptr | **notypeptr**
When **typeptr** is in effect, pointers to different types are never aliased. Specifying **typeptr** is an assertion to the compiler that no two pointers of different types point to the same storage location. These suboptions are only valid if **ansi** is also specified.

Usage
-qalias makes assertions to the compiler about the code that is being compiled. If the assertions about the code are false, then the code generated by the compiler may result in unpredictable behaviour when the application is run.

The following are not subject to type-based aliasing:

- Signed and unsigned types. For example, a pointer to a `signed int` can point to an `unsigned int`.
- Character pointer types can point to any type.
- Types qualified as `volatile` or `const`. For example, a pointer to a `const int` can point to an `int`.

Predefined macros
None.

Examples
To specify worst-case aliasing assumptions when compiling `myprogram.c`, enter:

```
invocation myprogram.c -O -qalias=noansi
```

Related information
- “-qipa” on page 118
- “#pragma disjoint” on page 241
- "Type-based aliasing" in the *XL C/C++ Language Reference*
- "The restrict type qualifier" in the *XL C/C++ Language Reference*

-qalign

Category
Portability and migration

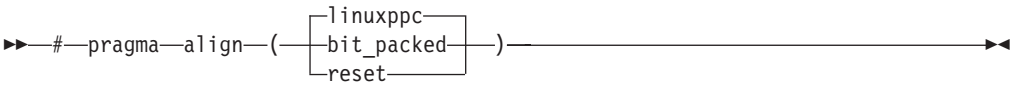
Pragma equivalent
#pragma options align, #pragma align

Purpose
Specifies the alignment of data objects in storage, which avoids performance problems with misaligned data.

Syntax

Option syntax

Pragma syntax



Defaults
linuxppc

Parameters
bit_packed
Bit field data is packed on a bitwise basis without respect to byte boundaries. **-qalign=bit_packed** may cause problems on the SPU if the bitfield container is spread across a natural boundary (i.e. 17-bit bitfield crossing a 4-byte boundary).

linuxppc
Uses GNU C/C++ alignment rules to maintain binary compatibility with GNU C/C++ objects.

reset (pragma only)
Discards the current pragma setting and reverts to the setting specified by the previous pragma directive. If no previous pragma was specified, reverts to the command-line or default option setting.

Usage
If you use the **-qalign** option more than once on the command line, the last alignment rule specified applies to the file.

The pragma directives override the **-qalign** compiler option setting for a specified section of program source code. The pragmas affect all aggregate definitions that

appear after a given pragma directive; if a pragma is placed inside a nested aggregate, it applies only to the definitions that follow it, not to any containing definitions. Any aggregate variables that are declared use the alignment rule that applied at the point at which the aggregate was *defined*, regardless of pragmas that precede the declaration of the variables. See below for examples.

For a complete explanation of the option and pragma parameters, as well as usage considerations, see "Aligning data in aggregates" in the *XL C/C++ Programming Guide*.

Predefined macros
None.

Examples
The following examples show the interaction of the option and pragmas. Assuming compilation with the command `xlc file2.c`, the following example shows how the pragma affects only an aggregate *definition*, not subsequent declarations of variables of that aggregate type.

```
/* file2.c  The default alignment rule is in effect */

typedef struct A A2;

#pragma options align=bit_packed /*  bit_packed alignment rules are now in effect */
struct A {
int a;
char c;
}; #pragma options align=reset /*  Default alignment rules are in effect again */

struct A A1;  /*  A1 and A3 are aligned using bit_packed alignment rules since   */
A2 A3;        /*  this rule applied when struct A was defined      */
```

Assuming compilation with the command `xlc file.c -qalign=bit_packed`, the following example shows how a pragma embedded in a nested aggregate definition affects only the definitions that follow it.

```
/* file2.c  The default alignment rule in effect is bit_packed  */

struct A {
int a;
#pragma options align=linuxppc /* Applies to B; A is unaffected  */
   struct B {
   char c;
   double d;
            } BB;   /*  BB uses linuxppc alignment rules  */
} AA;               /*  AA uses bit_packed alignment rules  /*
```

Related information
- "#pragma pack" on page 259
- "Aligning data" in the *XL C/C++ Programming Guide*
- "The __align specifier" in the *XL C/C++ Language Reference*
- "The aligned variable attribute" in the *XL C/C++ Language Reference*
- "The packed variable attribute" in the *XL C/C++ Language Reference*

-qalloca, -ma (C only)

Category
Object code control

Pragma equivalent
#pragma alloca

Purpose

Provides an inline definition of system function `alloca` when it is called from source code that does not include the `alloca.h` header.

The function `void* alloca(size_t size)` dynamically allocates memory, similarly to the standard library function `malloc`. The compiler automatically substitutes calls to the system `alloca` function with an inline built-in function `__alloca` in any of the following cases:

- You include the header file alloca.h
- You compile with **-Dalloca=__alloca**
- You directly call the built-in function using the form `__alloca`

The **-qalloca** and **-ma** options and **#pragma alloca** directive provide the same functionality in C only, if any of the above methods are not used.

Syntax

Option syntax

Pragma syntax

Defaults

Not applicable.

Usage

If you do not use any of the above-mentioned methods to ensure that calls to `alloca` are replaced with `__alloca`, `alloca` is treated as a user-defined identifier rather than as a built-in function.

Once specified, **#pragma alloca** applies to the rest of the file and cannot be disabled. If a source file contains any functions that you want compiled without **#pragma alloca**, place these functions in a different file.

You may want to consider using a C99 variable length array in place of `alloca`.

Predefined macros

None.

Examples

To compile `myprogram.c` so that calls to the function `alloca` are treated as inline, enter:

```
invocation myprogram.c -qalloca
```

Related information

- "-D" on page 69
- "Miscellaneous built-in functions" on page 305

-qaltivec

Category
Language element control

Pragma equivalent
None.

Purpose
Enables compiler support for vector data types and operators.

See the *XL C/C++ Language Reference* for complete documentation of vector data types.

Syntax

Defaults
-qaltivec

Predefined macros
__ALTIVEC__ is defined to 1 and __VEC__ is defined to 10205 when **-qaltivec** is in effect; otherwise, they are undefined.

Related information
- *AltiVec Technology Programming Interface Manual*, available at http://www.freescale.com/files/32bit/doc/ref_manual/ALTIVECPIM.pdf

-qarch

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Specifies the processor architecture for which the code (instructions) should be generated.

Syntax

Defaults
- **-qarch=cellppu** for compilation targeting the PPU.
- **-qarch=cellspu** for compilation targeting the SPU.

Parameters

auto (SPU only)
Automatically detects the specific architecture of the compiling machine. It assumes that the execution environment will be the same as the compilation environment. This option is implied if the **-O4** or **-O5** option is set or implied.

cellppu (PPU only)
Produces object code containing instructions that will run on the PPU.

cellspu (SPU only)
Produces object code containing instructions that will run on the SPU.

edp (SPU only)
Produces object code containing instructions that will run on the enhanced CBEA-compliant processor with a double precision SPU.

Predefined macros

See "Macros related to architecture settings" on page 277 for a list of macros that are predefined by **-qarch** suboptions.

Related information

- "-qtune" on page 214
- "-q32, -q64 (PPU only)" on page 42
- "Optimizing your applications"in the *XL C/C++ Programming Guide*

-qasm

Category

Language element control

Pragma equivalent

None.

Purpose

Controls the interpretation of and subsequent generation of code for assembler language extensions.

When **-qasm** is in effect, the compiler generates code for assembly statements in the source code. Suboptions specify the syntax used to interpret the content of the assembly statement.

Note: The system assembler program must be available for this command to have effect.

Syntax

-qasm syntax — C

-qasm syntax — C++

Defaults

-qasm=gcc

Parameters

gcc
Instructs the compiler to recognize the extended GCC syntax and semantics for assembly statements.

C++ **stdcpp**
Reserved for possible future use.

Specifying **-qasm** without a suboption is equivalent to specifying the default.

Usage

C The token `asm` is not a C language keyword. Therefore, at language levels **stdc89** and **stdc99**, which enforce strict compliance to the C89 and C99 standards, respectively, the option **-qkeyword=asm** must also be specified to compile source that generates assembly code. At all other language levels, the token `asm` is treated as a keyword unless the option **-qnokeyword=asm** is in effect. In C, the compiler-specific variants `__asm` and `__asm__` are keywords at all language levels and cannot be disabled.

C++ The tokens `asm`, `__asm`, and `__asm__` are keywords at all language levels. Suboptions of **-qnokeyword=***token* can be used to disable each of these reserved words individually.

For detailed information on the syntax and semantics of inline `asm` statements, see "Inline assembly statements" in the *XL C/C++ Language Reference*.

Predefined macros

- C __IBM_GCC_ASM is predefined to 1 when `asm` is recognized as a keyword and assembler code is generated; that is, at all language levels except **stdc89** | **stdc99**, or when **-qkeyword=asm** is in effect, and when **-qasm[=gcc]** is in effect. It is predefined to 0 when `asm` is recognized as a keyword but assembler code is not generated; that is, at all language levels except **stdc89** | **stdc99**, or when **-qkeyword=asm** is in effect, and when **-qnoasm** is in effect. It is undefined when the **stdc89** | **stdc99** language level or **-qnokeyword=asm** is in effect.
- C++ __IBM_GCC_ASM is predefined to 1 when `asm` is recognized as a keyword and assembler code is generated; that is, at all language levels, and when **-qasm[=gcc]** is in effect. It is predefined to 0 when `asm` is recognized as a keyword but assembler code is not generated; that is, at all language levels, and when **-qnoasm[=gcc]** is in effect. It is undefined when **-qnoasm=stdcpp** is in effect. __IBM_STDCPP_ASM is predefined to 0 when **-qnoasm=stdcpp** is in effect; otherwise it is undefined.

Examples

The following code snippet shows an example of the GCC conventions for `asm` syntax in inline statements:

```
int a, b, c;
int main() {
    asm("add %0, %1, %2" : "=r"(a) : "r"(b), "r"(c) );
}
```

Related information
- -qasm_as (PPU only)
- "-qlanglvl" on page 132
- "-qkeyword" on page 129
- "Inline assembly statements" in the *XL C/C++ Language Reference*
- "Keywords for language extensions"in the *XL C/C++ Language Reference*

-qasm_as (PPU only)

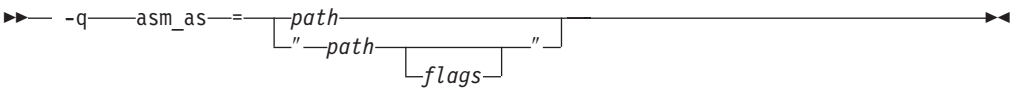
Category
Compiler customization

Pragma equivalent
None.

Purpose
Specifies the path and flags used to invoke the assembler in order to handle assembler code in an `asm` assembly statement.

Normally the compiler reads the location of the assembler from the configuration file; you can use this option to specify an alternate assembler program and flags to pass to that assembler.

Syntax



Defaults
By default, the compiler invokes the assembler program defined for the **as** command in the compiler configuration file.

Parameters
path
The full path name of the assembler to be used.

flags
A space-separated list of options to be passed to the assembler for assembly statements. Quotation marks must be used if spaces are present.

Predefined macros
None.

Examples
To instruct the compiler to use the assembler program at `/bin/as` when it encounters inline assembler code in `myprogram.c`, enter:

```
xlc myprogram.c -qasm_as=/bin/as
```

To instruct the compiler to pass some additional options to the assembler at `/bin/as` for processing inline assembler code in `myprogram.c`, enter:

```
invocation myprogram.c -qasm_as="/bin/as -a64 -l a.lst"
```

Related information
- "-qasm" on page 50

-qattr

Category
Listings, messages, and compiler information

Pragma equivalent
#pragma options [no]attr

Purpose
Produces a compiler listing that includes the attribute component of the attribute and cross-reference section of the listing.

Syntax

Defaults
-qnoattr

Parameters
full
Reports all identifiers in the program. If you specify **attr** without this suboption, only those identifiers that are used are reported.

Usage
If **-qattr** is specified after **-qattr=full**, it has no effect; the full listing is produced.

This option does not produce a cross-reference listing unless you also specify **-qxref**.

The **-qnoprint** option overrides this option.

Predefined macros
None.

Examples
To compile the program `myprogram.c` and produce a compiler listing of all identifiers, enter:

```
invocation myprogram.c -qxref -qattr=full
```

Related information
- "-qprint" on page 172
- "-qxref" on page 227

-B

Category
Compiler customization

Pragma equivalent
None.

Purpose
Determines substitute path names for XL C/C++ executables such as the compiler, assembler, linker, and preprocessor.

You can use this option if you want to keep multiple levels of some or all of the XL C/C++ executables and have the option of specifying which one you want to use. However, it is recommended that you use the **-qpath** option to accomplish this instead.

Syntax


Defaults
The default paths for the compiler executables are defined in the compiler configuration file.

Parameters
prefix
Defines part of a path name for programs you can name with the **-t** option. You must add a slash (/). If you specify the **-B** option without the *prefix*, the default prefix is /lib/o.

Usage
The **-t** option specifies the programs to which the **-B** prefix name is to be appended; see "-t" on page 202 for a list of these. If you use the **-B** option without **-t***programs*, the prefix you specify applies to all of the compiler executables.

The **-B** and **-t** options override the **-F** option.

Predefined macros
None.

Examples
In this example, an earlier level of the compiler components is installed in the default installation directory. To test the upgraded product before making it available to everyone, the system administrator restores the latest installation image under the directory `/home/jim` and then tries it out with commands similar to:

```
invocation -tcbI -B/home/jim/opt/ibmcmp/xlc/cbe/9.0/bin/ test_suite.c
```

Once the upgrade meets the acceptance criteria, the system administrator installs it in the default installation directory.

Related information
- "-qpath" on page 165
- "-t" on page 202
- "Invoking the compiler" on page 1

-qbigdata

Category
Linking

Pragma equivalent
None.

Purpose
Allows initialized data to be larger than 16 MB in size.

Syntax

Defaults
-qnobigdata

Usage
In 32-bit mode, the GNU C/C++ size limit for initialized data is 16 MB. Use this option when creating 32-bit applications in which initialized data and call routines in shared libraries (such as `open`, `close`, `printf`) exceed 16 MB.

Predefined macros
None.

-qbitfields

Category
Floating-point and integer control

Pragma equivalent
None.

Purpose
Specifies whether bit fields are signed or unsigned.

Syntax

Defaults
-qbitfields=signed

Parameters
signed
Bit fields are signed.

unsigned
Bit fields are unsigned.

Predefined macros
None.

-c

Category
Output control

Pragma equivalent
None.

Purpose
Prevents the completed object from being sent to the linker. With this option, the output is a .o file for each source file.

Syntax

Defaults
By default, the compiler invokes the linker to link object files into a final executable.

Usage
When this option is in effect, the compiler creates an output object file, *file_name*.o, for each valid source file, such as *file_name*.c, *file_name*.i, *file_name*.C, *file_name*.cpp. You can use the **-o** option to provide an explicit name for the object file.

The **-c** option is overridden if the **-E**, **-P**, or **-qsyntaxonly** options are specified.

Predefined macros
None.

Examples
To compile `myprogram.c` to produce an object file `myprogram.o`, but no executable file, enter the command:

```
invocation myprogram.c -c
```

To compile `myprogram.c` to produce the object file `new.o` and no executable file, enter:

```
invocation myprogram.c -c -o new.o
```

Related information
- "-E" on page 75
- "-o" on page 158
- "-P" on page 164
- "-qsyntaxonly (C only)" on page 202

-C, -C!

Category
Output control

Pragma equivalent
None.

Purpose
When used in conjunction with the **-E** or **-P** options, preserves or removes comments in preprocessed output.

When **-C** is in effect, comments are preserved. When **-C!** is in effect, comments are removed.

Syntax

Defaults
-C

Usage
The **-C** option has no effect without either the **-E** or the **-P** option. If **-E** is specified, continuation sequences are preserved in the output. If **-P** is specified, continuation sequences are stripped from the output, forming concatenated output lines.

You can use the **-C!** option to override the **-C** option specified in a default makefile or configuration file.

Predefined macros
None.

Examples
To compile `myprogram.c` to produce a file `myprogram.i` that contains the preprocessed program text including comments, enter:

```
invocation myprogram.c -P -C
```

Related information
- "-E" on page 75
- "-P" on page 164

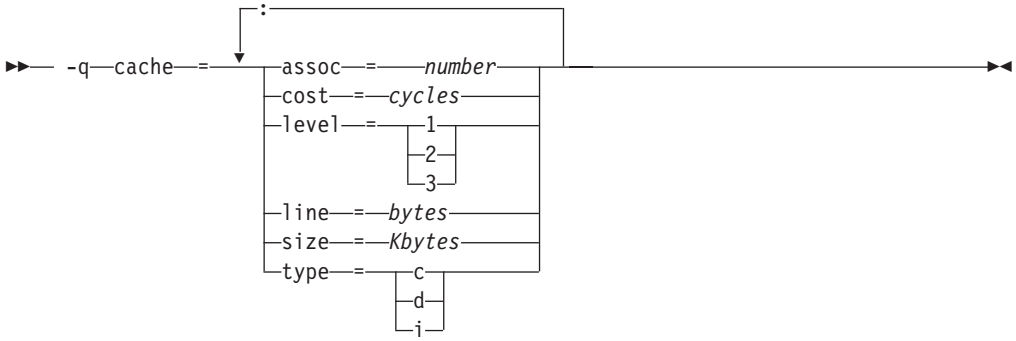
-qcache (PPU only)

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
When specified with **-O4**, **-O5**, or **-qipa**, specifies the cache configuration for a specific execution machine.

Syntax



Defaults

Automatically determined by the setting of the **-qtune** option.

-qcache=level=1:type=i:size=32:line=128:assoc=2:cost=4

-qcache=level=1:type=d:size=32:line=128:assoc=4:cost=4

-qcache=level=2:type=c:size=512:line=128:assoc=8:cost=36

Parameters

assoc
Specifies the set associativity of the cache.

number
Is one of:

0 Direct-mapped cache

1 Fully associative cache

N>1 n-way set associative cache

cost
Specifies the performance penalty resulting from a cache miss.

cycles

level
Specifies the level of cache affected.

level
Is one of:

1 Basic cache

2 Level-2 cache

3 TLB

line
Specifies the line size of the cache.

bytes
An integer representing the number of bytes of the cache line.

size
Specifies the total size of the cache.

Kbytes
An integer representing the number of kilobytes of the total cache.

type
Specifies that the settings apply to the specified *cache_type*.

cache_type
Is one of:

c Combined data and instruction cache

d Data cache

i Instruction cache

Predefined macros
None.

Related information
- "-qcache (PPU only)" on page 57
- "-O, -qoptimize" on page 159
- "-qtune" on page 214
- "-qipa" on page 118

-qchars

Category
Floating-point and integer control

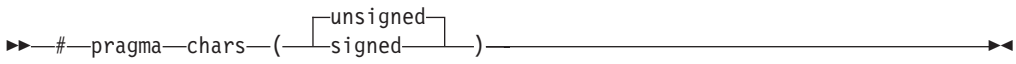
Pragma equivalent
#pragma options chars, #pragma chars

Purpose
Determines whether all variables of type `char` are treated as either `signed` or `unsigned`.

Syntax

Option syntax

Pragma syntax



Defaults
-qchars=unsigned

Parameters
unsigned
Variables of type `char` are treated as `unsigned char`.

signed
Variables of type `char` are treated as `signed char`.

Usage
Regardless of the setting of this option or pragma, the type of `char` is still considered to be distinct from the types `unsigned char` and `signed char` for purposes of type-compatibility checking or C++ overloading.

The pragma must appear before any source statements. If the pragma is specified more than once in the source file, the first one will take precedence. Once specified, the pragma applies to the entire file and cannot be disabled; if a source file contains any functions that you want to compile without **#pragma chars**, place these functions in a different file.

Predefined macros
- _CHAR_SIGNED and __CHAR_SIGNED__ are defined to 1 when **signed** is in effect; otherwise, it is undefined.
- _CHAR_UNSIGNED and _CHAR_UNSIGNED__ are defined to 1 when **unsigned** is in effect; otherwise, they are undefined.

Examples
To treat all `char` types as `signed` when compiling `myprogram.c`, enter:

```
xlc myprogram.c -qchars=signed
```

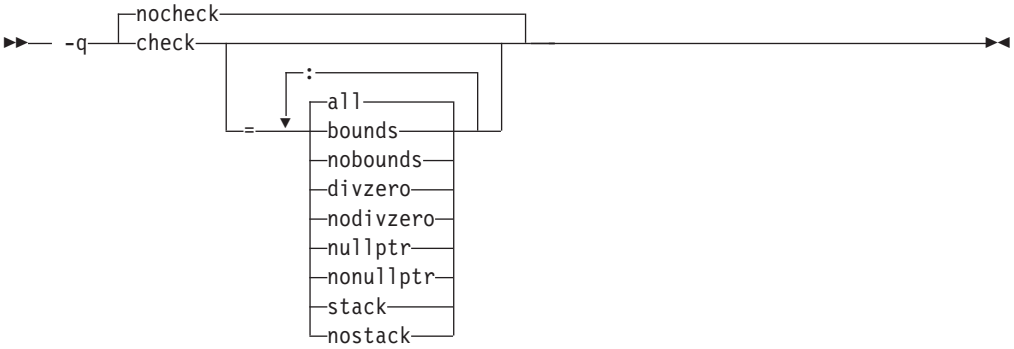
-qcheck

Category
Error checking and debugging

Pragma equivalent
#pragma options [no]check

Purpose
Generates code that performs certain types of runtime checking.

If a violation is encountered, a runtime error is raised by sending a SIGTRAP signal to the process (with the exception of the **[no]stack** suboption). Note that the runtime checks may result in slower application execution.

Syntax


Defaults
-qnocheck

Parameters

all (PPU only)
Enables all suboptions.

bounds | nobounds (PPU only)
Performs runtime checking of addresses for subscripting within an object of known size. The index is checked to ensure that it will result in an address that lies within the bounds of the object's storage. A trap will occur if the address does not lie within the bounds of the object.

This suboption has no effect on accesses to a variable length array.

divzero | nodivzero (PPU only)
Performs runtime checking of integer division. A trap will occur if an attempt is made to divide by zero.

nullptr | nonullptr (PPU only)
Performs runtime checking of addresses contained in pointer variables used to reference storage. The address is checked at the point of use; a trap will occur if the value is less than 512.

stack | nostack (SPU only)
Performs runtime checking for stack overflow. If stack overflow is detected, the program throws an exception by executing a halt instruction. The operating system kernel catches this exception and dumps the memory. The default is **nostack**. **-qcheck** implies **-qcheck=stack**.

Specifying the **-qcheck** option with no suboptions is equivalent to **-qcheck=all** when compiling for the PPU (equivalent to **-qcheck=stack** on the SPU).

Usage

You can specify the **-qcheck** option more than once. The suboption settings are accumulated, but the later suboptions override the earlier ones.

You can use the **all** suboption along with the **no...** form of one or more of the other options as a filter. For example, using:

```
xlc myprogram.c -qcheck=all:nonullptr
```

provides checking for everything except for addresses contained in pointer variables used to reference storage. If you use **all** with the **no...** form of the suboptions, **all** should be the first suboption.

Predefined macros

None.

Examples

The following code example shows the effect of **-qcheck=nullptr:bounds**:

```
void func1(int* p) {
  *p = 42;             /* Traps if p is a null pointer */
}

void func2(int i) {
  int array[10];
  array[i] = 42;     /* Traps if i is outside range 0 - 9 */
}
```

The following code example shows the effect of **-qcheck=divzero**:

```
void func3(int a, int b) {
  a / b;            /* Traps if b=0  */
}
```

-qcinc (C++ only)

Category
Input control

Pragma equivalent
None.

Purpose
Places an `extern "C" { }` wrapper around the contents of include files located in a specified directory.

Syntax

Defaults
-qnocinc

Parameters
directory_path
The directory where the include files to be wrapped with an `extern "C"` linkage specifier are located.

Predefined macros
None.

Examples
Assume your application `myprogram.C` includes header file `foo.h`, which is located in directory `/usr/tmp` and contains the following code:

```
int foo();
```

Compiling your application with:

```
ppuxlc++ myprogram.C -qcinc=/usr/tmp
```

will include header file `foo.h` into your application as:

```
extern "C" {
int foo();
}
```

-qcommon

Category
Object code control

Pragma equivalent
None.

Purpose
Controls where uninitialized global variables are allocated.

When **-qcommon** is in effect, uninitialized global variables are allocated in the common section of the object file. When **-qnocommon** is in effect, uninitialized global variables are initialized to zero and allocated in the data section of the object file.

Syntax

Defaults

- C **-qcommon** except when **-qmkshrobj** is specified; **-qnocommon** when **-qmkshrobj** is specified.
- C++ **-qnocommon**

Usage

This option does not affect static or automatic variables, or the declaration of structure or union members.

This option is overridden by the `common|nocommon` and `section` variable attributes. See "The common and nocommon variable attribute" and "The section variable attribute" in the *XL C/C++ Language Reference*.

Predefined macros

None.

Examples

In the following declaration, where `a` and `b` are global variables:

```
int a, b:
```

Compiling with **-qcommon** produces the equivalent of the following assembly code:

```
.comm _a,4
.comm _b,4
```

Compiling with **-qnocommon** produces the equivalent of the following assembly code:

```
        .globl _a
.data
.zerofill __DATA, __common, _a, 4, 2
        .globl _b
.data
.zerofill __DATA, __common, _b, 4, 2
```

Related information

- "-qmkshrobj (PPU only)" on page 156
- "The common and nocommon variable attribute" in the *XL C/C++ Language Reference*
- "The section variable attribute" in the *XL C/C++ Language Reference*

-qcompact

Category

Optimization and tuning

Pragma equivalent
#pragma options [no]compact

Purpose
Avoids optimizations that increase code size.

Code size is reduced by inhibiting optimizations that replicate or expand code inline, such as inlining or loop unrolling. Execution time may increase.

Syntax

Defaults
-qnocompact

Usage
This option only has an effect when specified with an optimization option.

Predefined macros
__OPTIMIZE_SIZE__ is predefined to 1 when **-qcompact** and an optimization level are in effect. Otherwise, it is undefined.

Examples
To compile `myprogram.c`, instructing the compiler to reduce code size whenever possible, enter:

```
invocation myprogram.c -O -qcompact
```

-qcomplexgccincl

Category
Compiler customization

Pragma equivalent
None.

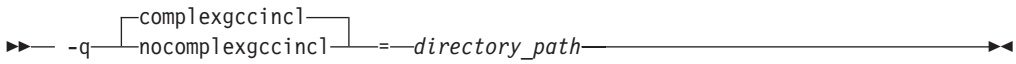
Purpose
Specifies whether to use GCC parameter-passing conventions for complex data types (equivalent to enabling **-qfloat=complexgcc**) for selected include files only.

When **-qcomplexgccincl** is in effect, the compiler internally wraps **#pragma complexgcc(on)** and **#pragma complexgcc(pop)** directives around the files located in specified directories. When **-qnocomplexgccincl** is in effect, include files found in the specified directories are not wrapped by these directives.

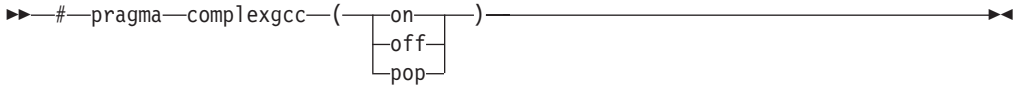
You can also use the pragma directives to enable or disable GCC parameter-passing conventions for complex data types for selected files or sections of code.

Syntax

Option syntax



Pragma syntax



Defaults

By default, files located in the standard directories for the XL C/C++ and GCC header files are wrapped with **#pragma complexgcc** directives. For a list of these, see "Directory search sequence for include files" on page 12.

Parameters

directory_path (option only)
: The directory in which the include files to be wrapped with **#pragma complexgcc** directives are located. If you do not specify a *directory_path*, the compiler assumes the default directories listed above.

on (pragma only)
: Sets **-qfloat=gccomplex** for the code that follows it. This instructs the compiler to use the GCC conventions for passing and returning parameters of complex type, by using general purpose registers.

off (pragma only)
: Sets **-qfloat=nogccomplex** for the code that follows it. This instructs the compiler to use AIX® conventions for passing and returning parameters of complex type, by using floating-point registers.

pop (pragma only)
: Discards the current pragma setting and reverts to the setting specified by the previous pragma directive. If no previous pragma was specified, reverts to the command-line or default option setting.

Usage

The current setting of the pragma affects only functions declared or defined while the setting is in effect. It does not affect other functions.

Calling functions through pointers to functions will always use the convention set by the **-qfloat=[no]complexgcc** command-line option in effect. An error will result if you mix and match functions that pass complex values by value or return complex values. For example, assume the following code is compiled with **-qfloat=nocomplexgcc**:

```
#pragma complexgcc(on)
void p (_Complex double x) {}

#pragma complexgcc(pop)
typedef void (*fcnptr) (_Complex double);

int main() {
    fcnptr ptr = p; /* error: function pointer is -qfloat=nocomplexgcc;
                              function is -qfloat=complexgcc */
}
```

Predefined macros

None.

Related information
- "-qfloat" on page 87

-qcpluscmt (C only)

Category
Language element control

Pragma equivalent
None.

Purpose
Enables recognition of C++-style comments in C source files.

Syntax

Defaults
- **-qcpluscmt** when the **xlc** or **c99** and related invocations are used, or when the **stdc99 | extc99** language level is in effect.
- **-qnocpluscmt** for all other invocation commands and language levels.

Predefined macros
__C99_CPLUSCMT is predefined to 1 when **-qcpluscmt** is in effect; otherwise, it is undefined.

Examples
To compile `myprogram.c` so that C++ comments are recognized as comments, enter:

```
invocation myprogram.c -qcpluscmt
```

Note that // comments are *not* part of C89. The result of the following valid C89 program will be incorrect:

```
main() {
  int i = 2;
  printf("%i\n", i //* 2 */
                 + 1);
}
```

The correct answer is 2 (2 divided by 1). When **-qcpluscmt** is in effect (as it is by default), the result is 3 (2 plus 1).

Related information
- "-C, -C!" on page 56
- "-qlanglvl" on page 132
- "Comments" in the *XL C/C++ Language Reference*

-qcrt

Category
Linking

Pragma equivalent
None.

Purpose
Specifies whether system startup files are to be linked.

When **-qcrt** is in effect, the system startup routines are automatically linked. When **-qnocrt** is in effect, the system startup files are not used at link time; only the files specified on the command line with the **-l** flag will be linked.

This option can be used in system programming to disable the automatic linking of the startup routines provided by the operating system.

Syntax

Defaults
-qcrt

Predefined macros
None.

Related information
- "-qlib" on page 144

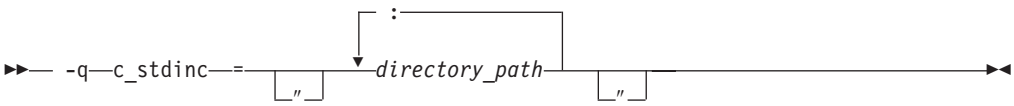
-qc_stdinc (C only)

Category
Compiler customization

Pragma equivalent
None.

Purpose
Changes the standard search location for the XL C header files.

Syntax



Defaults
By default, the compiler searches the directory specified in the configuration file for the XL C header files (this is normally /opt/ibmcmp/xlc/cbe/9.0/include/).

Parameters
directory_path
The path for the directory where the compiler should search for the XL C header files. The *directory_path* can be a relative or absolute path. You can surround the path with quotation marks to ensure it is not split up by the command line.

Usage
This option allows you to change the search paths for specific compilations. To permanently change the default search paths for the XL C headers, you use a configuration file to do so; see "Directory search sequence for include files" on page 12 for more information.

If this option is specified more than once, only the last instance of the option is used by the compiler.

This option is ignored if the **-qnostdinc** option is in effect.

Predefined macros
None.

Examples
To override the default search path for the XL C headers with `mypath/headers1` and `mypath/headers2`, enter:

```
invocation myprogram.c -qc_stdinc=mypath/headers1:mypath/headers2
```

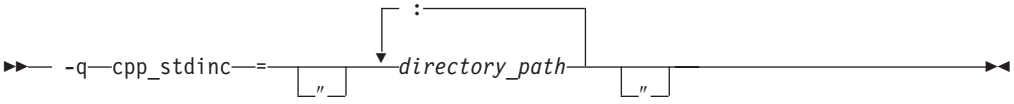
Related information
- "-qgcc_c_stdinc (C only)" on page 97
- "-qstdinc" on page 196
- "-qinclude" on page 109
- "Directory search sequence for include files" on page 12
- "Specifying compiler options in a configuration file" on page 8

-qcpp_stdinc (C++ only)

Category
Compiler customization

Pragma equivalent
None.

Purpose
Changes the standard search location for the XL C++ header files.

Syntax


Defaults
By default, the compiler searches the directory specified in the configuration file for the XL C++ header files (this is normally /opt/ibmcmp/xlc/cbe/9.0/include/).

Parameters
directory_path
The path for the directory where the compiler should search for the XL C++ header files. The *directory_path* can be a relative or absolute path. You can surround the path with quotation marks to ensure it is not split up by the command line.

Usage
This option allows you to change the search paths for specific compilations. To permanently change the default search paths for the XL C++ headers, you use a configuration file to do so; see "Directory search sequence for include files" on page 12 for more information.

If this option is specified more than once, only the last instance of the option is used by the compiler.

This option is ignored if the **-qnostdinc** option is in effect.

Predefined macros
None.

Examples
To override the default search path for the XL C++ headers with `mypath/headers1` and `mypath/headers2`, enter:

```
ppuxlc++ myprogram.C -qcpp_stdinc=mypath/headers1:mypath/headers2
```

Related information
- "-qgcc_cpp_stdinc (C++ only)" on page 98
- "-qstdinc" on page 196
- "-qinclude" on page 109
- "Directory search sequence for include files" on page 12
- "Specifying compiler options in a configuration file" on page 8

-D

Category
Language element control

Pragma equivalent
None.

Purpose
Defines a macro as in a `#define` preprocessor directive.

Syntax


Defaults
Not applicable.

Parameters
name
The macro you want to define. -D*name* is equivalent to `#define` *name*. For example, -DCOUNT is equivalent to `#define COUNT`.

definition
The value to be assigned to *name*. -D*name=definition* is equivalent to `#define` *name definition*. For example, -DCOUNT=100 is equivalent to `#define COUNT 100`.

Usage
Using the `#define` directive to define a macro name already defined by the **-D** option will result in an error condition.

The **-U***name* option, which is used to undefine macros defined by the **-D** option, has a higher precedence than the **-D***name* option.

Predefined macros
The compiler configuration file uses the **-D** option to predefine several macro names for specific invocation commands. For details, see the configuration file for your system.

Examples
To specify that all instances of the name `COUNT` be replaced by 100 in `myprogram.c`, enter:

```
invocation myprogram.c -DCOUNT=100
```

Related information
- "-U" on page 215
- Chapter 5, "Compiler predefined macros," on page 273

-qdataimported, -qdatalocal, -qtocdata (PPU only)

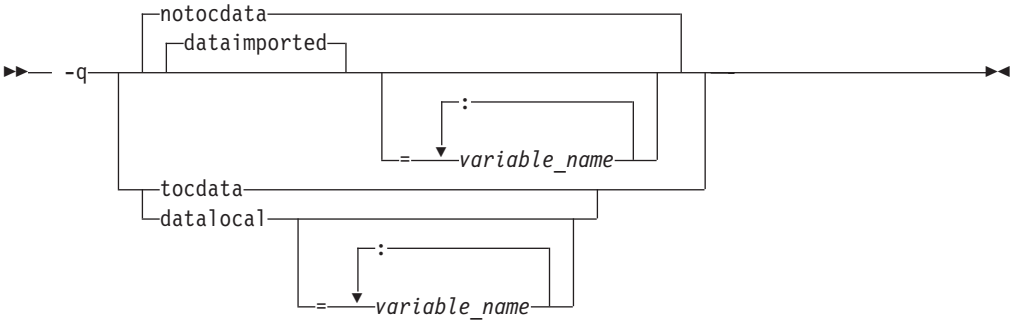
Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Marks data as local or imported in 64-bit compilations.

Local variables are statically bound with the functions that use them. You can use the **-qdatalocal** option to name variables that the compiler can assume are local. Alternatively, you can use the **-qtocdata** option to instruct the compiler to assume all variables are local.

Imported variables are dynamically bound with a shared portion of a library. You can use the **-qdataimported** option to name variables that the compiler can assume are imported. Alternatively, you can use the **-qnotocdata** option to instruct the compiler to assume all variables are imported.

Syntax


Defaults
-qdataimported or **-qnotocdata**: The compiler assumes all variables are imported.

Parameters
variable_name
The name of a variable that the compiler should assume is local or imported (depending on the option specified).

C++ Names must be specified using their mangled names. To obtain C++ mangled names, compile your source to object files only, using the **-c** compiler option, and use the **nm** operating system command on the resulting object file. (See also "Name mangling" in the *XL C/C++ Language Reference* for details on using the `extern "C"` linkage specifier on declarations to prevent name mangling.)

Specifying **-qdataimported** without any *variable_name* is equivalent to **-qnotocdata**: all variables are assumed to be imported. Specifying **-qdatalocal** without any *variable_name* is equivalent to **-qtocdata**: all variables are assumed to be local.

Usage
These options apply to 64-bit compilations only.

If any variables that are marked as local are actually imported, incorrect code may be generated and performance may decrease.

If you specify any of these options with no variables, the last option specified is used. If you specify the same variable name on more than one option specification, the last one is used.

Predefined macros
None.

Related information
• "-qprocimported, -qproclocal, -qprocunknown (PPU only)" on page 174

-qdbxextra (C only)

Category
Error checking and debugging

Pragma equivalent
#pragma options dbxextra

Purpose
When used with the **-g** option, specifies that debugging information is generated for unreferenced `typedef` declarations, `struct`, `union`, and `enum` type definitions.

To minimize the size of object and executable files, the compiler only includes information for `typedef` declarations, `struct`, `union`, and `enum` type definitions that are referenced by the program. When you specify the **-qdbxextra** option, debugging information is included in the symbol table of the object file. This option is equivalent to the **-qsymtab=unref** option.

Syntax

Defaults

-qnodbxextra: Unreferenced `typedef` declarations, `struct`, `union`, and `enum` type definitions are not included in the symbol table of the object file.

Usage

Using **-qdbxextra** may make your object and executable files larger.

Predefined macros

None.

Examples

To compile `myprogram.c` so that unreferenced `typedef`, structure, union, and enumeration declarations are included in the symbol table for use with a debugger, enter:

```
invocation myprogram.c -g -qdbxextra
```

Related information

- "-qfullpath" on page 95
- "-qlinedebug" on page 145
- "-g" on page 97
- "#pragma options" on page 255
- "-qsymtab (C only)" on page 201

-qdigraph

Category

Language element control

Pragma equivalent

#pragma options [no]digraph

Purpose

Enables recognition of digraph key combinations or keywords to represent characters not found on some keyboards.

Syntax

Defaults

- C **-qdigraph** when the **extc89** | **extended** | **extc99** | **stdc99** language level is in effect. **-qnodigraph** for all other language levels.
- C++ **-qdigraph**

Usage

A digraph is a keyword or combination of keys that lets you produce a character that is not available on all keyboards. For details on digraphs, see "Digraph characters" in the *XL C/C++ Language Reference*.

Predefined macros
__DIGRAPHS__ is predefined to 1 when **-qdigraph** is in effect; otherwise it is not defined.

Examples
To disable digraph character sequences when compiling your program, enter:

```
invocation myprogram.c -qnodigraph
```

Related information
- "-qlanglvl" on page 132
- "-qtrigraph" on page 214

-qdirectstorage

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Informs the compiler that a given compilation unit may reference write-through-enabled or cache-inhibited storage.

Syntax

Defaults
-qnodirectstorage

Usage
Use this option with discretion. It is intended for programmers who know how the memory and cache blocks work, and how to tune their applications for optimal performance. To ensure that your application will execute correctly on all implementations, you should assume that separate instruction and data caches exist and program your application accordingly.

-qdollar

Category
Language element control

Pragma equivalent
#pragma options [no]dollar

Purpose
Allows the dollar-sign ($) symbol to be used in the names of identifiers.

When **dollar** is in effect, the dollar symbol $ in an identifier is treated as a base character.

Syntax

Defaults
-qnodollar

Usage
If **nodollar** and the **ucs** language level are both in effect, the dollar symbol is treated as an extended character and translated into `\u0024`.

Predefined macros
None.

Examples
To compile `myprogram.c` so that `$` is allowed in identifiers in the program, enter:

```
invocation myprogram.c -qdollar
```

Related information
- "-qlanglvl" on page 132

-qdump_class_hierarchy (C++ only)

Category
Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Dumps a representation of the hierarchy and virtual function table layout of each class object to a file.

Syntax

Defaults
Not applicable.

Usage
The output file name consists of the source file name appended with a .class suffix.

Predefined macros
None.

Examples
To compile `myprogram.C` to produce a file named `myprogram.C.class` containing the class hierarchy information, enter:

```
ppuxlc++ myprogram.C -qdump_class_hierarchy
```

-e

Category
Linking

Pragma equivalent
None.

Purpose
When used together with the **-qmkshrobj**, specifies an entry point for a shared object.

Syntax

Defaults
-e=noentry

Parameters

name
The name of the entry point for the shared executable.

Usage
When linking object files, it is recommended that you *do not* use the **-e** option. The default entry point of the executable output is `__start`. Changing this label with the **-e** flag can cause erratic results.

This option is used only together with the **-qmkshrobj** option. See the description for the "-qmkshrobj (PPU only)" on page 156 for more information.

Predefined macros
None.

Related information
- "-qmkshrobj (PPU only)" on page 156

-E

Category
Output control

Pragma equivalent
None.

Purpose
Preprocesses the source files named in the compiler invocation, without compiling, and writes the output to the standard output.

Syntax

Defaults
By the default, source files are preprocessed, compiled, and linked to produce an executable file.

Usage
The **-E** option accepts any file name. Source files with unrecognized file name suffixes are treated and preprocessed as C files, and no error message is generated.

Unless **-qnoppline** is specified, `#line` directives are generated to preserve the source coordinates of the tokens. Continuation sequences are preserved.

Unless **-C** is specified, comments are replaced in the preprocessed output by a single space character. New lines and `#line` directives are issued for comments that span multiple source lines.

The **-E** option overrides the **-P**, **-o**, and **-qsyntaxonly** options.

Predefined macros
None.

Examples
To compile `myprogram.c` and send the preprocessed source to standard output, enter:

```
invocation myprogram.c -E
```

If `myprogram.c` has a code fragment such as:

```
#define SUM(x,y) (x + y)
int a ;
#define mm 1   /* This is a comment in a
                  preprocessor directive */
int b ;        /* This is another comment across
                  two lines */
int c ;
               /* Another comment */
c = SUM(a, /* Comment in a macro function argument*/
        b) ;
```

the output will be:

```
#line 2 "myprogram.c"
int a ;
#line 5
int b ;

int c ;

c = a + b ;
```

Related information
- "-qppline" on page 171
- "-C, -C!" on page 56
- "-P" on page 164
- "-qsyntaxonly (C only)" on page 202

-qeh (C++ only) (PPU only)

Category
Object code control

Pragma equivalent
None.

Purpose
Controls whether exception handling is enabled in the module being compiled.

When **-qeh** is in effect, exception handling is enabled. If your program does not use C++ structured exception handling, you can compile with **-qnoeh** to prevent generation of code that is not needed by your application.

Syntax

Defaults
-qeh

Usage
Specifying **-qeh** also implies **-qrtti**. If **-qeh** is specified together with **-qnortti**, RTTI information will still be generated as needed.

Predefined macros
__EXCEPTIONS is predefined to 1 when **-qeh** is in effect; otherwise, it is undefined.

Related information
- "-qrtti (C++ only) (PPU only)" on page 184

-qenum

Category
Floating-point and integer control

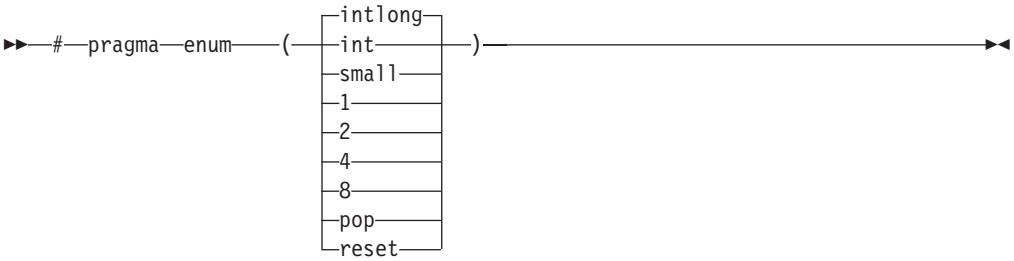
Pragma equivalent
#pragma options enum, #pragma enum

Purpose
Specifies the amount of storage occupied by enumerations.

Syntax

Option syntax

Pragma syntax



Defaults

-qenum=intlong

Parameters

1 Specifies that enumerations occupy 1 byte of storage, are of type `char` if the range of enumeration values falls within the limits of `signed char`, and `unsigned char` otherwise.

2 Specifies that enumerations occupy 2 bytes of storage, are of type `short` if the range of enumeration values falls within the limits of `signed short`, and `unsigned short` otherwise. C Values cannot exceed the range of `signed int`.

4 | int
Specifies that enumerations occupy 4 bytes of storage, are of type `int` if the range of enumeration values falls within the limits of `signed int`, and `unsigned int` otherwise.

8 Specifies that enumerations occupy 8 bytes of storage. In 32-bit compilation mode, the enumeration is of type `long long` if the range of enumeration values falls within the limits of `signed long long`, and `unsigned long long` otherwise. In 64-bit compilation mode (on the PPU only), the enumeration is of type `long` if the range of enumeration values falls within the limits of `signed long`, and `unsigned long` otherwise.

intlong
Specifies that enumerations occupy 8 bytes of storage if the range of values in the enumeration exceeds the limit for `int`. If the range of values in the enumeration does not exceed the limit for `int`, the enumeration will occupy 4 bytes of storage and is represented by `int`.

small
Specifies that enumerations occupy the smallest amount of space (1, 2, 4, or 8 bytes of storage) that can accurately represent the range of values in the enumeration. Signage is `unsigned`, unless the range of values includes negative values. If an 8-byte `enum` results, the actual enumeration type used is dependent on compilation mode.

pop | reset (pragma only)
Discards the current pragma setting and reverts to the setting specified by the previous pragma directive. If no previous pragma was specified, reverts to the command-line or default option setting.

Usage

The tables that follow show the priority for selecting a predefined type. The table also shows the predefined type, the maximum range of `enum` constants for the corresponding predefined type, and the amount of storage that is required for that predefined type, that is, the value that the `sizeof` operator would yield when

applied to the minimum-sized `enum`. All types are `signed` unless otherwise noted.

Table 20. Enumeration sizes and types

	enum=1		enum=2		enum=4		enum=8			
							32-bit compilation mode		64-bit compilation mode (PPU only)	
Range	var	const	var	const	var	const	var	const	var	const
0..127	char	int	short	int	int	int	long long	long long	long	long
-128..127	char	int	short	int	int	int	long long	long long	long	long
0..255	unsigned char	int	short	int	int	int	long long	long long	long	long
0..32767	ERROR[1]	int	short	int	int	int	long long	long long	long	long
-32768..32767	ERROR[1]	int	short	int	int	int	long long	long long	long	long
0..65535	ERROR[1]	int	unsigned short	int	int	int	long long	long long	long	long
0..2147483647	ERROR[1]	int	ERROR[1]	int	int	int	long long	long long	long	long
-(2147483647+1) ..2147483647	ERROR[1]	int	ERROR[1]	int	int	int	long long	long long	long	long
0..4294967295	ERROR[1]	unsigned int	ERROR[1]	unsigned int	unsigned int	unsigned int	long long	long long	long	long
$0..(2^{63}-1)$	ERROR[1]	long[2]	ERROR[1]	long[2]	ERROR[1]	long[2]	long long[2]	long long[2]	long[2]	long[2]
$-2^{63}..(2^{63}-1)$	ERROR[1]	long[2]	ERROR[1]	long[2]	ERROR[1]	long[2]	long long[2]	long long[2]	long[2]	long[2]
$0..2^{64}$	ERROR[1]	unsigned long[2]	ERROR[1]	unsigned long[2]	ERROR[1]	unsigned long[2]	unsigned long long[2]	unsigned long long[2]	unsigned long[2]	unsigned long[2]

	enum=int		enum=intlong				enum=small			
			32-bit compilation mode		64-bit compilation mode		32-bit compilation mode		64-bit compilation mode (PPU only)	
Range	var	const	var	const	var	const	var	const	var	const
0..127	int	int	int	int	int	int	unsigned char	int	unsigned char	int
-128..127	int	int	int	int	int	int	signed char	int	signed char	int
0..255	int	int	int	int	int	int	unsigned char	int	unsigned char	int
0..32767	int	int	int	int	int	int	unsigned short	int	unsigned short	int
-32768..32767	int	int	int	int	int	int	short	int	short	int
0..65535	int	int	int	int	int	int	unsigned short	int	unsigned short	int
0..2147483647	int	int	int	int	int	int	unsigned int	unsigned int	unsigned int	unsigned int
-(2147483647+1) ..2147483647	int	int	int	int	int	int	int	int	int	int
0..4294967295	unsigned int	unsigned int	unsigned int	unsigned int	unsigned int	unsigned int	unsigned int	unsigned int	unsigned int	unsigned int
0..(2^{63}-1)	ERR[2]	ERR[2]	long long[2]	long long[2]	long[2]	long[2]	unsigned long long[2]	unsigned long long[2]	unsigned long[2]	unsigned long[2]
-2^{63}..(2^{63}-1)	ERR[2]	ERR[2]	long long[2]	long long[2]	long[2]	long[2]	long long[2]	long long[2]	long[2]	long[2]
0..2^{64}	ERR[2]	ERR[2]	unsigned long long[2]	unsigned long long[2]	unsigned long[2]	unsigned long[2]	unsigned long long[2]	unsigned long long[2]	unsigned long[2]	unsigned long[2]

Notes:

1. These enumerations are too large for the **-qenum=1|2|48** settings. A Severe error is issued and compilation stops. To correct this condition, you should reduce the range of the enumerations, choose a larger **-qenum** setting, or choose a dynamic **-qenum** setting, such as **small** or **intlong**.
2. C Enumeration types must not exceed the range of `int` when compiling C applications to ISO C 1989 and ISO C 1999 Standards. When the **stdc89 | stdc99** language level in effect, the compiler will behave as follows if the value of an enumeration exceeds the range of `int`:
   a. If **-qenum=int** is in effect, a severe error message is issued and compilation stops.
   b. For all other settings of **-qenum**, an informational message is issued and compilation continues.

The **#pragma enum** directive must be precede the declaration of `enum` variables that follow; any directives that occur within a declaration are ignored and diagnosed with a warning.

For each **#pragma enum** directive that you put in a source file, it is good practice to have a corresponding **#pragma enum=reset** before the end of that file. This should prevent one file from potentially changing the setting of another file that includes it.

Examples

If the following fragment is compiled with the **enum=small** option:

```
enum e_tag {a, b, c} e_var;
```

the range of enumeration constants is 0 through 2. This range falls within all of the ranges described in the table above. Based on priority, the compiler uses predefined type `unsigned char`.

If the following fragment is compiled with the **enum=small** option:

```
enum e_tag {a=-129, b, c} e_var;
```

the range of enumeration constants is -129 through -127. This range only falls within the ranges of `short (signed short)` and `int (signed int)`. Because `short (signed short)` is smaller, it will be used to represent the `enum`.

The following code segment generates a warning and the second occurrence of the **enum** pragma is ignored:

```
#pragma enum=small
enum e_tag {
  a,
  b,
  #pragma enum=int /* error: cannot be within a declaration */
  c
} e_var;
#pragma enum=reset /* second reset isn't required */
```

The range of `enum` constants must fall within the range of either `unsigned int` or `int (signed int)`. For example, the following code segments contain errors:

```
#pragma enum=small
enum e_tag { a=-1,
             b=2147483648   /* error: larger than maximum int */
           } e_var;
#pragma options enum=reset
```

Predefined macros
None.

-qenablevmx (PPU only)

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Enables generation of vector instructions.

These instructions can offer higher performance when used with algorithmic-intensive tasks such as multimedia applications.

Syntax

Defaults
-qenablevmx for all supported **-qarch** values.

-qnoenablevmx, otherwise.

Usage
If **-qnoenablevmx** is in effect, **-qaltivec** and**-qhot=simd** cannot be used.

Predefined macros
None.

Related information
- "-qaltivec" on page 49
- "-qarch" on page 49
- "-qhot" on page 103

-F

Category
Compiler customization

Pragma equivalent
None.

Purpose
Names an alternative configuration file or stanza for the compiler.

Syntax

Defaults
By default, the compiler uses the configuration file that is configured at installation time, and uses the stanza defined in that file for the invocation command currently being used.

Parameters
file_path
The full path name of the alternate compiler configuration file to use.

stanza
The name of the configuration file stanza to use for compilation. This directs the compiler to use the entries under that *stanza* regardless of the invocation command being used. For example, if you are compiling with **ppuxlc** or **spuxlc**, but you specify the **c99** stanza, the compiler will use all the settings specified in the **c99** stanza.

Usage
Note that any file names or stanzas that you specify with the **-F** option override the defaults specified in the system configuration file. If you have specified a custom configuration file with the XLC_USR_CONFIG environment variable, that file is processed before the one specified by the -F option.

The **-B**, **-t**, and **-W** options override the **-F** option.

Predefined macros
None.

Examples
To compile `myprogram.c` using a stanza called `debug` that you have added to the default configuration file, enter:

```
invocation myprogram.c -F:debug
```

To compile `myprogram.c` using a configuration file called `/usr/tmp/myconfig.cfg`, enter:

```
invocation myprogram.c -F/usr/tmp/myconfig.cfg
```

To compile `myprogram.c` using the stanza `c99` you have created in a configuration file called `/usr/tmp/myconfig.cfg`, enter:

```
invocation myprogram.c -F/usr/tmp/myconfig.cfg:c99
```

Related information
- "Using custom compiler configuration files" on page 21
- "-B" on page 53
- "-t" on page 202
- "-W" on page 225
- "Specifying compiler options in a configuration file" on page 8
- "Compile-time and link-time environment variables" on page 20

-qfdpr

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Provides object files with information that the IBM Feedback Directed Program Restructuring (FDPR) performance-tuning utility needs to optimize the resulting executable file.

When **-qfdpr** is in effect, optimization data is stored in the object file.

Syntax


Defaults
-qnofdpr

Usage
For best results, use **-qfdpr** for all object files in a program; FDPR will perform optimizations only on the files compiled with **-qfdpr**, and not library code, even if it is statically linked.

The optimizations that the FDPR utility performs are similar to those that the **-qpdf** option performs.

The FDPR performance-tuning utility has its own set of restrictions, and it is not guaranteed to speed up all programs or produce executables that produce exactly the same results as the original programs.

Predefined macros
None.

Examples
To compile `myprogram.c` so it includes data required by the FDPR utility, enter:

```
invocation myprogram.c -qfdpr
```

Related information
- "-qpdf1, -qpdf2 (PPU only)" on page 167

-qflag

Category
Listings, messages, and compiler information

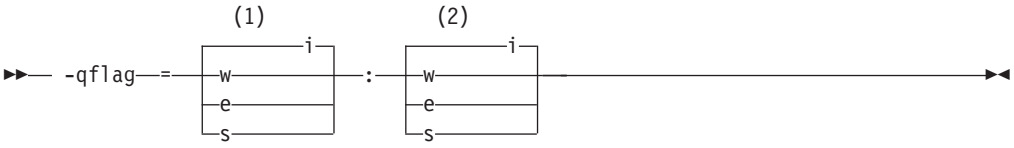
Pragma equivalent
#pragma options flag, #pragma report (C++ only)

Purpose
Limits the diagnostic messages to those of a specified severity level or higher.

The messages are written to standard output and, optionally, to the listing file if one is generated.

Syntax

-qflag syntax – C

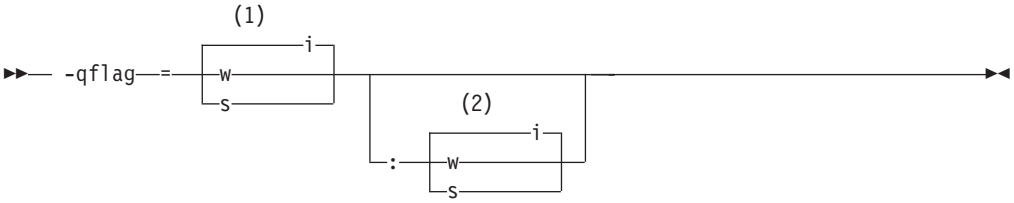


Notes:

1 Minimum severity level of messages reported in listing

2 Minimum severity level of messages reported on terminal

-qflag syntax – C++



Notes:

1 Minimum severity level of messages reported in listing

2 Minimum severity level of messages reported on terminal

Defaults

-qflag=i : i, which shows all compiler messages

Parameters

i Specifies that all diagnostic messages are to display: warning, error and informational messages. Informational messages (I) are of the lowest severity.

w Specifies that warning (W) and all types of error messages are to display.

C **e**
Specifies that only error (E), severe error (S), and unrecoverable error (U) messages are to display.

s C Specifies that only severe error (S) and unrecoverable error (U) messages are to display. C++ Specifies that only severe error (S) messages are to display.

Usage

C You must specify a minimum message severity level for both listing and terminal reporting.

C++ You must specify a minimum message severity level for the listing. If you do not specify a suboption for the terminal, the compiler assumes the same severity as for the listing.

Note that using **-qflag** does not enable the classes of informational message controlled by the **-qinfo** option; see **-qinfo** for more information.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the listing shows all messages that were generated and your workstation displays only error and higher messages (with their associated information messages to aid in fixing the errors), enter:

```
invocation myprogram.c -qflag=i:e
```

Related information
- "-qinfo" on page 110
- "-w" on page 224
- "Compiler messages" on page 15

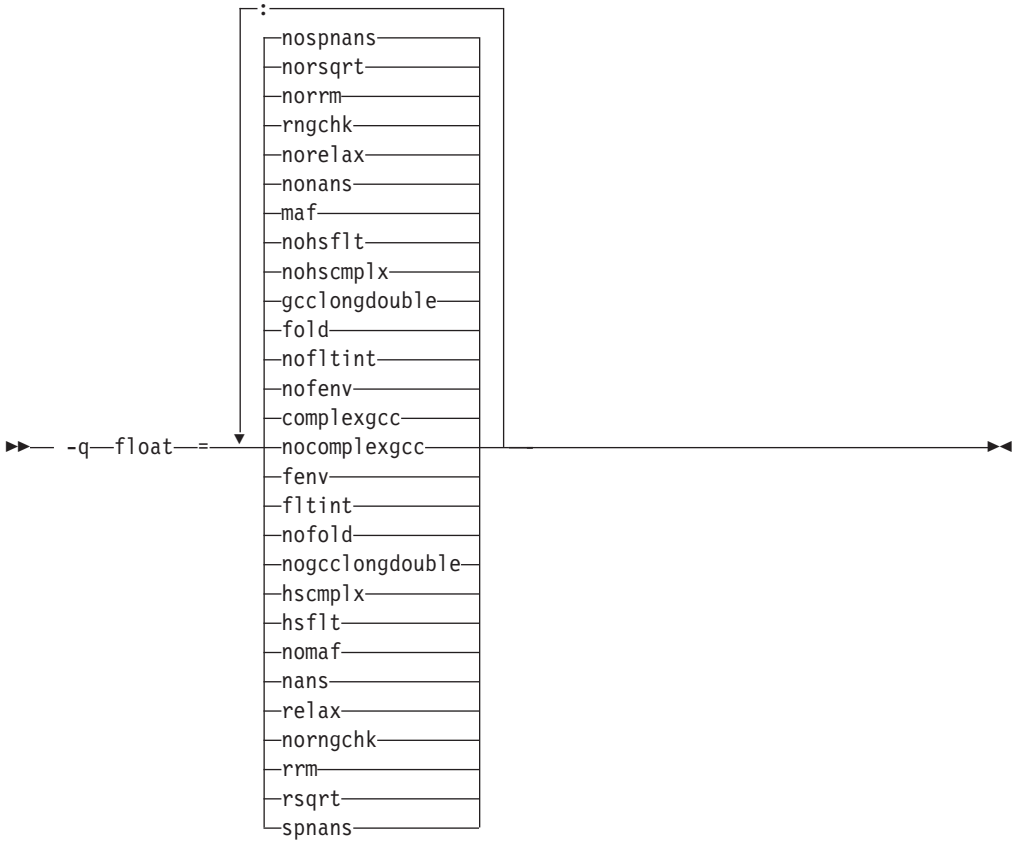
-qfloat

Category
Floating-point and integer control

Pragma equivalent
#pragma options float

Purpose
Selects different strategies for speeding up or improving the accuracy of floating-point calculations.

Syntax



Defaults

- **-qfloat=complexgcc:nofenv:nofltint:fold:gcclongdouble: nohscmplx:nohsflt:maf:nonans:norelax:rngchk:norrm:norsqrt:nospnans** for the PPU
- **-qfloat=complexgcc:nofenv:nofltint:fold:gcclongdouble:nohscmplx:nohsflt:maf:nans:norelax:rngch** for the SPU
- **-qfloat=fltint:rsqrt:norngchk** when **-qnostrict** or **-O3** or higher optimization level is in effect.
- **-qfloat=nocomplexgcc** when 64-bit mode is enabled.

Parameters

complexgcc | nocomplexgcc (PPU only)
Specifies whether GCC conventions for passing or returning complex numbers are to be used. **complexgcc** preserves compatibility with GCC-compiled code. This suboption does not have any effect if support for complex types is not in effect; see "-qlanglvl" on page 132 for details.

fenv | nofenv
Specifies whether the code depends on the hardware environment and whether to suppress optimizations that could cause unexpected results due to this dependency.

Certain floating-point operations rely on the status of Floating-Point Status and Control Register (FPSCR), for example, to control the rounding mode or to detect underflow. In particular, many compiler built-in functions read values directly from the FPSCR.

When **nofenv** is in effect, the compiler assumes that the program does not depend on the hardware environment, and that aggressive compiler optimizations that change the sequence of floating-point operations are allowed. When **fenv** is in effect, such optimizations are suppressed.

You should use **fenv** for any code containing statements that read or set the hardware floating-point environment, to guard against optimizations that could cause unexpected behavior.

Any directives specified in the source code (such as the standard C FENV_ACCESS pragma) take precedence over the option setting.

fltint | nofltint (PPU only)
Speeds up floating-point-to-integer conversions by using an inline sequence of code instead of a call to a library function. The library function, which is called when **nofltint** is in effect, checks for floating-point values outside the representable range of integers and returns the minimum or maximum representable integer if passed an out-of-range floating-point value.

If you compile with **-O3** or higher optimization level, **fltint** is enabled automatically. To disable it, also specify **-qstrict**.

fold | nofold
Evaluates constant floating-point expressions at compile time, which may yield slightly different results from evaluating them at run time. The compiler always evaluates constant expressions in specification statements, even if you specify **nofold**.

gcclongdouble | nogcclongdouble (PPU only)
Specifies whether the compiler uses GCC-supplied or IBM-supplied library functions for 128-bit long double operations.

gcclongdouble ensures binary compatibility with GCC for mathematical calculations. If this compatibility is not important in your application, you should use **nogcclongdouble** for better performance.

Note: Passing results from modules compiled with **nogcclongdouble** to modules compiled with **gcclongdouble** may produce different results for numbers such as Inf, NaN and other rare cases. To avoid such incompatibilities, the compiler provides built-in functions to convert IBM long double types to GCC long double types; see "Floating-point built-in functions" on page 290 for more information.

hscmplx | nohscmplx
Speeds up operations involving complex division and complex absolute value. This suboption, which provides a subset of the optimizations of the **hsflt** suboption, is preferred for complex calculations.

hsflt | nohsflt
Speeds up calculations by preventing rounding for single-precision expressions and by replacing floating-point division by multiplication with the reciprocal of the divisor. It also uses the same technique as the **fltint** suboption for floating-point-to-integer conversions. **hsflt** implies **hscmplx**.

The **hsflt** suboption overrides the **nans** and **spnans** suboptions.

Note: Use **-qfloat=hsflt** on applications that perform complex division and floating-point conversions where floating-point calculations have known characteristics. In particular, all floating-point results must be within the defined range of representation of single precision. Use with discretion, as this option may produce unexpected results without warning. For

complex computations, it is recommended that you use the **hscmplx** suboption (described above), which provides equivalent speed-up without the undesirable results of **hsflt**.

maf | nomaf
Makes floating-point calculations faster and more accurate by using floating-point multiply-add instructions where appropriate. The results may not be exactly equivalent to those from similar calculations performed at compile time or on other types of computers. Negative zero results may be produced. This suboption may affect the precision of floating-point intermediate results. If **-qfloat=nomaf** is specified, no multiply-add instructions will be generated unless they are required for correctness.

nans | nonans (PPU only)
Allows you to use the **-qflttrap=invalid:enable** option to detect and deal with exception conditions that involve signaling NaN (not-a-number) values. Use this suboption only if your program explicitly creates signaling NaN values, because these values never result from other floating-point operations.

relax | norelax
Relaxes strict IEEE conformance slightly for greater speed, typically by removing some trivial floating-point arithmetic operations, such as adds and subtracts involving a zero on the right.

rngchk | norngchk
At optimization level **-O3** and above, and without **-qstrict**, controls whether range checking is performed for input arguments for software divide and inlined square root operations. Specifying **norngchk** instructs the compiler to skip range checking, allowing for increased performance where division and square root operations are performed repeatedly within a loop.

Note that with **norngchk** in effect the following restrictions apply:

- The dividend of a division operation must not be +/-INF.
- The divisor of a division operation must not be 0.0, +/- INF, or denormalized values.
- The quotient of dividend and divisor must not be +/-INF.
- The input for a square root operation must not be INF.

If any of these conditions are not met, incorrect results may be produced. For example, if the divisor for a division operation is 0.0 or a denormalized number (absolute value < 2^{-1022} for double precision, and absolute value < 2^{-126} for single precision), NaN, instead of INF, may result; when the divisor is +/- INF, NaN instead of 0.0 may result. If the input is +INF for a sqrt operation, NaN, rather than INF, may result.

norngchk is only allowed when **-qnostrict** is in effect. If **-qstrict** is in effect, **norngchk** is ignored.

rrm | norrm (PPU only)
Prevents floating-point optimizations that require the rounding mode to be the default, round-to-nearest, at run time, by informing the compiler that the floating-point rounding mode may change or is not round-to-nearest at run time. You should use **rrm** if your program changes the runtime rounding mode by any means; otherwise, the program may compute incorrect results.

rsqrt | norsqrt
Speeds up some calculations by replacing division by the result of a square root with multiplication by the reciprocal of the square root.

rsqrt has no effect unless **-qignerrno** is also specified; `errno` will *not* be set for any `sqrt` function calls.

If you compile with **-O3** or higher optimization level, **rsqrt** is enabled automatically. To disable it, also specify **-qstrict**.

spnans | nospnans (PPU only)
Generates extra instructions to detect signalling NaN on conversion from single-precision to double-precision.

Usage
Using **-qfloat** suboptions other than the default settings may produce incorrect results in floating-point computations if not all required conditions for a given suboption are met. For this reason, you should only use this option if you are experienced with floating-point calculations involving IEEE floating-point values and can properly assess the possibility of introducing errors in your program. See also "Handling floating point operations" in the *XL C/C++ Programming Guide* for more information.

If the **-qstrict | -qnostrict** and **float** suboptions conflict, the last setting specified is used.

Predefined macros
None.

Examples
To compile myprogram.c so that constant floating point expressions are evaluated at compile time and multiply-add instructions are not generated, enter:

```
invocation myprogram.c -qfloat=fold:nomaf
```

Related information
- "-qarch" on page 49
- "-qcomplexgccincl" on page 64
- "-qflttrap (PPU only)"
- "-qstrict" on page 198

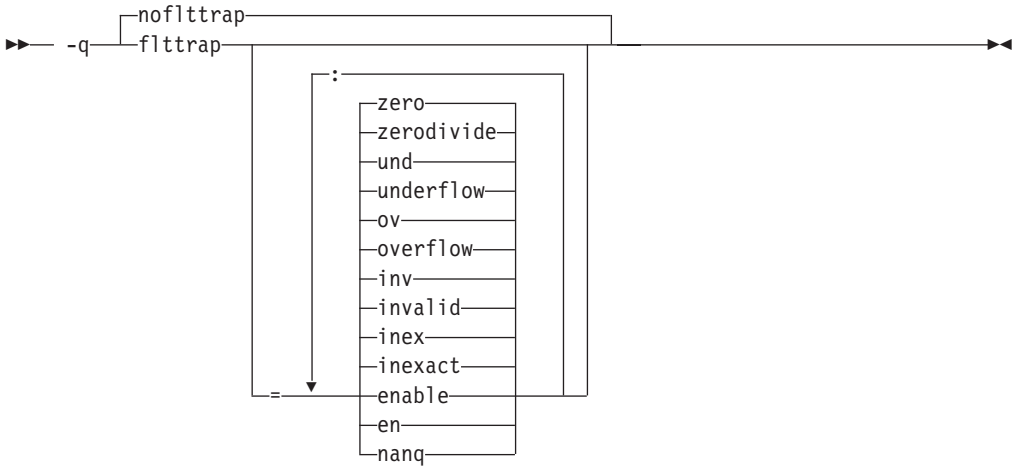
-qflttrap (PPU only)

Category
Error checking and debugging

Pragma equivalent
#pragma options [no]flttrap

Purpose
Determines the types of floating-point exception conditions to be detected at run time

Syntax



Defaults

-qnoflttrap

Parameters

enable, en
Enables trapping when the specified exceptions (**overflow**, **underflow**, **zerodivide**, **invalid**, or **inexact**) occur. You must specify this suboption if you want to turn on exception trapping without modifying your source code. If any of the specified exceptions occur, a SIGTRAP or SIGFPE signal is sent to the process with the precise location of the exception.

inexact, inex
Enables the detection of floating-point inexact operations. If a floating-point inexact operation occurs, an inexact operation exception status flag is set in the Floating-Point Status and Control Register (FPSCR).

invalid, inv
Enables the detection of floating-point invalid operations. If a floating-point invalid operation occurs, an invalid operation exception status flag is set in the FPSCR.

nanq
Generates code to detect NaNQ (Not a Number Quiet) and NaNS (Not a Number Signalling) exceptions before and after each floating point operation, including assignment, and after each call to a function returning a floating-point result to trap if the value is a NaN. Trapping code is generated regardless of whether the **enable** suboption is specified.

overflow, ov
Enables the detection of floating-point overflow. If a floating-point overflow occurs, an overflow exception status flag is set in the FPSCR.

underflow, und
Enables the detection of floating-point underflow. If a floating-point underflow occurs, an underflow exception status flag is set in the FPSCR.

zerodivide, zero
Enables the detection of floating-point division by zero. If a floating-point zero-divide occurs, a zero-divide exception status flag is set in the FPSCR.

Specifying **-qflttrap** option with no suboptions is equivalent to **-qflttrap=overflow : underflow : zerodivide : invalid : inexact**. Exceptions will be detected by the

hardware, but trapping is not enabled. Because this default does not include **enable**, it is probably only useful if you already use `fpsets` or similar subroutines in your source.

Usage

It is recommended that you use the **enable** suboption whenever compiling the `main` program with **-qflttrap**. This ensures that the compiler will generate the code to automatically enable floating-point exception trapping, without requiring that you include calls to the appropriate floating-point exception library functions in your code.

If you specify **-qflttrap** more than once, both with and without suboptions, the **-qflttrap** without suboptions is ignored.

This option is recognized during linking with IPA. Specifying the option at the link step overrides the compile-time setting.

If your program contains signalling NaNs, you should use the **-qfloat=nans** option along with **-qflttrap** to trap any exceptions.

The compiler exhibits behavior as illustrated in the following examples when the **-qflttrap** option is specified together with an optimization option:

- with **-O2**:
  - 1/0 generates a **div0** exception and has a result of infinity
  - 0/0 generates an invalid operation
- with **-O3** or greater:
  - 1/0 generates a **div0** exception and has a result of infinity
  - 0/0 returns zero multiplied by the result of the previous division.

Predefined macros

None.

Examples

When you compile this program:

```
#include <stdio.h>

int main()
{
  float x, y, z;
  x = 5.0;
  y = 0.0;
  z = x / y;
  printf("%f", z);
}
```

with the command:

```
invocation -qflttrap=zerodivide:enable divide_by_zero.c
```

the program stops when the division is performed.

The **zerodivide** suboption identifies the type of exception to guard against. The **enable** suboption causes a SIGTRAP or SIGFPE signal to be generated when the exception occurs.

Related information

- "-qfloat" on page 87

-qformat

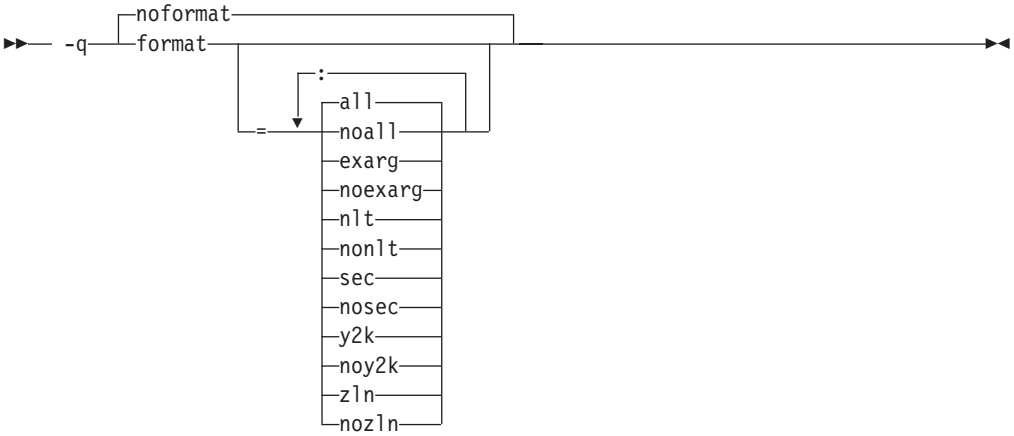
Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Warns of possible problems with string input and output format specifications.

Functions diagnosed are `printf`, `scanf`, `strftime`, `strfmon` family functions and functions marked with format attributes.

Syntax



Defaults
-qnoformat

Parameters
all | noall
Enables or disables all format diagnostic messages.

exarg | noexarg
Warns if excess arguments appear in `printf` and `scanf` style function calls.

nlt | nonlt
Warns if a format string is not a string literal, unless the format function takes its format arguments as a `va_list`.

sec | nosec
Warns of possible security problems in use of format functions.

y2k | noy2k
Warns of `strftime` formats that produce a 2-digit year.

zln | nozln
Warns of zero-length formats.

Specifying **-qformat** with no suboptions is equivalent to **-qformat=all**.

-qnoformat is equivalent to **-qformat=noall**.

Predefined macros
None.

Examples
To enable all format string diagnostics, enter either of the following:

```
invocation myprogram.c -qformat=all
invocation myprogram.c -qformat
```

To enable all format diagnostic checking except that for y2k date diagnostics, enter:

```
invocation myprogram.c -qformat=all:noy2k
```

-qfullpath

Category
Error checking and debugging

Pragma equivalent
#pragma options [no]fullpath

Purpose
When used with the **-g** option, this option records the full, or absolute, path names of source and include files in object files compiled with debugging information, so that debugging tools can correctly locate the source files.

When **fullpath** is in effect, the absolute (full) path names of source files are preserved. When **nofullpath** is in effect, the relative path names of source files are preserved.

Syntax

Defaults
-qnofullpath

Usage
If your executable file was moved to another directory, the debugger would be unable to find the file unless you provide a search path in the debugger. You can use **fullpath** to ensure that the debugger locates the file successfully.

Predefined macros
None.

Related information
- "-qlinedebug" on page 145
- "-g" on page 97

-qfuncsect

Category
Object code control

Pragma equivalent
#pragma options [no]funcsect

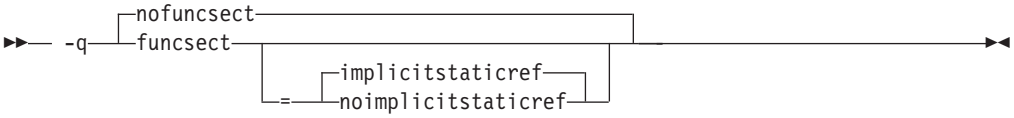
Purpose

Places instructions for each function in a separate object file control section or CSECT.

When **-qfuncsect** is specified the compiler generates references from each function to the static data area, if one exists, in order to ensure that if any function from that object file is included in the final executable, the static data area also is included. This is done to ensure that any static strings or strings from a pragma comment, possible containing copyright information, are also included in the executable. This can, in some cases, cause code bloat or unresolved symbols at link time.

When **-qnofuncsect** is in effect, each object file consists of a single control section combining all functions defined in the corresponding source file. You can use **-qfuncsect** to place each function in a separate control section.

Syntax



Defaults

-qnofuncsect

Parameters

implicitstaticref | **noimplicitstaticref**

Specifies whether references to the static data section of the object file by functions contained in static variables, virtual function tables, or exception handling tables, are maintained.

When your code contains a **#pragma comment** directive or a static string for copyright information purposes, the compiler automatically places these strings in the static data area, and generates references to these static data areas in the object code.

When **implicitstaticref** is in effect, any references to the static area by functions that are removed by the linker's garbage collection procedures are maintained; this may result in unresolved function definition errors by the linker.

When **noimplicitstaticref** is in effect, these references to the static area are removed, allowing for successful linking and potentially reduced executable size; note, however, that this may result in a failure to include the static data area and any copyright information that it may contain.

Specifying **-qfuncsect** with no suboption implies **implicitstaticref**.

Usage

Using multiple control sections increases the size of the object file, but can reduce the size of the final executable by allowing the linker to remove functions that are not called or that have been inlined by the optimizer at all places they are called.

The pragma directive must be specified before the first statement in the compilation unit.

Predefined macros
None.

Related information
- "#pragma comment" on page 239

-g

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Generates debug information for use by a symbolic debugger.

Syntax

Defaults
Not applicable.

Usage
Specifying **-g** will turn off all inlining unless you explicitly request it with an optimization option.

To specify that source files used with **-g** are referred to by either their absolute or their relative path name, use the **-qfullpath** option.

You can also use the **-qlinedebug** option to produce abbreviated debugging information in a smaller object size.

Predefined macros
None.

Examples
To compile `myprogram.c` to produce an executable program `testing` so you can debug it, enter:

```
invocation myprogram.c -o testing -g
```

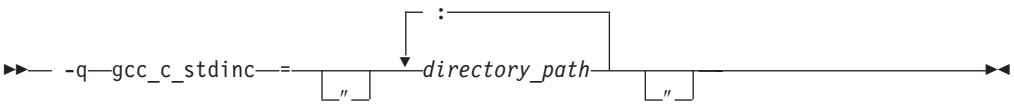
Related information
- "-qfullpath" on page 95
- "-qlinedebug" on page 145
- "-O, -qoptimize" on page 159

-qgcc_c_stdinc (C only)

Category
Compiler customization

Pragma equivalent
None.

Purpose
Changes the standard search location for the GNU C system header files.

Syntax


Defaults
By default, the compiler searches the directory specified in the configuration file.

Parameters
directory_path
The path for the directory where the compiler should search for the GNU C header files. You can surround the path with quotation marks to ensure it is not split up by the command line.

Usage
This option allows you to change the search paths for specific compilations. To permanently change the default search paths for the GNU C headers, you use a configuration file to do so; see "Directory search sequence for include files" on page 12 for more information.

If this option is specified more than once, only the last instance of the option is used by the compiler.

This option is ignored if the **-qnostdinc** option is in effect.

Predefined macros
None.

Examples
To override the default search paths for the GNU C headers with `mypath/headers1` and `mypath/headers2`, enter:

```
invocation myprogram.c -qgcc_c_stdinc=mypath/headers1:mypath:headers2
```

Related information
- "-qc_stdinc (C only)" on page 67
- "-qstdinc" on page 196
- "-qinclude" on page 109
- "Directory search sequence for include files" on page 12
- "Specifying compiler options in a configuration file" on page 8

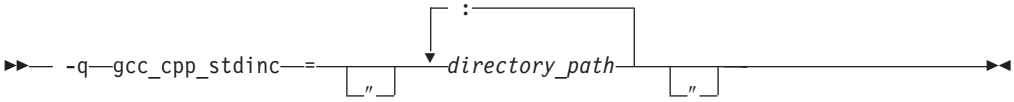
-qgcc_cpp_stdinc (C++ only)

Category
Compiler customization

Pragma equivalent
None

Purpose
Changes the standard search location for the GNU C++ system header files.

Syntax



Defaults
By default, the compiler searches the directory specified in the configuration file.

Parameters
directory_path
The path for the directory where the compiler should search for the GNU C++ header files. You can surround the path with quotation marks to ensure it is not split up by the command line.

Usage
This option allows you to change the search paths for specific compilations. To permanently change the default search paths for the GNU C++ headers, you use a configuration file to do so; see "Directory search sequence for include files" on page 12 for more information.

If this option is specified more than once, only the last instance of the option is used by the compiler.

This option is ignored if the **-qnostdinc** option is in effect.

Predefined macros
None.

Examples
To override the default search paths for the GNU C++ headers with `mypath/headers1` and `mypath/headers2`, enter:

```
ppuxlc++ myprogram.C -qgcc_cpp_stdinc=mypath/headers1:mypath:headers2
```

Related information
- "-qcpp_stdinc (C++ only)" on page 68
- "-qstdinc" on page 196
- "-qinclude" on page 109
- "Directory search sequence for include files" on page 12
- "Specifying compiler options in a configuration file" on page 8

-qgenproto (C only)

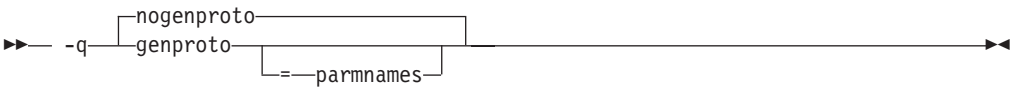
Category
Portability and migration

Pragma equivalent
None.

Purpose
Produces prototype declarations from K&R function definitions or function definitions with empty parentheses, and displays them to standard output.

The compiler accepts and compiles K&R function definitions or definitions with a function declarator with empty parentheses; however, these function definitions are considered by the C standard to be obsolete (the compiler will diagnose them if you enable the **-qinfo=obs** option). When **-qgenproto** is in effect, the compiler generates the corresponding prototype declarations and displays them to standard output. You can use this option to help you identify obsolete function definitions and automatically obtain equivalent prototypes.

Syntax



Defaults

-qnogenproto

Parameters

parmnames
Parameter names are included in the prototype. If you do not specify this suboption, parameter names will not be included in the prototype.

Predefined macros

None.

Examples

Compiling with **- qgenproto** for the following function definitions:

```
int foo(a, b)   // K&R function
  int a, b;
{
}

int faa(int i) { } // prototyped function

main() {  // missing void parameter
}
```

produces the following output on the display:

```
int foo(int, int);
int main(void);
```

Specifying **-qgenproto=parmnames** produces:

```
int foo(int a, int b);
int main(void);
```

-qhalt

Category

Error checking and debugging

Pragma equivalent

#pragma options halt

Purpose

Stops compilation before producing any object, executable, or assembler source files if the maximum severity of compile-time messages equals or exceeds the severity you specify.

Syntax

-qhalt syntax — C

-qhalt syntax — C++

Defaults

-qhalt=s

Parameters

i Specifies that compilation is to stop for all types of errors: warning, error and informational. Informational diagnostics (I) are of the lowest severity.

w Specifies that compilation is to stop for warnings (W) and all types of errors.

C **e**
Specifies that compilation is to stop for errors (E), severe errors (S), and unrecoverable errors (U).

s C Specifies that compilation is to stop for severe errors (S) and unrecoverable errors (U). C++ Specifies that compilation is to stop for severe errors (S).

Usage

When the compiler stops as a result of the **halt** option, the compiler return code is nonzero. For a list of return codes, see “Compiler return codes” on page 17.

When **-qhalt** is specified more than once, the lowest severity level is used.

Diagnostic messages may be controlled by the **-qflag** option.

You can also instruct the compiler to stop compilation based on the number of errors of a type of severity by using the **-qmaxerr** option, which overrides **-qhalt**.

C++ You can also use the **-qhaltonmsg** option to stop compilation according to error message number.

Predefined macros

None.

Examples
To compile `myprogram.c` so that compilation stops if a warning or higher level message occurs, enter:

```
invocation myprogram.c -qhalt=w
```

Related information
- "-qhaltonmsg (C++ only)"
- "-qflag" on page 85
- "-qmaxerr" on page 151

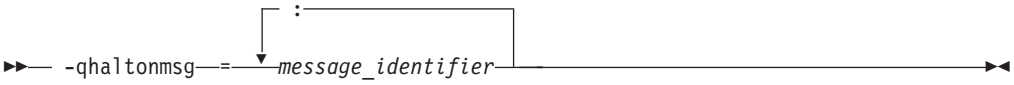
-qhaltonmsg (C++ only)

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Stops compilation before producing any object, executable, or assembler source files if a specified error message is generated.

Syntax



Defaults
Not applicable.

Parameters
message_identifier
Represents a message identifier. The message identifier must be in the following format:

```
15dd-number
```

where:

dd Is the two-digit code representing the compiler component that produces the message. See "Compiler message format" on page 15 for descriptions of these.

number
Is the message number.

Usage
When the compiler stops as a result of the **-qhaltonmsg** option, the compiler return code is nonzero.

Predefined macros
None.

Related information
- "Compiler messages" on page 15

-qhot

Category
Optimization and tuning

Pragma equivalent
#pragma novector, #pragma nosimd

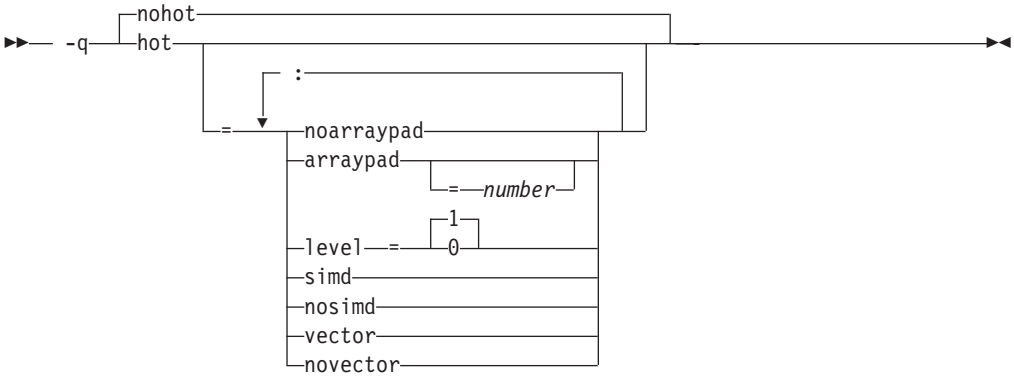
Purpose
Performs high-order loop analysis and transformations (HOT) during optimization.

The **-qhot** compiler option is a powerful alternative to hand tuning that provides opportunities to optimize loops and array language. This compiler option will always attempt to optimize loops, regardless of the suboptions you specify.

You can use the pragma directives to disable these transformations for selected sections of code.

Syntax

Option syntax



Pragma syntax

Defaults
- -qnohot
- **-qhot=noarraypad:level=0:simd:vector** for the PPU when **-O3** is in effect.
- **-qhot=noarraypad:level=1:simd:vector** for the PPU when **-O4** or **-O5** is in effect.
- **-qhot=noarraypad:level=0:simd:novector** for the SPU when **-O3** is in effect.
- Specifying **-qhot** without suboptions for the PPU is equivalent to **-qhot=level=1:simd:noarraypad:vector**. Specifying **-qhot** without suboptions for the SPU is equivalent to **-qhot=level=1:simd:noarraypad:novector**.

Parameters
arraypad | noarraypad (option only)
Permits the compiler to increase the dimensions of arrays where doing so might improve the efficiency of array-processing loops. (Because of the

implementation of the cache architecture, array dimensions that are powers of two can lead to decreased cache utilization.) Specifying **-qhot=arraypad** when your source includes large arrays with dimensions that are powers of 2 can reduce cache misses and page faults that slow your array processing programs. This can be particularly effective when the first dimension is a power of 2. If you use this suboption with no *number*, the compiler will pad any arrays where it infers there may be a benefit and will pad by whatever amount it chooses. Not all arrays will necessarily be padded, and different arrays may be padded by different amounts. If you specify a *number*, the compiler will pad every array in the code.

Note: Using **arraypad** can be unsafe, as it does not perform any checking for reshaping or equivalences that may cause the code to break if padding takes place.

number **(option only)**
A positive integer value representing the number of elements by which each array will be padded in the source. The pad amount must be a positive integer value. It is recommended that pad values be multiples of the largest array element size, typically 4, 8, or 16.

level=0 (option only)
Performs a subset of the high-order transformations and sets the default to **novector:nosimd:noarraypad**.

level=1 (option only)
Performs the default set of high-order transformations.

simd (option only) | nosimd
When simd is in effect, the compiler converts certain operations that are performed in a loop on successive elements of an array into a call to a vector instruction. This call calculates several results at one time, which is faster than calculating each result sequentially. Applying this suboption is useful for applications with significant image processing demands.

nosimd disables the conversion of loop array operations into calls to vector instructions.

vector (option only) | novector (PPU only)
When specified with **-qnostrict** and **-qignerrno**, or an optimization level of **-O3** or higher, **vector** causes the compiler to convert certain operations that are performed in a loop on successive elements of an array (for example, square root, reciprocal square root) into a call to a routine in the Mathematical Acceleration Subsystem (MASS) library in libxlopt. If the operations are in a loop, the vector version of the routine is called. If the operations are scalar, the scalar version of the routine is called. The **vector** suboption supports single and double-precision floating-point mathematics, and is useful for applications with significant mathematical processing demands.

novector disables the conversion of loop array operations into calls to MASS library routines.

Since vectorization can affect the precision of your program's results, if you are using **-O4** or higher, you should specify **-qhot=novector** if the change in precision is unacceptable to you.

Usage

If you do not also specify an optimization level when specifying **-qhot** on the command line, the compiler assumes **-O2**.

If you specify **-O3**, the compiler assumes **-qhot=level=0**; to prevent all HOT optimizations with **-O3**, you must specify **-qnohot**.

If you want to override the default **level** setting of **1** when using **-O4** or **-O5**, be sure to specify **-qhot=level=0** *after* the other options.

The pragma directives apply only to `while`, `do while`, and `for` loops that immediately follow the placement of the directives. They have no effect on other loops that may be nested within the specified loop.

You can also use the **-qreport** option in conjunction with **-qhot** to produce a pseudo-C report showing how the loops were transformed; see "-qreport" on page 180 for details.

Predefined macros
None.

Examples
The following example shows the usage of **#pragma nosimd** to disable **-qhot=simd** for a specific `for` loop:

```
...
#pragma nosimd
for (i=1; i<1000; i++) {
    /* program code */
}

...
```

Related information
- "-qarch" on page 49
- "-qenablevmx (PPU only)" on page 83
- "-O, -qoptimize" on page 159
- "-qstrict" on page 198
- "Using the Mathematical Acceleration Subsystem (MASS)" in the*XL C/C++ Programming Guide*

-I

Category
Input control

Pragma equivalent
None.

Purpose
Adds a directory to the search path for include files.

Syntax

Defaults
See "Directory search sequence for include files" on page 12 for a description of the default search paths.

Parameters

directory_path
The path for the directory where the compiler should search for the header files.

Usage

If **-qnostdinc** is in effect, the compiler searches *only* the paths specified by the **-I** option for header files, and not the standard search paths as well. If **-qidirfirst** is in effect, the directories specified by the **-I** option are searched before any other directories.

If the **-I** directory option is specified both in the configuration file and on the command line, the paths specified in the configuration file are searched first. The **-I** directory option can be specified more than once on the command line. If you specify more than one **-I** option, directories are searched in the order that they appear on the command line.

The **-I** option has no effect on files that are included using an absolute path name.

Predefined macros

None.

Examples

To compile `myprogram.c` and search `/usr/tmp` and then `/oldstuff/history` for included files, enter:

```
invocation myprogram.c -I/usr/tmp -I/oldstuff/history
```

Related information

- "-qidirfirst"
- "-qstdinc" on page 196
- "-qinclude" on page 109
- "Directory search sequence for include files" on page 12
- "Specifying compiler options in a configuration file" on page 8

-qidirfirst

Category

Input control

Pragma equivalent

#pragma options [no]idirfirst

Purpose

Specifies whether the compiler searches for user include files in directories specified by the **-I** option *before* or *after* searching any other directories.

When **-qidirfirst** is in effect, the compiler first searches the directories specified by the **-I** option before searching any other directories. When **-qnoidirfirst** is in effect, before searching directories named on the **-I** option, the compiler first searches a) the directories in which source files named on the **-qinclude** option are located; and b) the directories in which the including files are located.

Syntax

Defaults
-qnoidirfirst

Usage
This option only affects files included with the `#include "file_name"` directive or the **-qinclude** option; **-qidirfirst** is independent of the **-qnostdinc** option and has no effect on the search order for XL C/C++ or system header files. (For the search order of header files, see "Directory search sequence for include files" on page 12.) This option also has no effect on files that are included using an absolute path name.

The last valid pragma directive remains in effect until replaced by a subsequent pragma.

Predefined macros
None.

Examples
To compile `myprogram.c` and search `/usr/tmp/myinclude` for included files before searching the current directory (where the source file resides), enter:

```
invocation myprogram.c -I/usr/tmp/myinclude -qidirfirst
```

Related information
- "-I" on page 105
- "-qinclude" on page 109
- "-qstdinc" on page 196
- "-qc_stdinc (C only)" on page 67
- "-qcpp_stdinc (C++ only)" on page 68
- "Directory search sequence for include files" on page 12

-qignerrno

Category
Optimization and tuning

Pragma equivalent
#pragma options [no]ignerrno

Purpose
Allows the compiler to perform optimizations that assume `errno` is not modified by system calls.

Some system library functions set `errno` when an exception occurs. When **ignerrno** is in effect, the setting and subsequent side effects of `errno` are ignored. This allows the compiler to perform optimizations that assume `errno` is not modified by system calls.

Syntax

Defaults

- -qnoignerrno
- **-qignerrno** when **-O3** or higher optimization is in effect.

Usage

If you require both **-O3** or higher and the ability to set `errno`, you should specify **-qnoignerrno** *after* the optimization option on the command line.

Predefined macros

C++ __IGNERRNO__ is defined to 1 when **ignerrno** is in effect; otherwise, it is undefined.

Related information

- "-O, -qoptimize" on page 159

-qignprag

Category

Language element control

Pragma equivalent

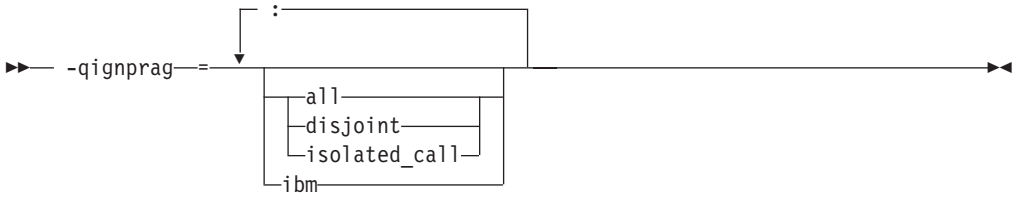
#pragma options [no]ignprag

Purpose

Instructs the compiler to ignore certain pragma statements.

This option is useful for detecting aliasing pragma errors. Incorrect aliasing gives runtime errors that are hard to diagnose. When a runtime error occurs, but the error disappears when you use **ignprag** with the **-O** option, the information specified in the aliasing pragmas is likely incorrect.

Syntax



Defaults

Not applicable.

Parameters

all
Ignores all **#pragma isolated_call** and **#pragma disjoint** directives in the source file.

disjoint
Ignores all **#pragma disjoint** directives in the source file.

ibm

C Ignores all **#pragma ibm snapshot** directives in the source file.

isolated_call

Ignores all **#pragma isolated_call** directives in the source file.

Predefined macros

None.

Examples

To compile `myprogram.c` and ignore any **#pragma isolated_call** directives, enter:

```
invocation myprogram.c -qignprag=isolated_call
```

Related information

- "#pragma disjoint" on page 241
- "-qisolated_call" on page 126
- "#pragma ibm snapshot" on page 247

-qinclude

Category

Input control

Pragma equivalent

None.

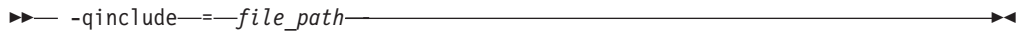
Purpose

Specifies additional header files to be included in a compilation unit, as though the files were named in an `#include` statement in the source file.

The headers are inserted before all code statements and any headers specified by an `#include` preprocessor directive in the source file.

This option is provided for portability among supported platforms.

Syntax



Defaults

Not applicable.

Parameters

file_path

The absolute or relative path and name of the header file to be included in the compilation units being compiled. If *file_path* is specified with a relative path, the search for it follows the sequence described in "Directory search sequence for include files" on page 12.

Usage

-qinclude is applied only to the files specified in the same compilation as that in which the option is specified. It is not passed to any compilations that occur during the link step, nor to any implicit compilations, such as those invoked by the option **-qtemplateregistry**, nor to the files generated by **-qtempinc**.

When the option is specified multiple times in an invocation, the header files are included in order of appearance on the command line. If the same header file is specified multiple times with this option, the header is treated as if included multiple times by `#include` directives in the source file, in order of appearance on the command line.

C++ When used with **-qtemplateregistry**, **-qinclude** is recorded in the template registry file, along with the source files affected by it. When these file dependencies initiate recompilation of the template registry, the **-qinclude** option is passed to the dependent files only if it had been specified for them when they were added to the template registry.

If you generate a listing file with **-qsource**, the header files included by **-qinclude** do not appear in the source section of the listing. Use **-qshowinc=usr** or **-qshowinc=all** in conjunction with **-qsource** if you want these header files to appear in the listing.

Any pragma directives that must appear before noncommentary statements in a source file will be affected; you cannot use **-qinclude** to include files if you need to preserve the placement of these pragmas.

Predefined macros
None.

Examples
To include the files `foo1.h` and `foo2.h` in the source file `foo.c`, enter:

```
invocation -qinclude=foo1.h foo.c  -qinclude=foo2.h
```

Related information
- "Directory search sequence for include files" on page 12

-qinfo

Category
Error checking and debugging

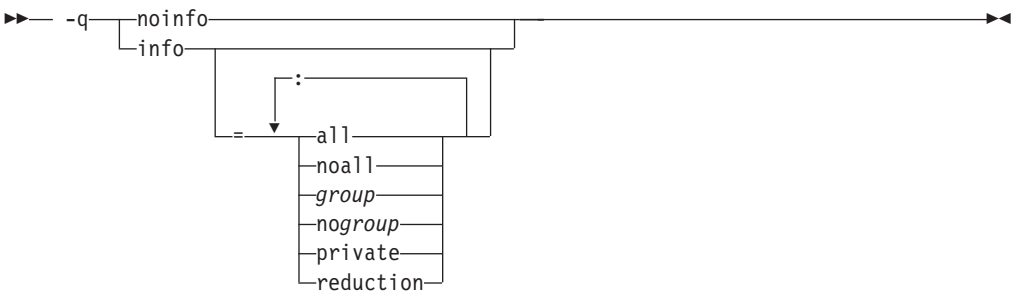
Pragma equivalent
#pragma options [no]info, #pragma info

Purpose
Produces or suppresses groups of informational messages.

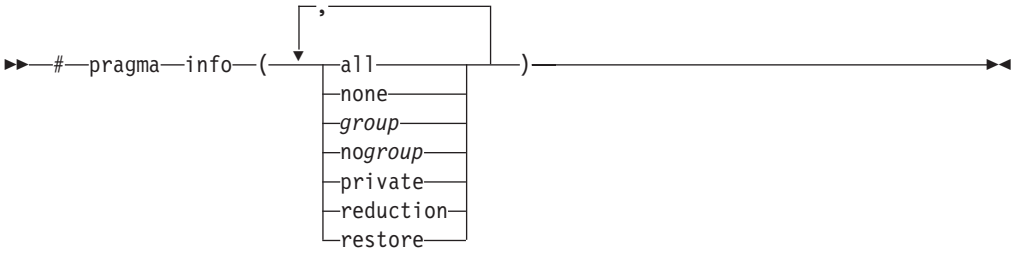
The messages are written to standard output and, optionally, to the listing file if one is generated.

Syntax

Option syntax



Pragma syntax



Defaults

- C -qnoinfo
- C++ -qinfo=lan:trx

Parameters

all Enables all diagnostic messages for all groups.

noall (option only)
Disables all diagnostic messages for all groups.

none (pragma only)
Disables all diagnostic messages for all groups.

private
Lists shared variables made private to a parallel loop.

reduction
Lists all variables that are recognized as reduction variables inside a parallel loop.

group | **no***group*
Enables or disables specific groups of messages, where *group* can be one or more of:

group	Type of informational messages returned or suppressed
C **c99 | noc99**	C code that may behave differently between C89 and C99 language levels.
C++ **cls | nocls**	C++ classes.
cmp | nocmp	Possible redundancies in `unsigned` comparisons.
cnd | nocnd	Possible redundancies or problems in conditional expressions.

cns | nocns Operations involving constants.

cnv | nocnv Conversions.

dcl | nodcl Consistency of declarations.

eff | noeff Statements and pragmas with no effect.

enu | noenu Consistency of `enum` variables.

ext | noext Unused external definitions.

gen | nogen General diagnostic messages.

gnr | nognr Generation of temporary variables.

got | nogot Use of `goto` statements.

ini | noini Possible problems with initialization.

lan | nolan Language level effects.

obs | noobs Obsolete features.

ord | noord Unspecified order of evaluation.

par | nopar Unused parameters.

por | nopor Nonportable language constructs.

ppc | noppc Possible problems with using the preprocessor.

ppt | noppt Trace of preprocessor actions.

pro | nopro Missing function prototypes.

rea | norea Code that cannot be reached.

ret | noret Consistency of return statements.

trd | notrd Possible truncation or loss of data or precision.

tru | notru Variable names truncated by the compiler.

trx | notrx Hexadecimal floating point constants rounding.

uni | nouni Uninitialized variables.

upg | noupg Generates messages describing new behaviors of the current compiler release as compared to the previous release.

use | nouse Unused auto and static variables.

C++ **vft | novft**
Generation of virtual function tables.

zea | nozea Zero-extent arrays.

restore (pragma only)
Discards the current pragma setting and reverts to the setting specified by the previous pragma directive. If no previous pragma was specified, reverts to the command-line or default option setting.

C Specifying **-qinfo** with no suboptions is equivalent to **-qinfo=all**.

C++ Specifying **-qinfo** with no suboptions is equivalent to **-qinfo=all:noppt**.

Specifying **-qnoinfo** is equivalent to **-qinfo=noall**.

Predefined macros

None.

Examples

To compile `myprogram.c` to produce informational message about all items except conversions and unreached statements, enter:

```
invocation myprogram.c -qinfo=all -qinfo=nocnv:norea
```

C The following example shows code constructs that the compiler detects when the code is compiled with **-qinfo=cnd:eff:got:obs:par:pro:rea:ret:uni** in effect:

```
#define COND 0

void faa() // Obsolete prototype (-qinfo=obs)
{
   printf("In faa\n"); // Unprototyped function call (-qinfo=pro)
}

int foo(int i, int k)
{
   int j; // Uninitialized variable (-qinfo=uni)

   switch(i) {
   case 0:
   i++;
   if (COND) // Condition is always false (-qinfo=cnd)
      i--;   // Unreachable statement (-qinfo=rea)
   break;

   case 1:
      break;
      i++;   // Unreachable statement (-qinfo=rea)
   default:
      k = (i) ? (j) ? j : i : 0;
}

   goto L;   // Use of goto statement (-qinfo=got)
   return 3; // Unreachable statement (-qinfo=rea)
L:
   faa(); // faa() does not have a prototype (-qinfo=pro)

// End of the function may be reached without returning a value
// because of there may be a jump to label L (-qinfo=ret)

} //Parameter k is never referenced (-qinfo=ref)

int main(void) {
({ int i = 0; i = i + 1; i; }); // Statement does not have side effects (-qinfo=eff)

 return foo(1,2);
}
```

C++ The following example shows code constructs that the compiler detects, with this code is compiled with **-qinfo=cls:cnd:eff:use** in effect:

```
#pragma abc       // pragma not supported (-qinfo=eff or -qinfo=gen)

int bar() __attribute__((xyz));    // attribute not supported (-qinfo=eff)
int j();

class A {
   public:
      A():  x(0), y(0), z(0) { };  // this constructor is in the correct order
                                   // hence, no info message.
      A(int m): y(0), z(0)
```

```
      { x=m; };            // suggest using member initialization list
                              for x (-qinfo=cls)

      A(int m, int n):
      x(0), z(0) { };       // not all data members are initialized
                            // namely, y is not initialized (-qinfo=cls)

      A(int m, int n, int* l):
      x(m), z(l), y(n) { };       // order of class initialization (-qinfo=cls)

    private:
      int x;
      int y;
      int *z;      // suggest having user-defined copy constructor/
                   // assignment operator to handle the pointer data member
                   // (-qinfo=cls)
};

int foo() {
   int j=5;
   j;        // null statement (-qinfo=eff)
             // The user may mean to call j().

return j;

}

void boo() {
   int x;
   int *i = &x;
   float *f;            // f is not used (-qinfo=use)
   f = (float *) i;     // incompatible type (-qinfo=eff)
                        // With ansi aliasing mode, a float pointer
                        // is not supposed to point to an int
}

void cond(int y) {
   const int i=0;
   int j;
   int k=0;

   if (i) {       // condition is always false (-qinfo=cnd)
            j=3;
    }

   if (1) {       // condition is always true  (-qinfo=cnd)
            j=4;
          }

   j=0;
   if (j==0) {     // cond. is always true  (-qinfo=cnd)
       j=5;
   }

   if (y) {
          k+=5
          }

   if (k==5) {     // This case cannot be determined, because k+=5
                   // is in a conditional block.
              j=6;
              }
}
```

In the following example, the **#pragma info(eff, nouni)** directive preceding `MyFunction1` instructs the compiler to generate messages identifying statements or

pragmas with no effect, and to suppress messages identifying uninitialized variables. The **#pragma info(restore)** directive preceding `MyFunction2` instructs the compiler to restore the message options that were in effect before the **#pragma info(eff, nouni)** directive was specified.

```
#pragma info(eff, nouni)
int MyFunction1()
{
  .
  .
  .

}

#pragma info(restore)
int MyFunction2()
{
  .
  .
  .

}
```

Related information
- "-qflag" on page 85

-qinitauto

Category
Error checking and debugging

Pragma equivalent
#pragma options [no]initauto

Purpose
Initializes uninitialized automatic variables to a specific value, for debugging purposes.

Syntax

Defaults
-qnoinitauto

Parameters
hex_value
A two-digit hexadecimal byte value.

Usage
This option generates extra code to initialize the value of automatic variables. It reduces the runtime performance of the program and should only be used for debugging.

Predefined macros
- C++ __INITAUTO__ is defined to the hex value specified on the **-qinitauto** option or pragma; otherwise, it is undefined.

- C++ __INITAUTO_W__ is defined to the hex value, repeated 4 times, specified on the **-qinitauto** option or pragma; otherwise, it is undefined.

Examples

To compile `myprogram.c` so that automatic variables are initialized to hex value FF (decimal 255), enter:

```
invocation myprogram.c -qinitauto=FF
```

-qinlglue (PPU only)

Processing
Object code control

Context
#pragma options [no]inlglue

Purpose
When used with **-O2** or higher optimization, inlines glue code that optimizes external function calls in your application.

Glue code, generated by the linker, is used for passing control between two external functions. When **inlglue** is in effect, the optimizer inlines glue code for better performance. When **noinlglue** is in effect, inlining of glue code is prevented.

Format

Defaults
-qnoinlglue

Usage
If you use the **-qtune** option with any of the suboptions that imply **-qinlglue** and you want to disable inlining of glue code, make sure to specify **-qnoinlglue** as well.

Inlining glue code can cause the code size to grow. **-qcompact** overrides the **-qinlglue** setting regardless of other options specified; if you want **-qinlglue** to be enabled, do not specify **-qcompact**.

The **-qinlglue** option only affects function calls through pointers or calls to an external compilation unit. For calls to an external function, you should specify that the function is imported by using, for example, the **-qprocimported** option.

Results
None.

- "-qcompact" on page 63
- "-qprocimported, -qproclocal, -qprocunknown (PPU only)" on page 174
- "-qtune" on page 214

-qinline

See “-Q, -qinline ” on page 176.

-qipa

Category

Optimization and tuning

Pragma equivalent

None.

Purpose

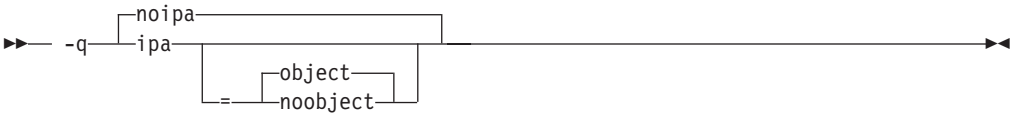
Enables or customizes a class of optimizations known as interprocedural analysis (IPA).

IPA is a two-step process: the first step, which takes place during compilation, consists of performing an initial analysis and storing interprocedural analysis information in the object file. The second step, which takes place during linking, and causes a complete recompilation of the entire application, applies the optimizations to the entire program.

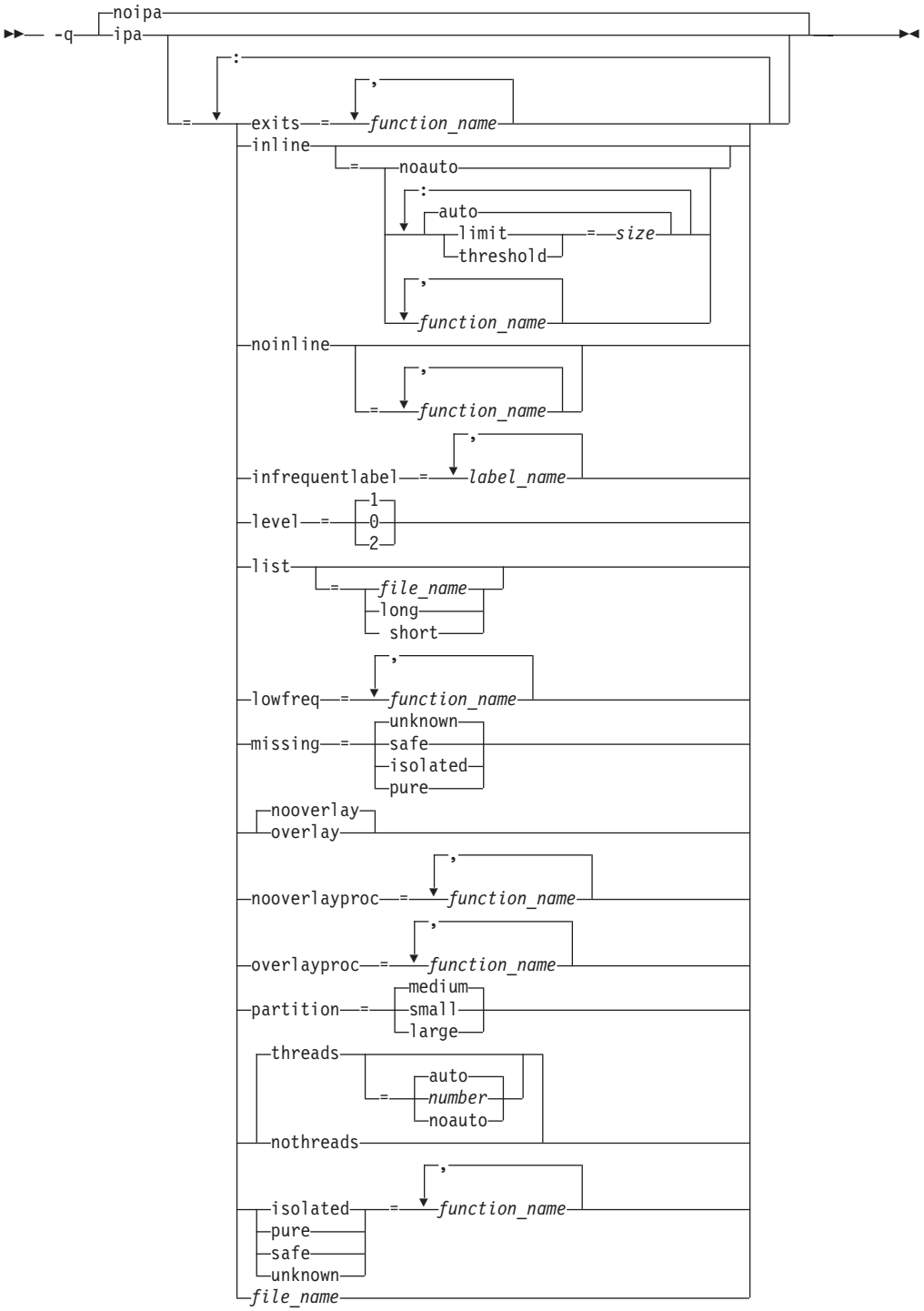
You can use **-qipa** during the compilation step, the link step, or both. If you compile and link in a single compiler invocation, only the link-time suboptions are relevant. If you compile and link in separate compiler invocations, only the compile-time suboptions are relevant during the compile step, and only the link-time suboptions are relevant during the link step.

Syntax

-qipa compile-time syntax



-qipa link-time syntax



Defaults

- -qnoipa
- **-qipa=inline=auto:level=1:missing=unknown:partition=medium:threads=auto** for the PPU and **-qipa=inline=auto:level=1:missing=unknown:nooverlay:partition=medium:threads=auto** for the SPU when **-O4** is in effect

- **-qipa=inline=auto:level=2:missing=unknown:partition=medium:threads=auto** for the PPU and **-qipa=inline=auto:level=2:missing=unknown:nooverlay:partition=medium:threads=auto** for the SPUwhen **-O5** is in effect
- **-qipa=inline=auto:level=0:missing=unknown:partition=medium:threads=auto** for the PPU when **-qpdf1** or **-qpdf2** is in effect

Parameters

The following are parameters that may be specified during a separate compile step only:

object | noobject
Specifies whether to include standard object code in the output object files.

Specifying **noobject** can substantially reduce overall compile time by not generating object code during the first IPA phase. Note that if you specify **-S** with **noobject**, **noobject** will be ignored.

If compiling and linking are performed in the same step and you do not specify the **-S** or any listing option, **-qipa=noobject** is implied.

Specifying **-qipa** with no suboptions on the compile step is equivalent to **-qipa=object**.

The following are parameters that may be specified during a combined compile and link in the same compiler invocation, or during a separate link step only:

function_name
For all suboptions, the name of a function, or a comma-separated list of functions.

C++ Names must be specified using their mangled names. To obtain C++ mangled names, compile your source to object files only, using the **-c** compiler option, and use the **nm** operating system command on the resulting object file. (See also "Name mangling" in the *XL C/C++ Language Reference* for details on using the `extern "C"` linkage specifier on declarations to prevent name mangling.)

Regular expression syntax can be used to specify names for all suboptions that take function names as suboptions. Syntax rules for specifying regular expressions are described below:

Expression	Description
string	Matches any of the characters specified in *string*. For example, `test` will match `testimony`, `latest`, and `intestine`.
^*string*	Matches the pattern specified by *string* only if it occurs at the beginning of a line.
*string***$**	Matches the pattern specified by *string* only if it occurs at the end of a line.
*str***.***ing*	The period (`.`) matches any single character. For example, `t.st` will match `test`, `tast`, `tZst`, and `t1st`.
*string**special_char*	The backslash (`\`) can be used to escape special characters. For example, assume that you want to find lines ending with a period. Simply specifying the expression `.$` would show all lines that had at least one character of any kind in it. Specifying `\.$` escapes the period (`.`), and treats it as an ordinary character for matching purposes.

Expression	Description
[*string*]	Matches any of the characters specified in *string*. For example, `t[a-g123]st` matches `tast` and `test`, but not `t-st` or `tAst`.
[^*string*]	Does not match any of the characters specified in *string*. For example, `t[^a-zA-Z]st` matches `t1st`, `t-st`, and `t,st` but not `test` or `tYst`.
*string**	Matches zero or more occurrences of the pattern specified by *string*. For example, `te*st` will match `tst`, `test`, and `teeeeeest`.
string+	Matches one or more occurrences of the pattern specified by *string*. For example, `t(es)+t` matches `test`, `tesest`, but not `tt`.
string?	Matches zero or one occurrences of the pattern specified by ***string***. For example, `te?st` matches either `tst` or `test`.
string{*m*,*n*}	Matches between *m* and *n* occurrence(s) of the pattern specified by *string*. For example, `a{2}` matches `aa`, and `b{1,4}` matches `b`, `bb`, `bbb`, and `bbbb`.
string1 | *string2*	Matches the pattern specified by either *string1* or *string2*. For example, `s | o` matches both characters `s` and `o`.

exits
Specifies names of functions which represent program exits. Program exits are calls which can never return and can never call any function which has been compiled with IPA pass 1. The compiler can optimize calls to these functions (for example, by eliminating save/restore sequences), because the calls never return to the program. These functions must not call any other parts of the program that are compiled with **-qipa**.

infrequentlabel
Specifies user-defined labels that are likely to be called infrequently during a program run.

label_name
The name of a label, or a comma-separated list of labels.

inline
Enables function inlining by the high-level optimizer. Valid suboptions are any of the following:

auto | **noauto**
Enables or disables automatic function inlining by the high-level optimizer. When **-qipa=inline=auto** is in effect, the compiler considers all functions that are under the maximum size limit (see below) for inlining. When **-qipa=inline=noauto** is in effect, only functions listed in the *function_name* suboption are considered for inlining.

limit
When **-qipa=inline=auto** is in effect, specifies a limit on the size of a calling function after inlining.

threshold
When **-qipa=inline=auto** is in effect, specifies a limit on the size of a called function for it to be considered for inlining.

size
A nonnegative integer representing the relative size of function before and after inlining. The *size* is an arbitrary value representing a combination of factors, including the estimated size of the called function, the number of calls to the function, and so on. If you do not specify a *size*, the default is

1024 for the **threshold** suboption and 8192 for the **limit** suboption. Larger values for this number allow the compiler to inline larger functions, more function calls, or both.

Specifying **-qipa=inline** with no suboptions is equivalent to **-qipa=inline=auto**.

Note: By default, the compiler will try to inline all functions, not just those that you specified with the *function_name* suboption. If you want to turn on inlining for only certain functions, specify **inline=noauto** after you specify **inline=***function_name*. (You must specify the suboptions in this order.) For example, to turn off inlining for all functions other than for `sub1`, specify **-qipa=inline=sub1:inline=noauto**.

noinline
When specified with no suboption, disables automatic function inlining by the high-level optimizer (equivalent to **-qipa=inline=noauto**). (Inlining may still be performed by the compiler front end or by the low-level optimizer; see "-Q, -qinline " on page 176 for details.) When used with the *function_name* suboption, specifies functions that are not to be considered for automatic inlining by the high-level optimizer.

isolated
Specifies a comma-separated list of functions that are not compiled with **-qipa**. Functions that you specify as *isolated* or functions within their call chains cannot refer directly to any global variable.

level
Specifies the optimization level for interprocedural analysis. Valid suboptions are one of the following:

0 Performs only minimal interprocedural analysis and optimization.

1 Enables inlining, limited alias analysis, and limited call-site tailoring.

2 Performs full interprocedural data flow and alias analysis.

If you do not specify a level, the default is 1.

list
Specifies that a listing file be generated during the link phase. The listing file contains information about transformations and analyses performed by IPA, as well as an optional object listing for each partition.

If you do not specify a *list_file_name*, the listing file name defaults to a.lst. If you specify **-qipa=list** together with any other option that generates a listing file, IPA generates an a.lst file that overwrites any existing a.lst file. If you have a source file named a.c, the IPA listing will overwrite the regular compiler listing a.lst. You can use the **-qipa=list=***list_file_name* suboption to specify an alternative listing file name.

Additional suboptions are one of the following:

short Requests less information in the listing file. Generates the Object File Map, Source File Map and Global Symbols Map sections of the listing.

long Requests more information in the listing file. Generates all of the sections generated by the **short** suboption, plus the Object Resolution Warnings, Object Reference Map, Inliner Report and Partition Map sections.

lowfreq
Specifies functions that are likely to be called infrequently. These are typically

error handling, trace, or initialization functions. The compiler may be able to make other parts of the program run faster by doing less optimization for calls to these functions.

missing
Specifies the interprocedural behavior of functions that are not compiled with **-qipa** and are not explicitly named in an **unknown**, **safe**, **isolated**, or **pure** suboption.

Valid suboptions are one of the following:

safe Specifies that the missing functions do not indirectly call a visible (not missing) function either through direct call or through a function pointer.

isolated
Specifies that the missing functions do not directly reference global variables accessible to visible function. Functions bound from shared libraries are assumed to be *isolated*.

pure Specifies that the missing functions are *safe* and *isolated* and do not indirectly alter storage accessible to visible functions. *pure* functions also have no observable internal state.

unknown
Specifies that the missing functions are not known to be *safe*, *isolated*, or *pure*. This suboption greatly restricts the amount of interprocedural optimization for calls to missing functions.

The default is to assume **unknown**.

overlay | nooverlay (SPU only)
Specifying **overlay** instructs the compiler to automatically create code overlays. The default, **nooverlay** specifies that the compiler should not automatically create code overlays. Related suboptions that allow for greater control of overlays are **overlayproc**, **nooverlayproc**, and **partition**. In the context of overlays, **partition** can be used to control the size of the overlay buffer. See Using automatic code overlays in the *XL C/C++ Programming Guide* for more information such as using overlays with custom linker scripts.

nooverlayproc (SPU only)
Specifies a comma-separated list of functions in SPU programs that should not be overlaid. Use this option for functions that you always want as resident in the local store. C++ function names must be mangled. By default, no functions are exempt from being overlaid. This suboption has no effect if **-qipa=overlay** is not specified.

overlayproc (SPU only)
Specifies a comma-separated list of functions in SPU programs that should be in the same overlay. Multiple **overlayproc** suboptions may be present to specify multiple overlay groups. If a function is listed in multiple groups, it will be placed in the last group. C++ function names must be mangled. By default, no functions are in explicit overlays. This suboption has no effect if **-qipa=overlay** is not specified.

partition
Specifies the size of each program partition created by IPA during pass 2. Valid suboptions are one of the following:

- **small**
- **medium**

- **large**

  Larger partitions contain more functions, which result in better interprocedural analysis but require more storage to optimize. Reduce the partition size if compilation takes too long because of paging. With SPU programs, when using **overlay**, the **partition** suboption controls the size of the overlay buffer.

pure
Specifies *pure* functions that are not compiled with **-qipa**. Any function specified as *pure* must be *isolated* and *safe*, and must not alter the internal state nor have side-effects, defined as potentially altering any data visible to the caller.

safe
Specifies *safe* functions that are not compiled with **-qipa** and do not call any other part of the program. Safe functions can modify global variables, but may not call functions compiled with **-qipa**.

threads | nothreads
Runs portions of the IPA optimization process during pass 2 in parallel threads, which can speed up the compilation process on multi-processor systems. Valid suboptions for the **threads** suboption are as follows:

auto | noauto
When **auto** is in effect, the compiler selects a number of threads heuristically based on machine load. When **noauto** is in effect, the compiler spawns one thread per machine processor.

number
Instructs the compiler to use a specific number of threads. *number* can be any integer value in the range of 1 to 32 767. However, *number* is effectively limited to the number of processors available on your system.

Specifying **threads** with no suboptions implies **-qipa=threads=auto**.

unknown
Specifies *unknown* functions that are not compiled with **-qipa**. Any function specified as *unknown* can make calls to other parts of the program compiled with **-qipa**, and modify global variables.

file_name
Gives the name of a file which contains suboption information in a special format.

The file format is the following:

```
# ... comment
attribute{, attribute} = name{, name}
missing = attribute{, attribute}
exits = name{, name}
lowfreq = name{, name}
inline
inline [ = auto | = noauto ]
inline = name{, name} [ from name{, name}]
inline-threshold = unsigned_int
inline-limit = unsigned_int
list [ = file-name | short | long ]
noinline
noinline = name{, name} [ from name{, name}]
level = 0 | 1 | 2
partition = small | medium | large
```

where *attribute* is one of:
- exits

- lowfreq
- unknown
- safe
- isolated
- pure

Specifying **-qipa** with no suboptions on the link step is equivalent to **-qipa=inline=auto:level=1:missing=unknown:partition=medium:threads=auto**.

Note: As of the V9.0 release of the compiler, the **pdfname** suboption is deprecated; you should use **-qpdf1=***pdfname* or **-qpdf2=***pdfname* in your new applications. See "-qpdf1, -qpdf2 (PPU only)" on page 167 for details.

Usage

Specifying **-qipa** automatically sets the optimization level to **-O2**. For additional performance benefits, you can also specify the **-Q** option. The **-qipa** option extends the area that is examined during optimization and inlining from a single function to multiple functions (possibly in different source files) and the linkage between them.

If any object file used in linking with **-qipa** was created with the **-qipa=noobject** option, any file containing an entry point (the main program for an executable program, or an exported function for a library) must be compiled with **-qipa**.

Some symbols which are clearly referenced or set in the source code may be optimized away by IPA, and may be lost to **debug** or **nm** outputs. Using IPA together with the **-g** compiler will usually result in non-steppable output.

Note that if you specify **-qipa** with **-#**, the compiler does not display linker information subsequent to the IPA link step.

For recommended procedures for using **-qipa**, see "Optimizing your applications"in the *XL C/C++ Programming Guide*.

Predefined macros

None.

Examples

The following example shows how you might compile a set of files with interprocedural analysis:

```
invocation -c *.c -qipa
invocation -o product *.o -qipa
```

Here is how you might compile the same set of files, improving the optimization of the second compilation, and the speed of the first compile step. Assume that there exist a set of routines, `user_trace1`, `user_trace2`, and `user_trace3`, which are rarely executed, and the routine `user_abort` that exits the program:

```
xlc -c *.c -qipa=noobject
xlc -c *.o -qipa=lowfreq=user_trace[123]:exit=user_abort
```

Related information

- "-Q, -qinline " on page 176
- "-qisolated_call" on page 126
- "#pragma execution_frequency" on page 243
- "-qpdf1, -qpdf2 (PPU only)" on page 167
- "-S" on page 186

- "Optimizing your applications" in the *XL C/C++ Programming Guide*
- Using automatic code overlays in the *XL C/C++ Programming Guide*

-qisolated_call

Category
Optimization and tuning

Pragma equivalent
#pragma options isolated_call, #pragma isolated_call

Purpose
Specifies functions in the source file that have no side effects other than those implied by their parameters.

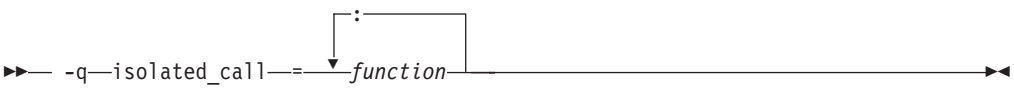
Essentially, any change in the state of the runtime environment is considered a side effect, including:

- Accessing a volatile object
- Modifying an external object
- Modifying a static object
- Modifying a file
- Accessing a file that is modified by another process or thread
- Allocating a dynamic object, unless it is released before returning
- Releasing a dynamic object, unless it was allocated during the same invocation
- Changing system state, such as rounding mode or exception handling
- Calling a function that does any of the above

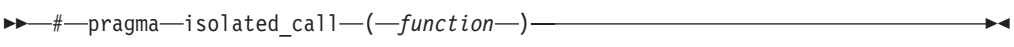
Marking a function as isolated indicates to the optimizer that external and static variables cannot be changed by the called function and that pessimistic references to storage can be deleted from the calling function where appropriate. Instructions can be reordered with more freedom, resulting in fewer pipeline delays and faster execution in the processor. Multiple calls to the same function with identical parameters can be combined, calls can be deleted if their results are not needed, and the order of calls can be changed.

Syntax

Option syntax



Pragma syntax



Defaults
Not applicable.

Parameters

function

The name of a function that does not have side effects or does not rely on functions or processes that have side effects. *function* is a primary expression that can be an identifier, operator function, conversion function, or qualified name. An identifier must be of type function or a `typedef` of function. C++ If the name refers to an overloaded function, all variants of that function are marked as isolated calls.

Usage

The only side effect that is allowed for a function named in the option or pragma is modifying the storage pointed to by any pointer arguments passed to the function, that is, calls by reference. The function is also permitted to examine non-volatile external objects and return a result that depends on the non-volatile state of the runtime environment. Do not specify a function that causes any other side effects; that calls itself; or that relies on local static storage. If a function is incorrectly identified as having no side effects, the program behavior might be unexpected or produce incorrect results.

The **#pragma options isolated_call** directive must be placed at the top of a source file, before any statements. The **#pragma isolated_call** directive can be placed at any point in the source file, before or after calls to the function named in the pragma.

The **-qignprag** compiler option causes aliasing pragmas to be ignored; you can use **-qignprag** to debug applications containing the **#pragma isolated_call** directive.

Predefined macros

None.

Examples

To compile `myprogram.c`, specifying that the functions `myfunction(int)` and `classfunction(double)` do not have side effects, enter:

```
invocation myprogram.c -qisolated_call=myfunction:classfunction
```

The following example shows you when to use the **#pragma isolated_call** directive (on the `addmult` function). It also shows you when not to use it (on the `same` and `check` functions):

```
#include <stdio.h>
#include <math.h>

int addmult(int op1, int op2);
#pragma isolated_call(addmult)

/* This function is a good candidate to be flagged as isolated as its */
/* result is constant with constant input and it has no side effects. */
int addmult(int op1, int op2) {
  int rslt;

  rslt = op1*op2 + op2;
  return rslt;
}

/* The function 'same' should not be flagged as isolated as its state */
/* (the static variable delta) can change when it is called. */
int same(double op1, double op2) {
  static double delta = 1.0;
  double temp;
```

```
  temp = (op1-op2)/op1;
  if (fabs(temp) < delta)
    return 1;
  else {
    delta = delta / 2;
    return 0;
  }
}

/* The function 'check' should not be flagged as isolated as it has a */
/* side effect of possibly emitting output. */
int check(int op1, int op2) {
  if (op1 < op2)
    return -1;
  if (op1 > op2)
    return 1;
  printf("Operands are the same.\n");
  return 0;
}
```

Related information
- "-qignprag" on page 108
- and in the *XL C/C++ Language Reference*

-qkeepinlines (C++ only)

Category
Object code control

Pragma equivalent
None.

Purpose
Keeps or discards definitions for unreferenced `extern` inline functions.

When **-qnokeepinlines** is in effect, definitions of unreferenced external inline functions are discarded. When **-qkeepinlines** is in effect, definitions of unreferenced external inline functions are kept.

Syntax

Defaults
-qnokeepinlines

Usage
-qnokeepinlines reduces the size of the object files.

Predefined macros
None.

Related information
- "-qstaticinline (C++ only)" on page 194

-qkeepparm

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
When used with **-O2** or higher optimization, specifies whether function parameters are stored on the stack.

A function usually stores its incoming parameters on the stack at the entry point. However, when you compile code with optimization options enabled, the compiler may remove these parameters from the stack if it sees an optimizing advantage in doing so. When **-qkeepparm** is in effect, parameters are stored on the stack even when optimization is enabled. When **-qnokeepparm** is in effect, parameters are removed from the stack if this provides an optimization advantage.

Syntax

Defaults
-qnokeepparm

Usage
Specifying **-qkeepparm** that the values of incoming parameters are available to tools, such as debuggers, by preserving those values on the stack. However, this may negatively affect application performance.

Predefined macros
None.

Related information

- "-O, -qoptimize" on page 159

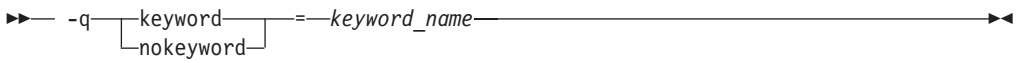
-qkeyword

Category
Language element control

Pragma equivalent
None

Purpose
Controls whether the specified name is treated as a keyword or as an identifier whenever it appears in your program source.

Syntax



Defaults
By default all the built-in keywords defined in the C and C++ language standards are reserved as keywords.

Usage
You cannot add keywords to the language with this option. However, you can use **-qnokeyword=***keyword_name* to disable built-in keywords, and use **-qkeyword=***keyword_name* to reinstate those keywords.

C++ This option can be used with all C++ built-in keywords.

C This option can also be used with the following C keywords:

- asm
- inline
- restrict
- typeof

Note: C `asm` is not a keyword when the **-qlanglvl** option is set to **stdc89** or **stdc99**.

Predefined macros
- C++ __BOOL__ is defined to 1 by default; however, it is undefined when **-qnokeyword=bool** is in effect.
- C __C99_INLINE is defined to 1 when **-qkeyword=inline** is in effect.
- __C99_RESTRICT is defined to 1 when **-qkeyword=restrict** is in effect.
- C __IBM_GCC_ASM is defined to 1 when **-qkeyword=asm** is in effect. (In C++ it is defined by default.)
- __IBM__TYPEOF__ is defined to 1 when **-qkeyword=typeof** is in effect.

Examples
C++ You can reinstate `bool` with the following invocation:

```
ppuxlc++ -qkeyword=bool
```

C You can reinstate `typeof` with the following invocation:

```
ppuxlc -qkeyword=typeof
```

Related information
- "-qasm" on page 50

-l

Category
Linking

Pragma equivalent
None.

Purpose
Searches for the specified library file, lib*key*.so, and then lib*key*.a for dynamic linking, or just for lib*key*.a for static linking.

Syntax

Defaults

The compiler default is to search only some of the compiler runtime libraries. The default configuration file specifies the default library names to search for with the **-l** compiler option, and the default search path for libraries with the **-L** compiler option.

The C and C++ runtime libraries are automatically added.

Parameters

key
The name of the library minus the `lib` characters.

Usage

You must also provide additional search path information for libraries not located in the default search path. The search path can be modified with the **-L** option.

The **-l** option is cumulative. Subsequent appearances of the **-l** option on the command line do not replace, but add to, the list of libraries specified by earlier occurrences of **-l**. Libraries are searched in the order in which they appear on the command line, so the order in which you specify libraries can affect symbol resolution in your application.

For more information, refer to the **ld** documentation for your operating system.

Predefined macros

None.

Examples

To compile `myprogram.c` and link it with library `mylibrary` (`libmylibrary.a`) found in the `/usr/mylibdir` directory, enter:

```
invocation myprogram.c -lmylibrary -L/usr/mylibdir
```

Related information

- "-L"
- "Specifying compiler options in a configuration file" on page 8

-L

Category

Linking

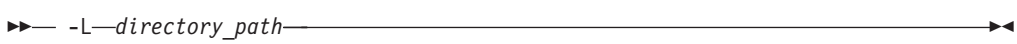
Pragma equivalent

None.

Purpose

At link time, searches the directory path for library files specified by the **-l** option.

Syntax



Defaults
The default is to search only the standard directories. See the compiler configuration file for the directories that are set by default.

Parameters
directory_path
The path for the directory which should be searched for library files.

Usage
If the **-L***directory* option is specified both in the configuration file and on the command line, search paths specified in the configuration file are the first to be searched at link time.

For more information, refer to the **ld** documentation for your operating system.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the directory `/usr/tmp/old` is searched for the library `libspfiles.a`, enter:

```
invocation myprogram.c -lspfiles -L/usr/tmp/old
```

Related information
- "-l" on page 130

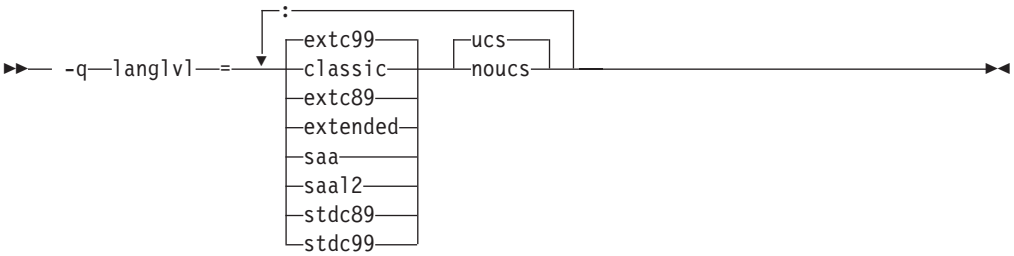
-qlanglvl

Category
Language element control

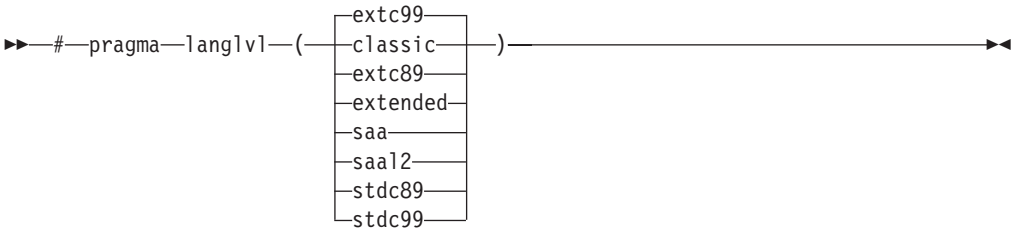
Pragma equivalent
C #pragma options langlvl, #pragma langlvl

Purpose
Determines whether source code and compiler options should be checked for conformance to a specific language standard, or subset or superset of a standard.

Syntax
-qlanglvl syntax — C



#pragma langlvl syntax — C only



-qlanglvl syntax — C++

Defaults

- C The default is set according to the command used to invoke the compiler:
  - **-qlanglvl=extc99:ucs** for the **ppuxlc** or **spuxlc** and related invocation commands
  - **-qlanglvl=extended:noucs** for the **ppucc** or **spucc** and related invocation commands
  - **-qlanglvl=stdc89:noucs** for the **ppuc89** or **spuc89** and related invocation commands
  - **-qlanglvl=stdc99:ucs** for the **ppuc99** or **spuc99** and related invocation commands
- C++ -qlanglvl=extended:anonstruct:anonunion:ansifor:ansisinit:c99__func__:noc99complex:c99compo

Parameters

The following are the **-qlanglvl/#pragma langlvl** parameters for C language programs:

classic

Allows the compilation of nonstandard programs, and conforms closely to the K&R level preprocessor.

The following outlines the differences between the **classic** language level and all other standard-based language levels:

Tokenization

Tokens introduced by macro expansion may be combined with adjacent tokens in some cases. Historically, this was an artifact of the text-based implementations of older preprocessors, and because, in older implementations, the preprocessor was a separate program whose output was passed on to the compiler.

For similar reasons, tokens separated only by a comment may also be combined to form a single token. Here is a summary of how tokenization of a program compiled in **classic** mode is performed:

1. At a given point in the source file, the next token is the longest sequence of characters that can possibly form a token. For example, `i+++++j` is tokenized as `i ++ ++ + j` even though `i ++ + ++ j` may have resulted in a correct program.

2. If the token formed is an identifier and a macro name, the macro is replaced by the text of the tokens specified on its #define directive. Each parameter is replaced by the text of the corresponding argument. Comments are removed from both the arguments and the macro text.
3. Scanning is resumed at the first step from the point at which the macro was replaced, as if it were part of the original program.
4. When the entire program has been preprocessed, the result is scanned again by the compiler as in the first step. The second and third steps do not apply here since there will be no macros to replace. Constructs generated by the first three steps that resemble preprocessing directives are not processed as such.

It is in the third and fourth steps that the text of adjacent but previously separate tokens may be combined to form new tokens.

The \ character for line continuation is accepted only in string and character literals and on preprocessing directives.

Constructs such as:

```
#if 0
  "unterminated
#endif
#define US "Unterminating string
char *s = US terminated now"
```

will not generate diagnostic messages, since the first is an unterminated literal in a FALSE block, and the second is completed after macro expansion. However:

```
char *s = US;
```

will generate a diagnostic message since the string literal in US is not completed before the end of the line.

Empty character literals are allowed. The value of the literal is zero.

Preprocessing directives

The # token must appear in the first column of the line. The token immediately following # is available for macro expansion. The line can be continued with \ only if the name of the directive and, in the following example, the (has been seen:

```
#define f(a,b) a+b
f\
(1,2)      /* accepted */
```

```
#define f(a,b) a+b
f(\
1,2)       /* not accepted */
```

The rules concerning \ apply whether or not the directive is valid. For example,

```
#\
define M 1   /* not allowed */
```

```
#def\
ine M 1      /* not allowed */
```

```
#define\
M 1          /* allowed */
```

```
#dfine\
M 1          /* equivalent to #dfine M 1, even
                though #dfine is not valid  */
```

Following are the preprocessor directive differences.

#ifdef/#ifndef
When the first token is not an identifier, no diagnostic message is generated, and the condition is FALSE.

#else When there are extra tokens, no diagnostic message is generated.

#endif
When there are extra tokens, no diagnostic message is generated.

#include
The < and > are separate tokens. The header is formed by combining the spelling of the < and > with the tokens between them. Therefore /* and // are recognized as comments (and are always stripped), and the " and ' do begin literals within the < and >. (Remember that in C programs, C++-style comments // are recognized when **-qcpluscmt** is specified.)

#line The spelling of all tokens which are not part of the line number form the new file name. These tokens need not be string literals.

#error
Not recognized.

#define
A valid macro parameter list consists of zero or more identifiers each separated by commas. The commas are ignored and the parameter list is constructed as if they were not specified. The parameter names need not be unique. If there is a conflict, the last name specified is recognized.

For an invalid parameter list, a warning is issued. If a macro name is redefined with a new definition, a warning will be issued and the new definition used.

#undef
When there are extra tokens, no diagnostic message is generated.

Macro expansion

- When the number of arguments on a macro invocation does not match the number of parameters, a warning is issued.
- If the (token is present after the macro name of a function-like macro, it is treated as too few arguments (as above) and a warning is issued.
- Parameters are replaced in string literals and character literals.
- Examples:

```
#define M()    1
#define N(a)   (a)
#define O(a,b) ((a) + (b))

M();  /* no error */
N();  /* empty argument */
O();  /* empty first argument
         and too few arguments */
```

Text output
No text is generated to replace comments.

extc89
Compilation conforms to the ANSI C89 standard, and accepts implementation-specific language extensions.

extc99
Compilation conforms to the ISO C99 standard, and accepts implementation-specific language extensions.

extended
Provides compatibility with the RT compiler and **classic**. This language level is based on C89.

saa
Compilation conforms to the current SAA® C CPI language definition. This is currently SAA C Level 2.

saal2
Compilation conforms to the SAA C Level 2 CPI language definition, with some exceptions.

stdc89
Compilation conforms strictly to the ANSI C89 standard, also known as ISO C90.

stdc99
Compilation conforms strictly to the ISO C99 standard.

ucs | noucs (option only)
Controls whether Unicode characters are allowed in identifiers, string literals and character literals in program source code. This suboption is enabled by default when **stdc99** or **extc99** is in effect. For details on the Unicode character set, see "The Unicode standard" in the *XL C/C++ Language Reference*.

The following **-qlanglvl** suboptions are accepted but ignored by the C compiler. Use **extended | extc99 | extc89** to enable the functions that these suboptions imply. For other language levels, the functions implied by these suboptions are disabled.

[no]gnu_assert
GNU C portability option.

[no]gnu_explicitregvar
GNU C portability option.

[no]gnu_include_next
GNU C portability option.

[no]gnu_locallabel
GNU C portability option.

[no]gnu_warning
GNU C portability option.

The following are the **-qlanglvl** parameters for C++ language programs:

extended
Compilation is based on the ISO C++ standard, with some differences to accommodate extended language features.

feature_suboption
Can be any of the following:

anonstruct | noanonstruct
Enables or disables support for anonymous structures and classes. Anonymous structures are typically used in unions, as in the following code fragment:

```
union U {
   struct {
      int i:16;
      int j:16;
   };
   int k;
} u;
// ...
u.j=3;
```

When the default, **-qlanglvl=anonstruct**, is in effect, anonymous structures are supported.

This is an extension to the C++ standard and gives behavior that is designed to be compatible with Microsoft® Visual C++. Specify **-qlanglvl=noanonstruct** for compliance with standard C++.

anonunion | noanonunion
Controls the members that are allowed in anonymous unions. When the default, **-qlanglvl=anonunion**, is in effect, anonymous unions can have members of all types that standard C++ allows in non-anonymous unions. For example, non-data members, such as structures, typedefs, and enumerations are allowed. Member functions, virtual functions, or objects of classes that have non-trivial default constructors, copy constructors, or destructors cannot be members of a union, regardless of the setting of this option.

This is an extension to standard C++ and gives behavior that is designed to be compatible with Microsoft Visual C++. Specify **-qlanglvl=noanonunion** for compliance with standard C++.

ansifor | noansifor
Controls whether scope rules defined in the C++ standard apply to names declared in `for` loop initialization statements. When the default, **-qlanglvl=ansifor**, is in effect, standard C++ rules are used, and the following code causes a name lookup error:

```
{
   //...
   for (int i=1; i<5; i++) {
      cout << i * 2 << endl;
   }
   i = 10;  // error
}
```

The reason for the error is that `i`, or any name declared within a `for` loop initialization statement, is visible only within the `for` statement. To correct the error, either declare `i` outside the loop or set **noansifor**.

When **-qlanglvl=noansifor** is in effect, the old language behavior is used; specify **-qlanglvl=noansifor** for compatibility with Microsoft Visual C++.

ansisinit | noansisinit
Controls whether standard C++ rules apply for handling static destructors for global and static objects. When the default, **-qlanglvl=ansisinit**, is in effect, the standard rules are used.

When **-qlanglvl=noansisinit** is in effect, the old language behavior is used.

c99__func__ | **noc99__func__**
Enables or disables support for the C99 `__func__` identifier. For details of this feature, see "The __func__ predefined identifier" in the *XL C/C++ Language Reference*.

c99complex | **noc99complex**
Enables or disables C99 complex data types and related keywords.

c99compoundliteral | **noc99compoundliteral**
Enables or disables support for C99 compound literals.

c99hexfloat | **noc99hexfloat**
Enables or disables support for C99-style hexadecimal floating constants.

c99vla | **noc99vla**
Enables or disables support for C99-type variable length arrays.

dependentbaselookup | **nodependentbaselookup**
Controls whether the name lookup rules for a template base class of dependent type defined in the TC1 of the C++ Standard apply. When the default, **-qlanglvl=dependentbaselookup**, is in effect, a member of a base class that is a dependent type hides a name declared within a template or any name from within the enclosing scope of the template. Specify **-qlanglvl=nodependentbaselookup** for compliance with TC1.

gnu_assert | **nognu_assert**
Enables or disables support for the following GNU C system identification assertions:
- #assert
- #unassert
- #cpu
- #machine
- #system

gnu_complex | **nognu_complex**
Enables or disables GNU complex data types and related keywords.

gnu_computedgoto | **nognu_computedgoto**
Enables or disables support for computed `goto` statements.

gnu_externtemplate | **nognu_externtemplate**
Enables or disables `extern` template instantiations. For details of this feature, see "Explicit instantiation" in the *XL C/C++ Language Reference*.

gnu_include_next | **nognu_include_next**
Enables or disables support for the GNU C `#include_next` preprocessor directive.

gnu_labelvalue | **nognu_labelvalue**
Enables or disables support for labels as values.

gnu_locallabel | **nognu_locallabel**
Enables or disables support for locally-declared labels.

gnu_membernamereuse | **nognu_membernamereuse**
Enables or disables reusing a template name in a member list as a `typedef`.

gnu_suffixij | **nognu_suffixij**
Enables or disables support for GNU-style complex numbers. When **-qlanglvl=gnu_suffixij** is in effect, a complex number can be ended with suffix i/I or j/J.

gnu_varargmacros | nognu_varargmacros
Enables or disables support for GNU-style macros with variable arguments. For details of this feature, see "Variadic macro extensions" in the *XL C/C++ Language Reference*.

gnu_warning | nognu_warning
Enables or disables support for the GNU C `#warning` preprocessor directive.

illptom | noillptom
Controls the expressions that can be used to form pointers to members. When the default, **-qlanglvl=illptom**, is in effect, the XL C++ compiler accepts some forms that are in common use but do not conform to the C++ Standard. For example, the following code defines a pointer to a function member, `p`, and initializes it to the address of `C::foo`, in the old style:

```
struct C {
void foo(int);
};

void (C::*p) (int) = C::foo;
```

This is an extension to standard C++ and gives behavior that is designed to be compatible with Microsoft Visual C++.

Specify **-qlanglvl=noillptom** for compliance with the C++ standard. The example code above must be modified to use the `&` operator.

```
struct C {
void foo(int);
};

void (C::*p) (int) = &C::foo;
```

implicitint | noimplicitint
Controls whether the compiler accepts missing or partially specified types as implicitly specifying `int`. When the default, **-qlanglvl=implicitint**, is in effect, a function declaration at namespace scope or in a member list will implicitly be declared to return `int`. Also, any declaration specifier sequence that does not completely specify a type will implicitly specify an integer type. The effect is as if the `int` specifier were present.

The following specifiers do not completely specify a type:
- auto
- const
- extern
- extern *"literal"*
- inline
- mutable
- friend
- register
- static
- typedef
- virtual
- volatile
- platform-specific types

For example, the return type of function `MyFunction` is `int` because it was omitted in the following code:

```
MyFunction()
{
   return 0;
}
```

Note that any situation where a type is specified is affected by this suboption. This includes, for example, template and parameter types, exception specifications, types in expressions (eg, `casts`, `dynamic_cast`, `new`), and types for conversion functions.

This is an extension to the C++ standard and gives behavior that is designed to be compatible with Microsoft Visual C++.

Specify **-qlanglvl=noimplicitint** for compliance with standard C++. For example, the function declaration above must be modified to:

```
int MyFunction()
{
   return 0;
}
```

offsetnonpod | nooffsetnonpod
Controls whether the `offsetof` macro can be applied to classes that are not data-only. C++ programmers often casually call data-only classes "Plain Old Data" (POD) classes. When the default, **-qlanglvl=offsetnonpod**, is in effect, you can apply `offsetof` to a class that contains one of the following:

- user-declared constructors or destructors
- user-declared assignment operators
- private or protected non-static data members
- base classes
- virtual functions
- non-static data members of type pointer to member
- a struct or union that has non-data members
- references

This is an extension to the C++ standard, and gives behavior that is designed to be compatible with Microsoft Visual C++. Specify **-qlanglvl=nooffsetnonpod** for compliance with standard C++.

olddigraph | noolddigraph
Enables or disables support for old-style digraphs. When the default, **-qlanglvl=olddigraph**, is in effect, old-style digraphs are not supported. When **-qlanglvl=olddigraph** is in effect, the following digraphs are supported:

Digraph	Resulting character
%%	# (pound sign)
%%%%	## (double pound sign, used as the preprocessor macro concatenation operator)

Specify **-qlanglvl=noolddigraph** for compatibility with standard C++.

This suboption only has effect when **-qdigraphs** is in effect.

oldfriend | nooldfriend
Controls whether friend declarations that name classes without elaborated class names are treated as C++ errors. When the default, **-qlanglvl=oldfriend**, is in effect, you can declare a friend class without elaborating the name of the class with the keyword `class`. For example, the statement below declares the class `IFont` to be a friend class:

```
friend IFont;
```

This is an extension to the C++ standard and gives behavior that is designed to be compatible with Microsoft Visual C++.

Specify the **-qlanglvl=nooldfriend** for compliance with standard C++. The example declaration above must be modified to the following:

```
friend class IFont;
```

oldtempacc | **nooldtempacc**
Controls whether access to a copy constructor to create a temporary object is always checked, even if creation of the temporary object is avoided. When the default, **-qlanglvl=oldtempacc**, is in effect, access checking is suppressed.

This is an extension to the C++ standard and gives behavior that is designed to be compatible with Microsoft Visual C++. Specify **-qlanglvl=nooldtempacc** for compliance with standard C++. For example, the `throw` statement in the following code causes an error because the copy constructor is a protected member of class C:

```
class C {
public:
   C(char *);
protected:
   C(const C&);
};

C foo() {return C("test");} // return copy of C object

void f()
{
// catch and throw both make implicit copies of
// the throw object
   throw C("error");   // throw a copy of a C object
   const C& r = foo(); // use the copy of a C object
//                               created by foo()
}
```

The example code above contains three ill formed uses of the copy constructor `C(const C&)`.

oldtmplalign | **nooldtmplalign**
Controls whether alignment rules specified for nested templates are ignored. When the default, **-qlanglvl=nooldtmplalign**, is in effect, these alignment rules are not ignored. For example, given the following template the size of `A<char>::B` will be 5 with **-qlanglvl=nooldtmplalign**, and 8 with **-qlanglvl=oldtmplalign** :

```
template <class T>
struct A {
#pragma options align=packed
 struct B {
  T m;
  int m2;
 };
#pragma options align=reset
};
```

oldtmplspec | **nooldtmplspec**
Controls whether template specializations that do not conform to the C++ standard are allowed. When the default, **-qlanglvl=oldtmplspec**, is in effect, you can explicitly specialize a template class as in the following example, which specializes the template class `ribbon` for type `char`:

```
template<class T> class ribbon { /*...*/};
class ribbon<char> { /*...*/};
```

This is an extension to standard C++ and gives behavior that is designed to be compatible with Microsoft Visual C++.

Specify **-qlanglvl=nooldtmplspec** for compliance with standard C++. In the example above, the template specialization must be modified to:

```
template<class T> class ribbon { /*...*/};
template<> class ribbon<char> { /*...*/};
```

redefmac | **noredefmac**
Controls whether a macro can be redefined without a prior `#undef` or `undefine()` statement.

trailenum | **notrailenum**
Controls whether trailing commas are allowed in `enum` declarations. When the default, **-qlanglvl=trailenum**, is in effect, one or more trailing commas are allowed at the end of the enumerator list. For example, the following `enum` declaration uses this extension:

```
enum grain { wheat, barley, rye,, };
```

This is an extension to the C++ standard, and is intended to provide compatibility with Microsoft Visual C++.

Specify **-qlanglvl=notrailenum** for compliance with standard C++.

typedefclass | **notypedefclass**
Controls whether a typedef name can be specified where a class name is expected. When the default, **-qlanglvl=typedefclass**, is in effect, the standard C++ rule applies, and a typedef name cannot be specified where a class name is expected. Specify **-qlanglvl=typedefclass** to allow the use of typedef names in base specifiers and constructor initializer lists.

ucs | **noucs**
Controls whether Unicode characters are allowed in identifiers, string literals and character literals in program source code. For details on the Unicode character set, see "The Unicode standard" in the *XL C/C++ Language Reference*.

varargmacros | **novarargmacros**
Enables or disables support for C99-style variable argument lists in function-like macros. For details of this feature, see "Function-like macros" in the *XL C/C++ Language Reference*.

zeroextarray | **nozeroextentarray**
Controls whether zero-extent arrays are allowed as the last non-static data member in a class definition. When the default, **-qlanglvl=zeroextentarray**, is in effect, arrays with zero elements are allowed. The example declarations below define dimensionless arrays `a` and `b`.

```
struct S1 { char a[0]; };
struct S2 { char b[]; };
```

This is an extension to the C++ standard, and is intended to provide compatibility with Microsoft Visual C++.

Specify **-qlanglvl=nozeroextarray** for compliance with standard C++.

Usage

C++ In general, if you specify a suboption with the **no** form of the option, the compiler will diagnose any uses of the feature in your code with a warning, unless you disable the warning with the **-qsuppress** option. Additionally, you can use the **-qinfo=por** option to generate informational messages along with the following suboptions:

- [no]c99complex
- [no]gnu_complex

C Since the pragma directive makes your code non-portable, it is recommended that you use the option rather than the pragma. If you do use the pragma, it must appear before any noncommentary lines in the source code. Also, because the directive can dynamically alter preprocessor behavior, compiling with the preprocessing-only options may produce results different from those produced during regular compilation.

Predefined macros

See "Macros related to language levels" on page 278 for a list of macros that are predefined by **-qlanglvl** suboptions.

Related information

- "-qsuppress" on page 199
- "The IBM XL C language extensions" and "The IBM XL C++ language extensions" in *XL C/C++ Language Reference*

-qlargepage

Category

Optimization and tuning

Pragma equivalent

None.

Purpose

Takes advantage of large pages for applications designed to execute in a large page memory environment.

When **-qlargepage** is in effect to compile a program designed for a large page environment, an increase in performance can occur.

Syntax

Defaults

-qnolargepage

Usage

Note that this option is only useful in the following conditions:

- Large pages must be available and configured on the system.
- You must compile with an option that enables loop optimization, such as **-O3** or **-qhot**.
- You must link with the **-blpdata** option.

See your operating system documentation for more information on using large page support.

Predefined macros
None.

Examples
To compile `myprogram.c` to use large page heaps, enter:

```
invocation myprogram.c -qlargepage -blpdata
```

-qlib

Category
Linking

Pragma equivalent
None.

Purpose
Specifies whether standard system libraries and XL C/C++ libraries are to be linked.

When **-qlib** is in effect, the standard system libraries and compiler libraries are automatically linked. When **-qnolib** is in effect, the standard system libraries and compiler libraries are not used at link time; only the libraries specified on the command line with the **-l** flag will be linked.

This option can be used in system programming to disable the automatic linking of unneeded libraries.

Syntax

Defaults
-qlib

Usage
Using **-qnolib** specifies that no libraries, including the system libraries as well as the XL C/C++ libraries (these are found in the lib/ and lib64/ subdirectories of the compiler installation directory), are to be linked. The system startup files are still linked, unless **-qnocrt** is also specified.

Note that if your program references any symbols that are defined in the standard libraries or compiler-specific libraries, link errors will occur. To avoid these unresolved references when compiling with **-qnolib**, be sure to explicitly link the required libraries by using the command flag **-l** and the library name.

Predefined macros
None.

Examples
To compile `myprogram.c` without linking to any libraries except the compiler library libxlopt.a, enter:

```
invocation myprogram.c -qnolib -lxlopt
```

Related information
- "-qcrt" on page 66

-qlibansi

Category
Optimization and tuning

Pragma equivalent
#pragma options [no]libansi

Purpose
Assumes that all functions with the name of an ANSI C library function are in fact the system functions.

When **libansi** is in effect, the optimizer can generate better code because it will know about the behavior of a given function, such as whether or not it has any side effects.

Syntax

Defaults
-qnolibansi

Predefined macros
C++ __LIBANSI__ is defined to 1 when **libansi** is in effect; otherwise, it is not defined.

-qlinedebug

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Generates only line number and source file name information for a debugger.

When **-qlinedebug** is in effect, the compiler produces minimal debugging information, so the resulting object size is smaller than that produced by the **-g** debugging option. You can use the debugger to step through the source code, but you will not be able to see or query variable information. The traceback table, if generated, will include line numbers.

Syntax

Defaults
-qnolinedebug

Usage
When **-qlinedebug** is in effect, function inlining is disabled.

Avoid using **-qlinedebug** with **-O** (optimization) option. The information produced may be incomplete or misleading.

The **-g** option overrides the **-qlinedebug** option. If you specify **-g** with **-qnolinedebug** on the command line, **-qnolinedebug** is ignored and a warning is issued.

Predefined macros
None.

Examples
To compile `myprogram.c` to produce an executable program `testing` so you can step through it with a debugger, enter:

```
invocation myprogram.c -o testing -qlinedebug
```

Related information
- "-g" on page 97
- "-O, -qoptimize" on page 159

-qlist

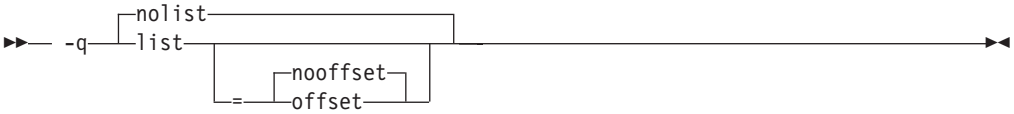
Category
Listings, messages, and compiler information

Pragma equivalent
#pragma options [no]list

Purpose
Produces a compiler listing file that includes an object or assembly listing.

When **list** is in effect, a listing file is generated with a .lst suffix for each source file named on the command line. For details of the contents of the listing file, see "Compiler listings" on page 17.

You can use the object or assembly listing to help understand the performance characteristics of the generated code and to diagnose execution problems.

Syntax


Defaults
-qnolist

Parameters

offset | nooffset

Changes the offset of the PDEF header from `00000` to the offset of the start of the text area. Specifying the option allows any program reading the .lst file to add the value of the PDEF and the line in question, and come up with the same value whether **offset** or **nooffset** is specified. The **offset** suboption is only relevant if there are multiple procedures in a compilation unit.

Specifying **list** without the suboption is equivalent to **list=nooffset**.

Usage

The **-qnoprint** compiler option overrides this option.

Predefined macros

None.

Examples

To compile `myprogram.c` and to produce a listing (.lst) file that includes an object listing, enter:

```
invocation myprogram.c -qlist
```

Related information

- "-qlistopt"
- "-qprint" on page 172
- "-qsource" on page 190

-qlistopt

Category

Listings, messages, and compiler information

Pragma equivalent

None.

Purpose

Produces a compiler listing file that includes all options in effect at the time of compiler invocation.

When **listopt** is in effect, a listing file is generated with a .lst suffix for each source file named on the command line. The listing shows options in effect as set by the compiler defaults, the configuration file, and command line settings. For details of the contents of the listing file, see "Compiler listings" on page 17.

Syntax

Defaults

-qnolistopt

Usage

Option settings caused by pragma statements in the program source are not shown in the compiler listing.

The **-qnoprint** compiler option overrides this option.

Predefined macros
None.

Examples
To compile `myprogram.c` to produce a listing (.lst) file that shows all options in effect, enter:

```
invocation myprogram.c -qlistopt
```

Related information
- "-qlist" on page 146
- "-qprint" on page 172
- "-qsource" on page 190

-qlonglit (PPU only)

Category
Floating-point and integer control

Pragma equivalent
None.

Purpose
In 64-bit mode, promotes literals with implicit type of `int` to `long`.

Syntax

Defaults
-qnolonglit

Usage
The following table shows the default implicit types for constants and the implicit types when **-qlonglit** is in effect.

Suffix	Decimal literals		Hexadecimal or octal literals	
	Default implicit type	**Implicit type with -qlonglit in effect**	**Default implicit type**	**Implicit type with -qlonglit in effect**
unsuffixed	int long int	long int	int unsigned int long int unsigned long int	long int unsigned long int
`u` or `U`	unsigned int unsigned long int	unsigned long int	unsigned int unsigned long int	unsigned long int
`l` or `L`	long int	long int	long int unsigned long int	long int unsigned long int
Both `u` or `U`, and `l` or `L`	unsigned long int	unsigned long int	unsigned long int	unsigned long int
`ll` or `LL`	long long int	long long int	long long int unsigned long long int	long long int unsigned long long int
Both `u` or `U`, and `ll` or `LL`	unsigned long long int	unsigned long long int	unsigned long long int	unsigned long long int

Predefined macros
None.

-qlonglong

Category
Language element control

Pragma equivalent
#pragma options [no]longlong

Purpose
Allows IBM `long long` integer types in your program.

Syntax

Defaults
- C **-qlonglong** for the **ppucc** or **spucc** invocation command or the **-qlanglvl=extended** | **extc89** option; **-qnolonglong** for the **ppuc89** or **spuc89** invocation command or **-qlanglvl=stdc89** option.
- C++ **-qlonglong**

Usage
C This option only has an effect with the **ppucc** or **spucc** or **ppuc89** or **spuc89** invocation commands, or when the **-qlanglvl** option is set to **extended** | **stdc89** | **extc89**. It is not valid for the **ppuxlc** or **spuxlc** invocation command or when the language level **stdc99** | **extc99** is in effect, as the `long long` support provided by this option is incompatible with the semantics of the `long long` types mandated by the C99 standard. For details, see "Integer literals" in the *XL C/C++ Language Reference*.

Predefined macros
_LONG_LONG is defined to 1 when `long long` data types are available; otherwise, it is undefined.

Examples
To compile `myprogram.c` with support for IBM `long long` integers, enter:

```
ppucc myprogram.c [-qlonglong]
```

Related information
- "Integer literals" in the *XL C/C++ Language Reference*

-ma (C only)
See “-qalloca, -ma (C only)” on page 47.

-qmakedep, -M

Category
Output control

Pragma equivalent
None.

Purpose
Creates an output file containing targets suitable for inclusion in a description file for the **make** command.

The output file is named with a .d suffix.

Syntax


Defaults
Not applicable.

Parameters
gcc (-qmakedep option only)
The format of the generated **make** rule to matches the GCC format: the description file includes a single target listing all of the main source file's dependencies.

If you specify -**qmakedep** with no suboption, or **-M**, the description file specifies a separate rule for each of the main source file's dependencies.

Usage
For each source file with a .c, .C, .cpp, or .i suffix named on the command line, an output file is generated with the same name as the object file and a .d suffix. Output files are not created for any other types of input files. If you use the **-o** option to rename the object file, the output file uses the name you specified on the **-o** option. See below for examples.

The output files generated by these options are not **make** files; they must be linked before they can be used with the **make** command. For more information on this command, see your operating system documentation.

The output file contains a line for the input file and an entry for each include file. It has the general form:

file_name.o:*include_file_name*
file_name.o:*file_name.suffix*

You can also use the following option with **qmakedep** and **-M**:

-MF=*file_path*
Sets the name of the output file, where *file_path* is the full or partial path or file name for the output file. See below for examples.

Include files are listed according to the search order rules for the `#include` preprocessor directive, described in "Directory search sequence for include files" on page 12. If the include file is not found, it is not added to the .d file.

Files with no include statements produce output files containing one line that lists only the input file name.

Predefined macros
None.

Examples
To compile `mysource.c` and create an output file named `mysource.d`, enter:

```
invocation -c -qmakedep mysource.c
```

To compile `foo_src.c` and create an output file named `mysource.d`, enter:

```
invocation -c -qmakedep foo_src.c -MF mysource.d
```

To compile `foo_src.c` and create an output file named `mysource.d` in the `deps/` directory, enter:

```
invocation -c -qmakedep foo_src.c -MF deps/mysource.d
```

To compile `foo_src.c` and create an object file named `foo_obj.o` and an output file named `foo_obj.d`, enter:

```
invocation -c -qmakedep foo_src.c -o foo_obj.o
```

To compile `foo_src.c` and create an object file named `foo_obj.o` and an output file named `mysource.d`, enter:

```
invocation -c -qmakedep foo_src.c -o foo_obj.o -MF mysource.d
```

To compile `foo_src1.c` and `foo_src2.c` to create two output files, named `foo_src1.d` and `foo_src2.d`, respectively, in the `c:/tmp/` directory, enter:

```
invocation -c -qmakedep foo_src1.c foo_src2.c -MF c:/tmp/
```

Related information
- "-MF" on page 155
- "-o" on page 158
- "Directory search sequence for include files" on page 12

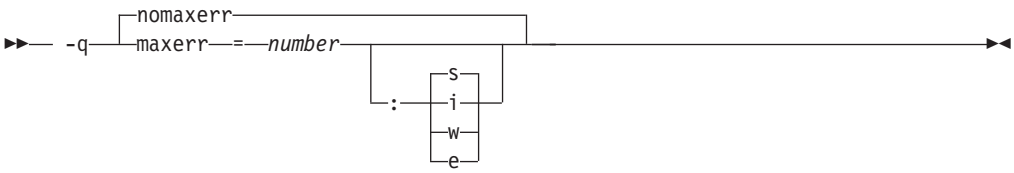
-qmaxerr

Category
Error checking and debugging

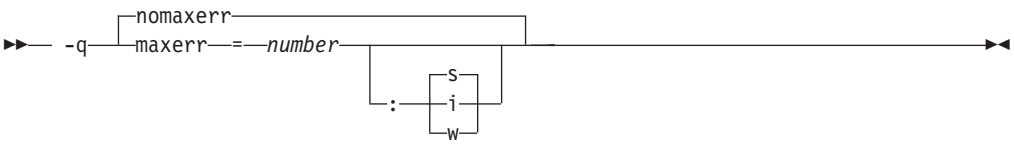
Pragma equivalent
None.

Purpose
Halts compilation when a specified number of errors of a specified severity level or higher is reached.

Syntax
-qmaxerr syntax — C



-qmaxerr syntax — C++



Defaults

-qnomaxerr: The compiler continues to process as much input as possible, until it is not able to generate code.

Parameters

number
Must be an integer with a value of 1 or greater. An unrecoverable error occurs when the number of errors reaches the limit specified, and compilation stops.

i Specifies a minimum severity level of Informational (I).

w Specifies a minimum severity level of Warning (W).

C **e**
Specifies a minimum severity level of Error (E).

s Specifies a minimum severity level of Severe error (S).

If you specify **-qmaxerr** with no severity level and the **-qhalt** option or pragma is also in effect, the severity level specified by **halt** is used. If you specify **-qmaxerr** with no severity level and **halt** is not in effect, the default severity level is **s**.

Usage

If the **-qmaxerr** option is specified more than once, the **-qmaxerr** option specified last determines the action of the option. If both the **-qmaxerr** and **-qhalt** options are specified, the **-qmaxerr** or **-qhalt** option specified last determines the severity level used by the **-qmaxerr** option.

Diagnostic messages may be controlled by the **-qflag** option.

Predefined macros

None.

Examples

To stop compilation of `myprogram.c` when 10 warnings are encountered, enter the command:

```
invocation myprogram.c -qmaxerr=10:w
```

To stop compilation of `myprogram.c` when 5 severe errors are encountered, assuming that the current **-qhalt** option value is **s** (severe), enter the command:

```
invocation myprogram.c -qmaxerr=5
```

To stop compilation of `myprogram.c` when 3 informational messages are encountered, enter the command:

```
invocation myprogram.c -qmaxerr=3:i
```

or:

```
invocation myprogram.c -qmaxerr=3 -qhalt=i
```

Related information
- "-qflag" on page 85
- "-qhalt" on page 100
- "Message severity levels and compiler response" on page 16

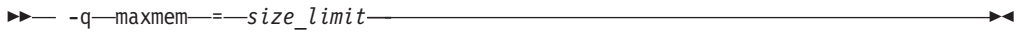
-qmaxmem

Category
Optimization and tuning

Pragma equivalent
#pragma options maxmem

Purpose
Limits the amount of memory that the compiler allocates while performing specific, memory-intensive optimizations to the specified number of kilobytes.

Syntax



Defaults
- **-qmaxmem=8192** when **-O2** is in effect.
- **-qmaxmem=-1** when **-O3** or higher optimization is in effect.

Parameters
size_limit
The number of kilobytes worth of memory to be used by optimizations. The limit is the amount of memory for specific optimizations, and not for the compiler as a whole. Tables required during the entire compilation process are not affected by or included in this limit.

A value of -1 permits each optimization to take as much memory as it needs without checking for limits.

Usage
A smaller limit does not necessarily mean that the resulting program will be slower, only that the compiler may finish before finding all opportunities to increase performance. Increasing the limit does not necessarily mean that the resulting program will be faster, only that the compiler is better able to find opportunities to increase performance if they exist.

Setting a large limit has no negative effect on the compilation of source files when the compiler needs less memory. However, depending on the source file being compiled, the size of subprograms in the source, the machine configuration, and the workload on the system, setting the limit too high, or to -1, might exceed available system resources.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the memory specified for local table is 16384 kilobytes, enter:

```
invocation myprogram.c -qmaxmem=16384
```

-qmbcs, -qdbcs

Category
Language element control

Pragma equivalent
#pragma options [no]mbcs, #pragma options [no]dbcs

Purpose
Enables support for multibyte character sets (MBCS) and Unicode characters in your source code.

When **mbcs** or **dbcs** is in effect, multibyte character literals and comments are recognized by the compiler. When **nombcs** or **nodbcs** is in effect, the compiler treats all literals as single-byte literals.

Syntax

Defaults
-qnombcs, -qnodbcs

Usage
For rules on using multibyte characters in your source code, see "Multibyte characters" in the *XL C/C++ Language Reference*.

In addition, you can use multibyte characters in the following contexts:

- In file names passed as arguments to compiler invocations on the command line; for example:

  ```
  ppuxlc /u/myhome/c_programs/kanji_files/multibyte_char.c -omultibyte_char
  ```

- In file names, as suboptions to compiler options that take file names as arguments
- In the definition of a macro name using the **-D** option; for example:

  ```
  -DMYMACRO="kpsmultibyte_chardcs"
  -DMYMACRO='multibyte_char'
  ```

Listing files display the date and time for the appropriate international language, and multibyte characters in the source file name also appear in the name of the corresponding list file. For example, a C source file called:

multibyte_char.c

gives a list file called

multibyte_char.lst

Predefined macros
None.

Examples
To compile myprogram.c if it contains multibyte characters, enter:

```
invocation myprogram.c -qmbcs
```

Related information
- "-D" on page 69

-MF

Category
Output control

Pragma equivalent
None.

Purpose
Specifies the target for the output generated by the **-qmakedep** or **-M** options.

This option is used only together with the **-qmakedep** or **-M** options. See the description for the "-qmakedep, -M" on page 149 for more information.

Syntax

Defaults
Not applicable.

Parameters
path
The target output path. *path* can be a full directory path or file name. If *path* is the name of a directory, the dependency file generated by the compiler is placed into the specified directory. If you do not specify a directory, the dependency file is stored in the current working directory.

Usage
If the file specified by **-MF** option already exists, it will be overwritten.

If you specify a single file name for the **-MF** option when compiling multiple source files, only a single dependency file will be generated containing the **make** rule for the last file specified on the command line.

Predefined macros
None.

Related information
- "-qmakedep, -M" on page 149
- "-o" on page 158
- "Directory search sequence for include files" on page 12

-qminimaltoc (PPU only)

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Controls the generation of the table of contents (TOC), which the compiler creates for an executable file in 64-bit compilation mode.

Programs compiled in 64-bit mode have a limit of 8192 TOC entries. As a result, you may encounter "relocation truncation" error messages when linking large programs in 64-bit mode; these error messages are caused by TOC overflow conditions. When **-qminimaltoc** is in effect, the compiler avoids these overflow conditions by placing TOC entries into a separate data section for each object file.

Specifying **-qminimaltoc** ensures that the compiler creates only one TOC entry for each compilation unit. Specifying this option can minimize the use of available TOC entries, but its use impacts performance. Use the **-qminimaltoc** option with discretion, particularly with files that contain frequently executed code.

Syntax

Defaults
-qnominimaltoc

Usage
This compiler option applies to 64-bit compilations only.

Compiling with **-qminimaltoc** may create slightly slower and larger code for your program. However, these effects may be minimized by specifying optimizing options when compiling your program.

Predefined macros
None.

-qmkshrobj (PPU only)

Category
Output control

Pragma equivalent
None.

Purpose
Creates a shared object from generated object files.

You should use this option, together with the related options described below, instead of calling the linker directly to create a shared object. The advantages of using this option are the automatic handling of link-time C++ template instantiation (using either the template include directory or the template registry), and compatibility with **-qipa** link-time optimizations (such as those performed at **-O5**)..

Syntax

Defaults
By default, the output object is linked with the runtime libraries and startup routines to create an executable file.

Usage
Specifying **-qmkshrobj** implies **-qpic**.

You can also use the following related options with the **-qmkshrobj**:

-o *shared_file*
The name of the file that will hold the shared file information. The default is a.out.

-e *name*
Sets the entry name for the shared executable to *name*.

For detailed information on using **-qmkshrobj** to create shared libraries, see "Constructing a library" in the *XL C/C++ Programming Guide*.

Predefined macros
None.

Examples
To construct the shared library `big_lib.so` from three smaller object files, type:

```
invocation -qmkshrobj -o big_lib.so lib_a.o lib_b.o lib_c.o
```

Related information
- "-o" on page 158
- "-e" on page 75
- "-qpriority (C++ only)" on page 173
- "-qpic" on page 170

-qnewcheck (C++ only)

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Specifies whether the compiler inserts a check to determine whether a null pointer has been returned by a call to a version of `operator new` or `operator new[]` with a non-empty `throw` specification.

The check serves to guard initialization code, such as a constructor call, in case the `operator new` returns null. Normally, this check is not necessary, because the non-empty `throw` versions of `operator new` specify that an exception of type `std::bad_alloc` is thrown if the requested memory cannot be allocated. However, on platforms that do not support C++ exceptions, such as the Cell Broadband Engine processor SPU, `operator new` will only return a null pointer if memory allocation fails. When **-qnewcheck** is in effect, the compiler inserts the check, and if the null pointer is returned, the constructor for the object being allocated is not invoked. When **-qnonewcheck** is in effect, the compiler omits the check, in order to improve performance.

Syntax

Defaults
-qnonewcheck

Usage
If you want to prevent the compiler from invoking a constructor on a null memory address (should the requested memory allocation fail) for code targeting the SPU that contains `new` or `new[]` expressions, or in code containing non-standard user-defined allocation functions, you can compile with **-qnewcheck**; however, your code will still need to handle the result of the check.

This option applies only to the `throw(std::bad_alloc)` versions of the `operator new` functions declared in the standard library header <new>, or to user-defined allocation functions with a non-empty `throw` specification. It does not apply to the standard or user-defined `nothrow` or empty `throw` versions of `operator new`, in which case the null pointer check is *always* inserted. (In the case of the `inline` versions of these operators, the check is removed after optimization.) For more information, see your C++ Standard Library documentation, or the declarations in the <new> header file on your system.

Predefined macros
None.

Related information
- "The new operator" in the *XL C/C++ Language Reference*

-o

Category
Output control

Pragma equivalent
None.

Purpose
Specifies a name for the output object, assembler, or executable file.

Syntax

Defaults
See “Types of output files” on page 5 for the default file names and suffixes produced by different phases of compilation.

Parameters
path
When you are using the option to compile from source files, *path* can be the

name of a file or directory. The *path* can be a relative or absolute path name. When you are using the option to link from object files, *path* must be a file name.

If the *path* is the name of an existing directory, files created by the compiler are placed into that directory. If *path* is not an existing directory, the *path* is the name of the file produced by the compiler. See below for examples.

You can not specify a file name with a C or C++ source file suffix (.C, .c, .cpp, or .i), such as `myprog.c` or `myprog.i`; this results in an error and neither the compiler nor the linker is invoked.

Usage
If you use the **-c** option with **-o** together and the *path* is not an existing directory, you can only compile one source file at a time. In this case, if more than one source file name is listed in the compiler invocation, the compiler issues a warning message and ignores **-o**.

The **-E**, **-P**, and **-qsyntaxonly** options override the **-o** option.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the resulting executable is called `myaccount`, assuming that no directory with name `myaccount` exists, enter:

```
invocation myprogram.c -o myaccount
```

To compile `test.c` to an object file only and name the object file `new.o`, enter:

```
invocation test.c -c -o new.o
```

Related information
- "-c" on page 56
- "-E" on page 75
- "-P" on page 164
- "-qsyntaxonly (C only)" on page 202

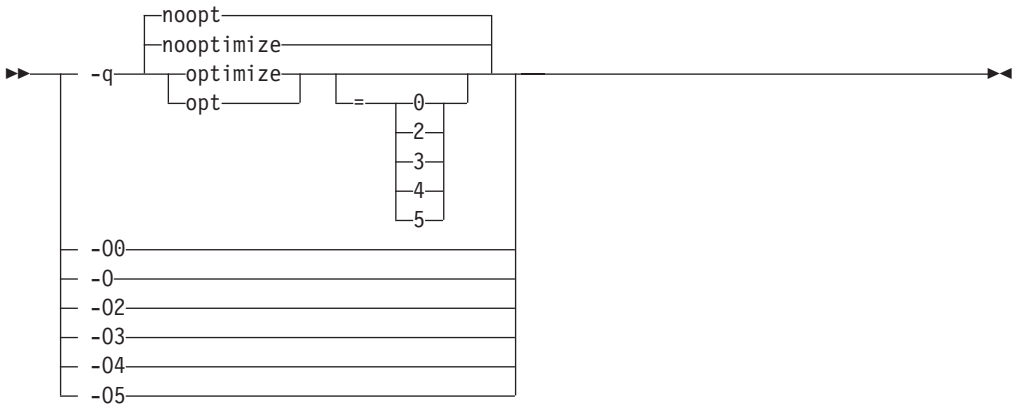
-O, -qoptimize

Category
Optimization and tuning

Pragma equivalent
#pragma options [no]optimize

Purpose
Specifies whether to optimize code during compilation and, if so, at which level.

Syntax



Defaults

-qnooptimize or **-O0** or **-qoptimize=0**

Parameters

-O0 | nooptimize | noopt | optimize|opt=0
Performs only quick local optimizations such as constant folding and elimination of local common subexpressions.

This setting implies **-qstrict_induction** unless **-qnostrict_induction** is explicitly specified.

-O
| -O2 | optimize | opt | optimize|opt=2
Performs optimizations that the compiler developers considered the best combination for compilation speed and runtime performance. The optimizations may change from product release to release. If you need a specific level of optimization, specify the appropriate numeric value.

This setting implies **-qstrict** and **-qnostrict_induction**, unless explicitly negated by **-qstrict_induction** or **-qnostrict**.

-O3 | optimize|opt=3
Performs additional optimizations that are memory intensive, compile-time intensive, or both. They are recommended when the desire for runtime improvement outweighs the concern for minimizing compilation resources.

-O3 applies the **-O2** level of optimization, but with unbounded time and memory limits. **-O3** also performs higher and more aggressive optimizations that have the potential to slightly alter the semantics of your program. The compiler guards against these optimizations at **-O2**. The aggressive optimizations performed when you specify **-O3** are:

1. Aggressive code motion, and scheduling on computations that have the potential to raise an exception, are allowed.

   Loads and floating-point computations fall into this category. This optimization is aggressive because it may place such instructions onto execution paths where they *will* be executed when they *may* not have been according to the actual semantics of the program.

   For example, a loop-invariant floating-point computation that is found on some, but not all, paths through a loop will not be moved at **-O2** because the computation may cause an exception. At **-O3**, the compiler will move it because it is not certain to cause an exception. The same is true for motion of loads. Although a load through a pointer is never moved, loads off the static or stack base register are considered movable at **-O3**. Loads in general

are not considered to be absolutely safe at **-O2** because a program can contain a declaration of a static array `a` of 10 elements and load `a[60000000003]`, which could cause a segmentation violation.

The same concepts apply to scheduling.

Example:

In the following example, at **-O2**, the computation of `b+c` is not moved out of the loop for two reasons:

- It is considered dangerous because it is a floating-point operation
- `t` does not occur on every path through the loop

At **-O3**, the code is moved.

```
  ...
int i ;
float a[100], b, c ;
for (i = 0 ; i < 100 ; i++)
 {
 if (a[i] < a[i+1])
  a[i] = b + c ;
 }
  ...
```

2. Conformance to IEEE rules are relaxed.

   With **-O2** certain optimizations are not performed because they may produce an incorrect sign in cases with a zero result, and because they remove an arithmetic operation that may cause some type of floating-point exception.

   For example, **X + 0.0** is not folded to X because, under IEEE rules, **-0.0 + 0.0 = 0.0**, which is **-X**. In some other cases, some optimizations may perform optimizations that yield a zero result with the wrong sign. For example, **X - Y * Z** may result in a **-0.0** where the original computation would produce **0.0**.

   In most cases the difference in the results is not important to an application and **-O3** allows these optimizations.

3. Floating-point expressions may be rewritten.

   Computations such as **a*b*c** may be rewritten as **a*c*b** if, for example, an opportunity exists to get a common subexpression by such rearrangement. Replacing a divide with a multiply by the reciprocal is another example of reassociating floating-point computations.

4. Specifying **-O3** implies **-qhot=level=0**, unless you explicitly specify **-qhot** or **-qhot=level=1** option.

-qfloat=rsqrt is set by default with **-O3**.

-qmaxmem=1 is set by default with **-O3**, allowing the compiler to use as much memory as necessary when performing optimizations.

Built-in functions do not change `errno` at **-O3**.

Integer divide instructions are considered too dangerous to optimize even at **-O3**.

Refer to "-qfltrap (PPU only)" on page 91 to see the behavior of the compiler when you specify **optimize** options with the **-qfltrap** option.

You can use the **-qstrict** and **-qstrict_induction** compiler options to turn off effects of **-O3** that might change the semantics of a program. Specifying **-qstrict**

together with **-O3** invokes all the optimizations performed at **-O2** as well as further loop optimizations. Reference to the **-qstrict** compiler option can appear before or after the **-O3** option.

The **-O3** compiler option followed by the **-O** option leaves **-qignerrno** on.

When **-O3** and **-qhot=level=1** are in effect, the compiler replaces any calls in the source code to standard math library functions with calls to the equivalent MASS library functions, and if possible, the vector versions.

-O4 | optimize|opt=4
This option is the same as **-O3**, except that it also:

- Sets the **-qhot** option
- Sets the **-qipa** option

Note: Later settings of **-O**, **-qcache**, **-qhot**, **-qipa**, **-qarch**, and **-qtune** options will override the settings implied by the **-O4** option.

-O5 | optimize|opt=5
This option is the same as **-O4**, except that it:

- Sets the **-qipa=level=2** option to perform full interprocedural data flow and alias analysis.

Note:

- Later settings of **-O**, **-qcache**, **-qipa**, **-qarch**, and **-qtune** options will override the settings implied by the **-O5** option.
- The use of **-O5** compiler options is recommended on the SPU to get the maximum performance from your application.

Usage

Increasing the level of optimization may or may not result in additional performance improvements, depending on whether additional analysis detects further opportunities for optimization.

Compilations with optimizations may require more time and machine resources than other compilations.

Optimization can cause statements to be moved or deleted, and generally should not be specified along with the **-g** flag for debugging programs. The debugging information produced may not be accurate.

Predefined macros

- __OPTIMIZE__ is predefined to 2 when **-O | O2** is in effect; it is predefined to 3 when **-O3 | O4 | O5** is in effect. Otherwise, it is undefined.
- __OPTIMIZE_SIZE__ is predefined to 1 when **-O | -O2 | -O3 | -O4 | -O5** and **-qcompact** are in effect. Otherwise, it is undefined.

Examples

To compile and optimize `myprogram.c`, enter:

```
invocation myprogram.c -O3
```

Related information

- "Optimizing your applications" in the *XL C/C++ Programming Guide*.

-qoptdebug

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
When used with high levels of optimization, produces files containing optimized pseudocode that can be read by a debugger.

An output file with a .optdbg extension is created for each source file compiled with **-qoptdebug**. You can use the information contained in this file to help you understand how your code actually behaves under optimization.

Syntax

Defaults
-qnooptdebug

Usage
-qoptdebug only has an effect when used with an option that enables the high-level optimizer, namely **-O3** or higher optimization level, or **-qhot**, **-qipa**, or **-qpdf**. You can use the option on both compilation and link steps. If you specify it on the compile step, one output file is generated for each source file. If you specify it on the **-qipa** link step, a single output file is generated.

You must still use the **-g** or **-qlinedebug** option to include debugging information that can be used by a debugger.

For more information and examples of using this option, see "Using -qoptdebug to help debug optimized programs" in the *XL C/C++ Programming Guide*.

Predefined macros
None.

Related information
- "-O, -qoptimize" on page 159
- "-qhot" on page 103
- "-qipa" on page 118
- "-qpdf1, -qpdf2 (PPU only)" on page 167
- "-g" on page 97
- "-qlinedebug" on page 145

-p, -pg, -qprofile (PPU only)

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Prepares the object files produced by the compiler for profiling.

When you compile with a profiling option, the compiler produces monitoring code that counts the number of times each routine is called. The compiler replaces the startup routine of each subprogram with one that calls the monitor subroutine at the start. When you execute the compiled program and it ends normally, it writes the recorded information to a gmon.out file. You can then use the **gprof** command to generate a runtime profile.

Syntax


Defaults
Not applicable.

Usage
When you are compiling and linking in separate steps, you must specify the profiling option in both steps.

If the **-qtbtable** option is not set, the profiling options will generate full traceback tables.

Predefined macros
None.

Examples
To compile `myprogram.c` to include profiling data, enter:

```
invocation myprogram.c -p
```

Remember to compile *and* link with one of the profiling options. For example:

```
invocation myprogram.c -p -c
invocation myprogram.o -p -o program
```

Related information
- "-qtbtable (PPU only)" on page 204
- See your operating system documentation for more information on the **gprof** command.

-P

Category
Output control

Pragma equivalent
None.

Purpose
Preprocesses the source files named in the compiler invocation, without compiling, and creates an output preprocessed file for each input file.

The preprocessed output file has the same name as the input file, with an .i suffix.

Syntax

Defaults
By default, source files are preprocessed, compiled, and linked to produce an executable file.

Usage
The **-P** option accepts any file name, except those with an .i suffix. Otherwise, source files with unrecognized file name suffixes are treated and preprocessed as C files, and no error message is generated.

Unless **-qppline** is specified, `#line` directives are not generated.

Line continuation sequences are removed and the source lines are concatenated.

The **-P** option retains all white space including line-feed characters, with the following exceptions:

- All comments are reduced to a single space (unless **-C** is specified).
- Line feeds at the end of preprocessing directives are not retained.
- White space surrounding arguments to function-style macros is not retained.

The **-P** option is overridden by the **-E** option. The **-P** option overrides the **-c**, **-o**, and **-qsyntaxonly** option.

Predefined macros
None.

Related information
- "-C, -C!" on page 56
- "-E" on page 75
- "-qppline" on page 171
- "-qsyntaxonly (C only)" on page 202

-qpath

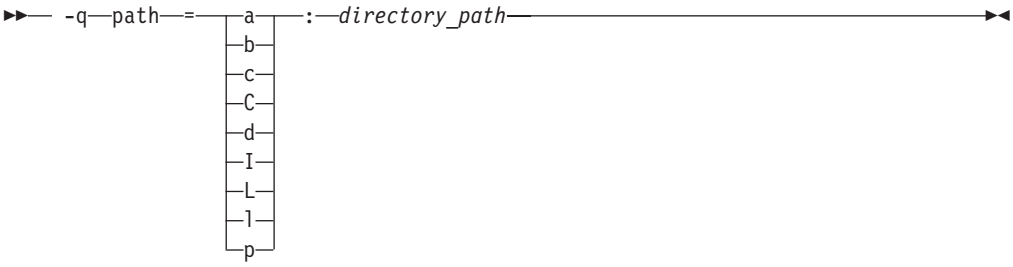
Category
Compiler customization

Pragma equivalent
None.

Purpose
Determines substitute path names for XL C/C++ executables such as the compiler, assembler, linker, and preprocessor.

You can use this option if you want to keep multiple levels of some or all of the XL C/C++ executables and have the option of specifying which one you want to use. This option is preferred over the **-B** and **-t** options.

Syntax



Defaults

By default, the compiler uses the paths for compiler components defined in the configuration file.

Parameters

directory_path
The path to the directory where the alternate programs are located.

The following table shows the correspondence between **-qpath** parameters and the component executable names:

Parameter	Description	Executable name
a	Assembler	ppu-as or spu-as
b	Low-level optimizer	xlCcode
c	Compiler front end	xlcentry, xlCentry
C++ C	C++ compiler front end	xlCentry
d	Disassembler	dis
I	High-level optimizer, compile step	ipa
L	High-level optimizer, link step	ipa
l	Linker	ppu-ld or spu-ld
p	Preprocessor	n/a

Usage

The **-qpath** option overrides the **-F**, **-t**, and **-B** options.

Note that using the **p** suboption causes the source code to be preprocessed separately before compilation, which can change the way a program is compiled.

Predefined macros

None.

Examples

To compile `myprogram.c` using a substitute **xlc** compiler in `/lib/tmp/mine/` enter:

```
invocation myprogram.c -qpath=c:/lib/tmp/mine/
```

To compile `myprogram.c` using a substitute linker in `/lib/tmp/mine/`, enter:

```
invocation myprogram.c -qpath=l:/lib/tmp/mine/
```

Related information

- "-B" on page 53
- "-F" on page 83
- "-t" on page 202

-qpdf1, -qpdf2 (PPU only)

Category

Optimization and tuning

Pragma equivalent

None.

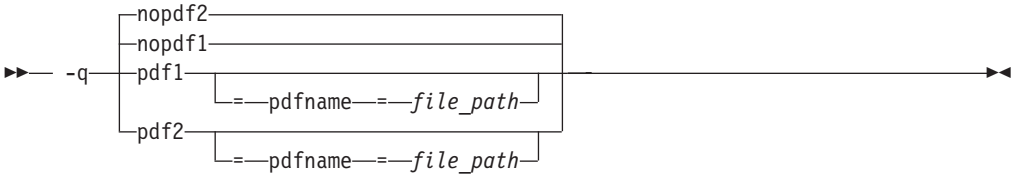
Purpose

Tunes optimizations through *profile-directed feedback* (PDF), where results from sample program execution are used to improve optimization near conditional branches and in frequently executed code sections.

PDF is a two-step process. You first compile the application with **-qpdf1** and a minimum optimization level of **-O2**, with linking. You then run the resulting application with a typical data set. During the test run, profile data is written to a profile file (by default, this file is named ._pdf and is saved in the current working directory, or in the directory named by the PDFDIR environment variable, if it is set). You then recompile, and/or link or relink the application with **-qpdf2** and a minimum optimization level of **-O2**, which fine-tunes the optimizations applied according to the profile data collected during the program execution.

PDF is intended to be used after other debugging and tuning is finished, as one of the last steps before putting the application into production.

Syntax



Defaults

-qnopdf1, -qnopdf2

Parameters

pdfname= *file_path*

Specifies the path to the file that will hold the profile data. By default, the file name is ._pdf, and it is placed in the current working directory or in the directory named by the PDFDIR environment variable. You can use the **pdfname** suboption to allow you to do simultaneous runs of multiple executables using the same PDF directory. This is especially useful when tuning with PDF on dynamic libraries.

Usage

You must compile the main program with PDF for profiling information to be collected at run time.

You must use the same compilation options for the PDF2 compilation as for the PDF1 compilation.

If you do not want the optimized object files to be relinked during the second step, specify **-qpdf2 -qnoipa**. Note, however, that if you change a source file that was compiled previously with **-qpdf1**, you will need to go through the entire first pass process again.

To specify the directory and file name for the profile file when using both **-qpdf1** and **-qpdf2**, you must use the **pdfname** suboption. For examples, see "Optimizing your applications"in the *XL C/C++ Programming Guide*.

For recommended procedures for using PDF, see "Optimizing your applications" in the *XL C/C++ Programming Guide*.

The following utility programs, found in /opt/ibmcmp/xlc/cbe/9.0/bin/, are available for managing the directory to which profile data is written:

cleanpdf

Removes all profiling information from the directory specified by *directory_path*; or if *pathname* is not specified, from the directory set by the PDFDIR environment variable; or if PDFDIR is not set, from the current directory. Removing profiling information reduces runtime overhead if you change the program and then go through the PDF process again.

Run **cleanpdf** only when you are finished with the PDF process for a particular application. Otherwise, if you want to resume using PDF with that application, you will need to recompile all of the files again with **-qpdf1**.

resetpdf

Same as **cleanpdf**, described above.

Predefined macros

None.

Related information

- “-qipa” on page 118
- "Optimizing your applications" in the *XL C/C++ Programming Guide*

-qphsinfo

Category

Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Reports the time taken in each compilation phase to standard output.

Syntax


Defaults
-qnophsinfo

Usage
The output takes the form *number1*/*number2* for each phase where *number1* represents the CPU time used by the compiler and *number2* represents the total of the compiler time and the time that the CPU spends handling system calls.

Predefined macros
None.

Examples
C To compile `myprogram.c` and report the time taken for each phase of the compilation, enter:

```
invocation myprogram.c -qphsinfo
```

The output will look similar to:

```
C Init    - Phase Ends;   0.010/  0.040
IL Gen    - Phase Ends;   0.040/  0.070
W-TRANS   - Phase Ends;   0.000/  0.010
OPTIMIZ   - Phase Ends;   0.000/  0.000
REGALLO   - Phase Ends;   0.000/  0.000
AS        - Phase Ends;   0.000/  0.000
```

Compiling the same program with **-O4** gives:

```
C Init    - Phase Ends;   0.010/  0.040
IL Gen    - Phase Ends;   0.060/  0.070
IPA       - Phase Ends;   0.060/  0.070
IPA       - Phase Ends;   0.070/  0.110
W-TRANS   - Phase Ends;   0.060/  0.180
OPTIMIZ   - Phase Ends;   0.010/  0.010
REGALLO   - Phase Ends;   0.010/  0.020
AS        - Phase Ends;   0.000/  0.000
```

C++ To compile `myprogram.C` and report the time taken for each phase of the compilation, enter:

```
ppuxlc++ myprogram.C -qphsinfo
```

The output will look similar to:

```
Front End - Phase Ends;   0.004/  0.005
W-TRANS   - Phase Ends;   0.010/  0.010
OPTIMIZ   - Phase Ends;   0.000/  0.000
REGALLO   - Phase Ends;   0.000/  0.000
AS        - Phase Ends;   0.000/  0.000
```

Compiling the same program with **-O4** gives:

```
Front End - Phase Ends;   0.004/  0.006
IPA       - Phase Ends;   0.040/  0.040
IPA       - Phase Ends;   0.220/  0.280
W-TRANS   - Phase Ends;   0.030/  0.110
OPTIMIZ   - Phase Ends;   0.030/  0.030
REGALLO   - Phase Ends;   0.010/  0.050
AS        - Phase Ends;   0.000/  0.000
```

-qpic

Category
Object code control

Pragma equivalent
None.

Purpose
Generates Position-Independent Code suitable for use in shared libraries.

Syntax

Defaults
- **-qnopic** for 32-bit compilation targeting the PPU or SPU.
- **-qpic=small** for 64-bit compilation targeting the PPU.
- **-qpic=small** when the **-qmkshrobj** compiler option is specified.

Parameters
small
Instructs the compiler to assume that the size of the Global Offset Table in 32-bit mode or Table of Contents in 64-bit mode is no larger than 64 Kb.

large
Allows the Global Offset Table to be larger than 64 Kb in size, allowing more addresses to be stored in the table. Code generated with this option is usually larger than that generated with **-qpic=small**.**-qpic=large** only works in 32-bit mode.

Specifying **-qpic** without any suboptions is equivalent to **-qpic=small**.

Usage
For 64-bit compilation targeting the PPU, **-qpic** is enabled and cannot be disabled.

Predefined macros
None.

Examples
To compile a shared library `libmylib.so`, use the following commands:

```
invocation mylib.c -qpic=small -c -o mylib.o
invocation -qmkshrobj mylib -o libmylib.so.1
```

Related information
- "-q32, -q64 (PPU only)" on page 42
- "-qmkshrobj (PPU only)" on page 156

-qppline

Category
Object code control

Pragma equivalent
None.

Purpose
When used in conjunction with the **-E** or **-P** options, enables or disables the generation of `#line` directives.

Syntax

Defaults
- **-qnoppline** when **-P** is in effect
- **-qppline** when **-E** is in effect

Usage
The **-C** option has no effect without either the **-E** or the **-P** option. With the **-E** option, line directives are written to standard output. With the **-P** option, line directives are written to an output file.

Predefined macros
None.

Examples
To preprocess `myprogram.c` to write the output to `myprogram.i`, and generate `#line` directives:

```
invocation myprogram.c -P -qppline
```

Related information
- "-E" on page 75
- "-P" on page 164

-qprefetch (PPU only)

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Inserts prefetch instructions automatically where there are opportunities to improve code performance.

When **-qprefetch** is in effect, the compiler may insert prefetch instructions in compiled code. When **-qnoprefetch** is in effect, prefetch instructions are not inserted in compiled code.

Syntax

Defaults
-qprefetch

Usage
The **-qnoprefetch** option will not prevent built-in functions such as `__prefetch_by_stream` from generating prefetch instructions.

Predefined macros
None.

-qprint

Category
Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Enables or suppresses listings.

When **-qprint** is in effect, listings are enabled if they are requested by other compiler options that produce listings. When **-qnoprint** is in effect, all listings are suppressed, regardless of whether listing-producing options are specified.

Syntax

Defaults
-qprint

Usage
You can use **-qnoprint** to override all listing-producing options and equivalent pragmas, regardless of where they are specified. These options are:

- -qattr
- -qlist
- -qlistopt
- -qsource
- -qxref

Predefined macros
None.

Examples
To compile `myprogram.c` and suppress all listings, even if some files have **#pragma options source** and similar directives, enter:

```
invocation myprogram.c -qnoprint
```

-qpriority (C++ only)

Category
Object code control

Pragma equivalent
#pragma options priority, #pragma priority

Purpose
Specifies the priority level for the initialization of static objects.

The C++ standard requires that all global objects within the same translation unit be constructed from top to bottom, but it does not impose an ordering for objects declared in different translation units. The **-qpriority** option and **#pragma priority** directive allow you to impose a construction order for all static objects declared within the same load module. Destructors for these objects are run in reverse order during termination.

Syntax

Option syntax

Pragma syntax

Defaults
The default priority level is 65 535.

Parameters
number
An integer literal in the range of 101 to 65 535. A lower value indicates a higher priority; a higher value indicates a lower priority. If you do not specify a *number*, the compiler assumes 65 535.

Usage
More than one **#pragma priority** can be specified within a translation unit. The priority value specified in one pragma applies to the constructions of all global objects declared after this pragma and before the next one. However, in order to be consistent with the Standard, priority values specified within the same translation unit must be strictly increasing. Objects with the same priority value are constructed in declaration order.

The effect of a **#pragma priority** exists only within one load module. Therefore, **#pragma priority** cannot be used to control the construction order of objects in different load modules.

Note: The C++ variable attribute `init_priority` can also be used to assign a priority level to a shared variable of class type. See "The init_priority variable attribute" in the *XL C/C++ Language Reference* for more information.

Examples

To compile the file `myprogram.C` to produce an object file `myprogram.o` so that objects within that file have an initialization priority of 2 000, enter:

```
ppuxlc++ myprogram.C -c -qpriority=2000
```

Refer to "Initializing static objects in libraries" in the *XL C/C++ Programming Guide* for further examples.

Related information

- "Initializing static objects in libraries"in the *XL C/C++ Programming Guide*

-qprocimported, -qproclocal, -qprocunknown (PPU only)

Category

Optimization and tuning

Pragma equivalent

#pragma options proclocal, #pragma options procimported, #pragma options procunknown

Purpose

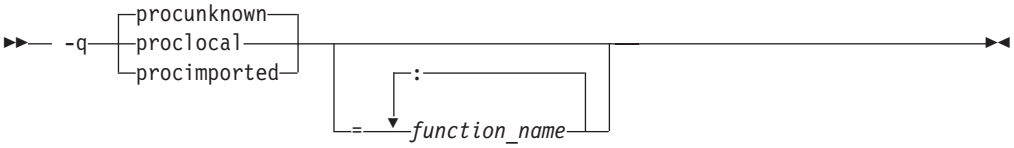
Marks functions as local, imported, or unknown in 64-bit compilations.

Local functions are statically bound with the functions that call them; smaller, faster code is generated for calls to such functions. You can use the **proclocal** option or pragma to name functions that the compiler can assume are local.

Imported functions are dynamically bound with a shared portion of a library. Code generated for calls to functions marked as imported may be larger, but is faster than the default code sequence generated for functions marked as unknown. You can use the **procimported** option or pragma to name functions that the compiler can assume are imported.

Unknown functions are resolved to either statically or dynamically bound objects during linking. You can use the **procunkown** option or pragma to name functions that the compiler can assume are unknown.

Syntax



Defaults

-qprocunknown: The compiler assumes that all functions' definitions are unknown.

Parameters

function_name
The name of a function that the compiler should assume is local, imported, or

unknown (depending on the option specified). If you do not specify any *function_name*, the compiler assumes that *all* functions are local, imported, or unknown.

C++ Names must be specified using their mangled names. To obtain C++ mangled names, compile your source to object files only, using the **-c** compiler option, and use the **nm** operating system command on the resulting object file. (See also "Name mangling" in the *XL C/C++ Language Reference* for details on using the `extern "C"` linkage specifier on declarations to prevent name mangling.)

Usage
This option applies to 64-bit compilations only.

If any functions that are marked as local resolve to shared library functions, the linker will detect the error and issue warnings. If any of the functions that are marked as imported resolve to statically bound objects, the generated code may be larger and run more slowly than the default code sequence generated for unknown functions.

If you specify more than one of these options with no function names, the last option specified is used. If you specify the same function name on more than one option specification, the last one is used.

Predefined macros
None.

Examples
To compile `myprogram.c` along with the archive library `oldprogs.a` so that:

- Functions `fun` and `sun` are specified as local
- Functions `moon` and `stars` are specified as imported
- Function `venus` is specified as unknown

use the following command:

```
invocation myprogram.c oldprogs.a -qprolocal=fun(int):sun()
  -qprocimported=moon():stars(float) -qprocunknown=venus()
```

If the following example, in which a function marked as local instead resolves to a shared library function, is compiled with **-qproclocal**:

```
int main(void)
{
    printf("Just in function foo1()\n");
    printf("Just in function foo1()\n");
}
```

a linker error will result. To correct this problem, you should explicitly mark the called routine as being imported from a shared object. In this case, you would recompile the source file and explicitly mark `printf` as imported by compiling with `-qproclocal -qprocimported=printf`.

Related information

- "-qdataimported, -qdatalocal, -qtocdata (PPU only)" on page 70

-qproto (C only)

Category
Object code control

Pragma equivalent
#pragma options [no]proto

Purpose
Specifies the linkage conventions for passing floating-point arguments to functions that have not been prototyped.

When **proto** is in effect, the compiler assumes that the arguments in function calls are the same types as the corresponding parameters of the function definition, even if the function has not been prototyped. By asserting that an unprototyped function actually expects a floating-point argument if it is called with one, you allow the compiler to pass floating-point arguments in floating-point registers exclusively. When **noproto** is in effect, the compiler does not make this assumption, and must pass floating-point parameters in floating-point and general purpose registers.

Syntax

Defaults
-qnoproto

Usage
This option only is only valid when the compiler allows unprototyped functions; that is, with the **ppucc**, **spucc**, **ppuxlc**, or **spuxlc** invocation command, or with the **-qlanglvl** option set to **classic | extended | extc89 | extc99**.

Predefined macros
None.

Examples
To compile `my_c_program.c` to allow the compiler to use the standard linkage conventions for floating-point parameters, even when functions are not prototyped, enter:

```
invocation my_c_program.c -qproto
```

-Q, -qinline

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Attempts to inline functions instead of generating calls to those functions, for improved performance.

C++ Specifying **-Q** (or **-qinline**) enables automatic inlining by the compiler front end. Specifying **-Q** with **-O** provides additional inlining by enabling inlining by the low-level optimizer. In both cases, the compiler attempts to inline all functions, in addition to those defined inside a class declaration or explicitly marked with the `inline` specifier.

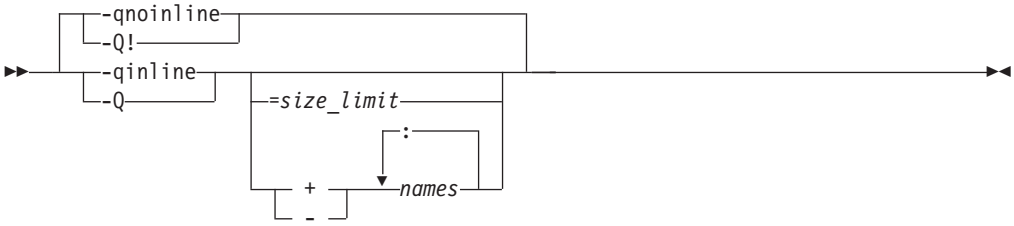
C You must specify a minimum optimization level of **-O** along with **-Q** (or **-qinline**) to enable inlining of functions, including those declared with the `inline` specifier. You can also use the **-Q** option to specify restrictions on the functions that should or should not be inlined.

In all cases where **-Q** (or **-qinline**) is in effect, the compiler uses heuristics to determine whether inlining a specific function will result in a performance benefit. That is, whether a function is appropriate for inlining is subject to limits on the number of inlined calls and the amount of code size increase as a result. Therefore, simply enabling inlining does not guarantee that a given function will be inlined.

Specifying **-Q!** (or **-qnoinline**) disables all inlining, including that performed by the high-level optimizer with the **-qipa** option, and functions declared explicitly as `inline`.

Syntax

-qinline and -Q syntax — C



-qinline and -Q syntax — C++

Defaults

-qnoinline or -Q!

Parameters

C *size_limit*

A positive integer representing the number of executable statements in a function. Declarations are not counted, as you can see in the example below:

```
increment()
{
  int a, b, i;
   for (i=0; i<10; i++) /* statement 1 */
   {
      a=i;              /* statement 2 */
      b=i;              /* statement 3 */
   }
}
```

The number of executable statements in a function must be fewer than or equal to *size_limit* for it to be considered for inlining. Specifying a value of **0** causes no functions to be inlined except those functions listed in the *name*

suboption, or those marked with supported forms of the `inline` function specifier. If you do not specify *size*, the default value is 20.

C **+**

The compiler attempts to inline all functions that meet the criterion specified by *size*, as well as those listed by *name*.

C **-**

The compiler attempts to inline all functions that meet the criterion specified by *size*, except those listed by *name*.

C *name*

The name of a function to be inlined. Separate each function name with a colon (**:**). This suboption overrides any setting of the *size* value. Note that this suboption does not affect functions explicitly declared with the `inline` specifier; when **-O** and **-Q** | **-qinline** are in effect, those functions are *always* considered for inlining. You can specify this suboption as an argument to both the positive and negative forms of the options, to precisely control which functions are most likely to be inlined.

A warning message is issued for functions that are not defined in the source file being compiled.

Usage

To maximize inlining, specify optimization (**-O**) and also specify the appropriate **-qinline** or **-Q** options.

Because inlining does not always improve runtime performance, you should test the effects of this option on your code. Do not attempt to inline recursive or mutually recursive functions.

If you specify the **-g** option to generate debug information, inlining may be suppressed.

Predefined macros

None.

Examples

To compile `myprogram.c` so that no functions are inlined, enter:

```
invocation myprogram.c -O -qnoinline
```

C To compile `myprogram.c` so that the compiler attempts to inline all functions of fewer than 12 statements, enter:

```
invocation myprogram.c -O -qinline=12
```

C Assuming that the functions `salary`, `taxes`, `expenses`, and `benefits` have more than 20 executable statements each, to compile `myprogram.c` so that the compiler attempts to inline all appropriate functions (that is, those that have fewer than the default of 20 statements) *plus* these functions, enter:

```
invocation myprogram.c -O -qinline+salary:taxes:expenses:benefits
```

C Assuming that the functions `salary`, `taxes`, `expenses`, and `benefits` have fewer than 20 executable statements each, to compile `myprogram.c` so that the compiler attempts to inline all appropriate functions (that is, those that have fewer than the default of 20 statements) *except* these functions, enter:

```
invocation myprogram.c -O -qinline-salary:taxes:expenses:benefits
```

C You can use a size value of zero along with function names to inline specific functions. For example:

```
-O -qinline=0
```

followed by:

```
-qinline+salary:taxes:benefits
```

causes *only* the functions named `salary`, `taxes`, or `benefits` to be inlined, if possible, and no others.

Related information

- "-g" on page 97
- "-qipa" on page 118
- "-O, -qoptimize" on page 159
- "The inline function specifier" in *XL C/C++ Language Reference*

-r

Category

Object code control

Pragma equivalent

None.

Purpose

Produces a relocatable object, even though the file contains unresolved symbols.

Syntax

Defaults

Not applicable.

Usage

A file produced with this flag is expected to be used as a file parameter in another compiler invocation.

Predefined macros

None.

Examples

To compile `myprogram.c` and `myprog2.c` into a single object file `mytest.o`, enter:

```
invocation myprogram.c myprog2.c -r -o mytest.o
```

-R

Category

Linking

Pragma equivalent

None.

Purpose
At link time, writes search paths for shared libraries into the executable, so that these directories are searched at program run time for any required shared libraries.

Syntax

Defaults
The default is to include only the standard directories. See the compiler configuration file for the directories that are set by default.

Usage
If the **-R***directory_path* option is specified both in the configuration file and on the command line, the paths specified in the configuration file are searched first at run time.

The **-R** compiler option is cumulative. Subsequent occurrences of **-R** on the command line do not replace, but add to, any directory paths specified by earlier occurrences of **-R**.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the directory `/usr/tmp/old` is searched at run time along with standard directories for the dynamic library `libspfiles.so`, enter:

```
invocation myprogram.c -lspfiles -R/usr/tmp/old
```

Related information
- "-L" on page 131

-qreport

Category
Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Produces listing files that show how sections of code have been optimized.

A listing file is generated with a .lst suffix for each source file named on the command line. When used with an option that enables vectorization, the listing file shows a pseudo-C code listing and a summary of how program loops are optimized. The report also includes diagnostic information to show why specific loops could not be vectorized.

Syntax

Defaults
-qnoreport

Usage
For **-qreport** to generate a loop transformation listing, you must also specify one of the following options on the command line:

- **-qhot[=simd]**
- **-O5**
- **-qipa=level=2**

If you use **-qreport** with **-O5** or **-qipa=level=2**, the report will be generated after the link step.

The pseudo-C code listing is not intended to be compilable. Do not include any of the pseudo-C code in your program, and do not explicitly call any of the internal routines whose names may appear in the pseudo-C code listing.

Predefined macros
None.

Examples
To compile `myprogram.c` so the compiler listing includes a report showing how loops are optimized, enter:

```
invocation -qhot -O3 -qreport myprogram.c
```

Related information
- "-qhot" on page 103
- "-qipa" on page 118
- "-qoptdebug" on page 163
- ***Using -qoptdebug to help debug optimized programs*** in the *XL C/C++ Programming Guide*

-qreserved_reg

Category
Object code control

Pragma equivalent
None.

Purpose
Indicates that the given list of registers cannot be used during the compilation except as a stack pointer, frame pointer or in some other fixed role.

You should use this option in modules that are required to work with other modules that use global register variables or hand-written assembler code.

Syntax

Defaults
Not applicable.

Parameters

register_name
A valid register name on the target platform. Valid registers for the PPU are:

r0 to r31
General purpose registers

f0 to f31
Floating-point registers

v0 to v31
Vector registers

Valid registers for the SPU are 0 to 127, or v0 to v127.

Usage

-qreserved_reg is cumulative, for example, specifying `-qreserved_reg=r14` and `-qreserved_reg=r15` is equivalent to specifying `-qreserved_reg=r14:r15`.

Duplicate register names are ignored.

Predefined macros

None.

Examples

To specify that `myprogram.c` reserves the general purpose registers r3 and r4, enter:

```
invocation myprogram.c -qreserved_reg=r3:r4
```

Related information

- "Variables in specified registers" in the *XL C/C++ Language Reference*

-qro (PPU only)

Category

Object code control

Pragma equivalent

#pragma options ro, #pragma strings

Purpose

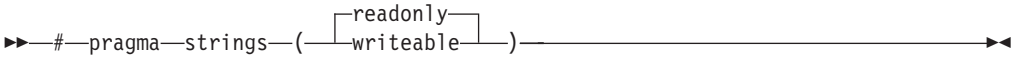
Specifies the storage type for string literals.

When **ro** or **strings=readonly** is in effect, strings are placed in read-only storage. When **noro** or **strings=writeable** is in effect, strings are placed in read/write storage.

Syntax

Option syntax

Pragma syntax



Defaults

C Strings are read-only for all invocation commands except **ppucc** or **spucc**. If the **ppucc** or **spucc** invocation command is used, strings are writeable.

C++ Strings are read-only.

Parameters

readonly (pragma only)
String literals are to be placed in read-only memory.

writeable (pragma only)
String literals are to be placed in read-write memory.

Usage

Placing string literals in read-only memory can improve runtime performance and save storage. However, code that attempts to modify a read-only string literal may generate a memory error.

The pragmas must appear before any source statements in a file.

Predefined macros

None.

Examples

To compile `myprogram.c` so that the storage type is writable, enter:

```
invocation myprogram.c -qnoro
```

Related information

- "-qro (PPU only)" on page 182
- "-qroconst (PPU only)"

-qroconst (PPU only)

Category

Object code control

Pragma equivalent

#pragma options [no]roconst

Purpose

Specifies the storage location for constant values.

When **roconst** is in effect, constants are placed in read-only storage. When **noroconst** is in effect, constants are placed in read/write storage.

Syntax

Defaults

- C **-qroconst** for all compiler invocations except **ppucc** or **spucc** and its derivatives. **-qnoroconst** for the **ppucc** or **spucc** invocation and its derivatives.
- C++ **-qroconst**

Usage

Placing constant values in read-only memory can improve runtime performance, save storage, and provide shared access. However, code that attempts to modify a read-only constant value generates a memory error.

"Constant" in the context of the **-qroconst** option refers to variables that are qualified by `const`, including `const`-qualified characters, integers, floats, enumerations, structures, unions, and arrays. The following constructs are not affected by this option:

- Variables qualified with `volatile` and aggregates (such as a structure or a union) that contain `volatile` variables
- Pointers and complex aggregates containing pointer members
- Automatic and static types with block scope
- Uninitialized types
- Regular structures with all members qualified by `const`
- Initializers that are addresses, or initializers that are cast to non-address values

The **-qroconst** option does not imply the **-qro** option. Both options must be specified if you wish to specify storage characteristics of both string literals (**-qro**) and constant values (**-qroconst**).

Predefined macros

None.

Related information

- "-qro (PPU only)" on page 182

-qrtti (C++ only) (PPU only)

Category

Object code control

Pragma equivalent

#pragma options rtti

Purpose

Generates runtime type identification (RTTI) information for exception handling and for use by the `typeid` and `dynamic_cast` operators.

Syntax

Defaults

-qrtti

Usage
For improved runtime performance, suppress RTTI information generation with the **-qnortti** setting.

You should be aware of the following effects when specifying the **-qrtti** compiler option:

- Contents of the virtual function table will be different when **-qrtti** is specified.
- When linking objects together, all corresponding source files must be compiled with the correct **-qrtti** option specified.
- If you compile a library with mixed objects (**-qrtti** specified for some objects, **-qnortti** specified for others), you may get an undefined symbol error.

Predefined macros
- __RTTI_ALL__ is defined to 1 when **-qrtti** is in effect; otherwise, it is undefined.
- __NO_RTTI__ is defined to 1 when **-qnortti** is in effect; otherwise, it is undefined.

Related information
- "-qeh (C++ only) (PPU only)" on page 76

-s

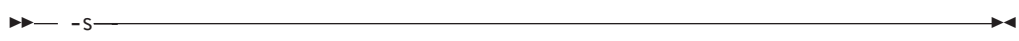
Category
Object code control

Pragma equivalent
None.

Purpose
Strips the symbol table, line number information, and relocation information from the output file.

This command is equivalent to the operating system **strip** command.

Syntax



Defaults
The symbol table, line number information, and relocation information are included in the output file.

Usage
Specifying **-s** saves space, but limits the usefulness of traditional debug programs when you are generating debug information using options such as **-g**.

Predefined macros
None.

Related information
- "-g" on page 97

-S

Category
Output control

Pragma equivalent
None.

Purpose
Generates an assembler language file for each source file.

The resulting file has an .s suffix and can be assembled to produce object .o files or an executable file (a.out).

Syntax

Defaults
Not applicable.

Usage
You can invoke the assembler with any compiler invocation command. For example,

```
invocation myprogram.s
```

will invoke the assembler, and if successful, the linker to create an executable file, a.out.

If you specify **-S** with **-E** or **-P**, **-E** or **-P** takes precedence. Order of precedence holds regardless of the order in which they were specified on the command line.

You can use the **-o** option to specify the name of the file produced only if no more than one source file is supplied. For example, the following is *not* valid:

```
invocation myprogram1.c myprogram2.c -o -S
```

Predefined macros
None.

Examples
To compile `myprogram.c` to produce an assembler language file `myprogram.s`, enter:

```
invocation myprogram.c -S
```

To assemble this program to produce an object file `myprogram.o`, enter:

```
invocation myprogram.s -c
```

To compile `myprogram.c` to produce an assembler language file `asmprogram.s`, enter:

```
invocation myprogram.c -S -o asmprogram.s
```

Related information
- "-E" on page 75
- "-P" on page 164

-qsaveopt

Category
Object code control

Pragma equivalent
None.

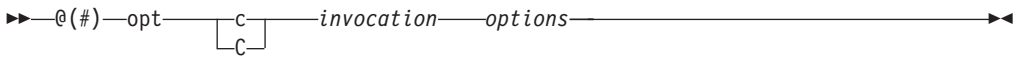
Purpose
Saves the command-line options used for compiling a source file, the version and level of each compiler component invoked during compilation, and other information to the corresponding object file.

Syntax

Defaults
-qnosaveopt

Usage
This option has effect only when compiling to an object (.o) file (that is, using the **-c** option). Though each object may contain multiple compilation units, only one copy of the command-line options is saved. Compiler options specified with pragma directives are ignored.

Command-line compiler options information is copied as a string into the object file, using the following format:



where:

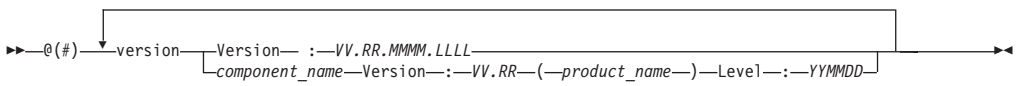
c Signifies a C language compilation.

C Signifies a C++ language compilation.

invocation
Shows the command used for the compilation, for example, **ppuxlc**.

options The list of command line options specified on the command line, with individual options separated by spaces.

Compiler version and release information, as well as the version and level of each component invoked during compilation, are also saved to the object file in the format:



where:

V Represents the version.

R Represents the release.

M Represents the modification.

L Represents the level.

component_name
Specifies the components that were invoked for this compilation, such as the low-level optimizer.

product_name
Indicates the product to which the component belongs (for example, `C/C++` or `Fortran`).

YYMMDD
Represents the year, month, and date of the installed update. If the update installed is at the base level, the level is displayed as BASE.

If you want to simply output this information to standard output without writing it to the object file, use the **-qversion** option.

Predefined macros
None.

Examples
Compile `t.c` with the following command:

```
invocation t.c -c -qsaveopt -qhot
```

Issuing the **strings -a** command on the resulting `t.o` object file produces information similar to the following:

```
opt c /opt/ibmcmp/xlc/cbe/9.0/bin/ppuxlc -c -qsaveopt -qhot t.c
version IBM XL C/C++ for Multicore Acceleration for Linux, V9.0
version Version: 09.00.0000.0001
version Driver Version: 09.00(C/C++) Level: 060414
version Front End  Version: 09.00(C/C++)  Level: 060419
version C++ Front End Version : 09.00(C/C++)  Level: 060420
version High Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran)  Level: 060411
version Low Level Optimizer  Version: 09.00(C/C++) and 11.01(Fortran) Level: 060418
```

c identifies the source used as C, `/opt/ibmcmp/xlc/cbe/9.0/bin/ppuxlc` shows the invocation command used, and `-qhot -qsaveopt` shows the compilation options.

The remaining lines list each compiler component invoked during compilation, and its version and level. Components that are shared by multiple products may show more than one version number. Level numbers shown may change depending on the updates you have installed on your system.

Related information
- "-qversion" on page 221

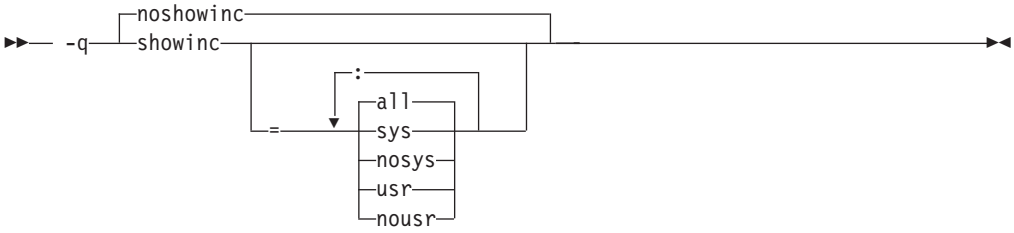
-qshowinc

Category
Listings, messages, and compiler information

Pragma equivalent
#pragma options [no]showinc

Purpose
When used with **-qsource** option to generate a listing file, selectively shows user or system header files in the source section of the listing file.

Syntax



Defaults

-qnoshowinc: Header files included in source files are not shown in the source listing.

Parameters

all Shows both user and system include files in the program source listing.

sys
Shows system include files (that is, files included with the `#include <filename>` preprocessor directive) in the program source listing.

usr
Shows user include files (that is, files included with the `#include "filename"` preprocessor directive or with **-qinclude**) in the program source listing.

Specifying **showinc** with no suboptions is equivalent to **-qshowinc=sys : usr** and **-qshowinc=all**. Specifying **noshowinc** is equivalent to **-qshowinc=nosys : nousr**.

Usage

This option has effect only when the **-qlist** or **-qsource** compiler options is in effect.

Predefined macros

None.

Examples

To compile `myprogram.c` so that all included files appear in the source listing, enter:

```
invocation myprogram.c -qsource -qshowinc
```

Related information

- "-qsource" on page 190

-qsmallstack

Category

Optimization and tuning

Pragma equivalent

None.

Purpose

Reduces the size of the stack frame.

Syntax

Defaults
-qnosmallstack

Usage
Programs that allocate large amounts of data to the stack, such as threaded programs, may result in stack overflows. This option can reduce the size of the stack frame to help avoid overflows.

This option is only valid when used together with IPA (**-qipa**, **-O4**, **-O5** compiler options).

Specifying this option may adversely affect program performance.

Predefined macros
None.

Examples
To compile `myprogram.c` to use a small stack frame, enter:

```
invocation myprogram.c -qipa -qsmallstack
```

Related information
- "-g" on page 97
- "-qipa" on page 118

-qsource

Category
Listings, messages, and compiler information

Pragma equivalent
#pragma options [no]source

Purpose
Produces a compiler listing file that includes the source section of the listing and provides additional source information when printing error messages.

When **source** is in effect, a listing file is generated with a .lst suffix for each source file named on the command line. For details of the contents of the listing file, see "Compiler listings" on page 17.

Syntax

Defaults
-qnosource

Usage
You can selectively print parts of the source by using pairs of **#pragma options source** and **#pragma options nosource** preprocessor directives throughout your source program. The source following **#pragma options source** and preceding **#pragma options nosource** is printed.

The **-qnoprint** option overrides this option.

Predefined macros
None.

Examples
To compile `myprogram.c` to produce a compiler listing that includes the source code, enter:

```
invocation myprogram.c -qsource
```

Related information
- "-qlist" on page 146
- "-qlistopt" on page 147
- "-qprint" on page 172

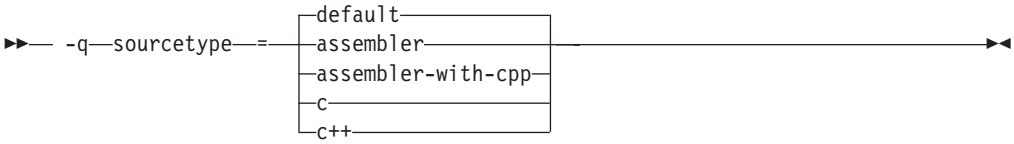
-qsourcetype

Category
Input control

Pragma equivalent
None.

Purpose
Instructs the compiler to treat all recognized source files as a specified source type, regardless of the actual file name suffix.

Ordinarily, the compiler uses the file name suffix of source files specified on the command line to determine the type of the source file. For example, a .c suffix normally implies C source code, and a .C suffix normally implies C++ source code. The **-qsourcetype** option instructs the compiler to not rely on the file name suffix, and to instead assume a source type as specified by the option.

Syntax


Defaults
-qsourcetype=default

Parameters
assembler
All source files following the option are compiled as if they are assembler language source files.

assembler-with-cpp
All source files following the option are compiled as if they are assembler language source files that need preprocessing.

c All source files following the option are compiled as if they are C language source files.

c++
All source files following the option are compiled as if they are C++ language source files. This suboption is equivalent to the **-+** option.

default
The programming language of a source file is implied by its file name suffix.

Usage
If you do not use this option, files must have a suffix of .c to be compiled as C files, and .C (uppercase C), .cc, .cp, .cpp, .cxx, or .c++ to be compiled as C++ files.

This option applies whether the file system is case-sensitive or not. That is, even in a case-insensitive file system, where `file.c` and `file.C` refer to the same physical file, the compiler still recognizes the case difference of the file name argument on the command line and determines the source type accordingly.

Note that the option only affects files that are specified on the command line *following* the option, but not those that precede the option. Therefore, in the following example:

```
invocation goodbye.C -qsourcetype=c hello.C
```

`hello.C` is compiled as a C source file, but `goodbye.C` is compiled as a C++ file.

The **-qsourcetype** option should not be used together with the **-+** option.

Predefined macros
None.

Examples
To treat the source file `hello.C` as being a C language source file, enter:

```
invocation -qsourcetype=c hello.C
```

Related information
- "-+ (plus sign) (C++ only)" on page 41

-qspill

Category
Compiler customization

Pragma equivalent
#pragma options [no]spill

Purpose
Specifies the size (in bytes) of the register spill space, the internal program storage areas used by the optimizer for register spills to storage.

Syntax

Defaults
-qspill=512

Parameters
size
An integer representing the number of bytes for the register allocation spill area.

Usage
If your program is very complex, or if there are too many computations to hold in registers at one time and your program needs temporary storage, you might need to increase this area. Do not enlarge the spill area unless the compiler issues a message requesting a larger spill area. In case of a conflict, the largest spill area specified is used.

Predefined macros
None.

Examples
If you received a warning message when compiling `myprogram.c` and want to compile it specifying a spill area of 900 entries, enter:

```
invocation myprogram.c -qspill=900
```

-qsrcmsg (C only)

Category
Listings, messages, and compiler information

Pragma equivalent
#pragma options [no]srcmsg

Purpose
Adds the corresponding source code lines to diagnostic messages generated by the compiler.

When **nosrcmsg** is in effect, the error message simply shows the file, line and column where the error occurred. When **srcmsg** is in effect, the compiler reconstructs the source line or partial source line to which the diagnostic message refers and displays it before the diagnostic message. A pointer to the column position of the error may also be displayed.

Syntax

Defaults
-qnosrcmsg

Usage
When **srcmsg** is in effect, the reconstructed source line represents the line as it appears after macro expansion. At times, the line may be only partially

reconstructed. The characters "...." at the start or end of the displayed line indicate that some of the source line has not been displayed.

Use **-qnosrcmsg** to display concise messages that can be parsed.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the source line is displayed along with the diagnostic message when an error occurs, enter:

```
invocation myprogram.c -qsrcmsg
```

-qstaticinline (C++ only)

Category
Language element control

Pragma equivalent
None.

Purpose
Controls whether inline functions are treated as having `static` or `extern` linkage.

When **-qnostaticinline** is in effect, the compiler treats inline functions as `extern`: only one function body is generated for a function marked with the `inline` function specifier, regardless of how many definitions of the same function appear in different source files. When **-qstaticinline** is in effect, the compiler treats inline functions as having `static` linkage: a separate function body is generated for each definition in a different source file of the same function marked with the `inline` function specifier.

Syntax

Defaults
-qnostaticinline

Usage
When **-qnostaticinline** is in effect, any redundant functions definitions for which no bodies are generated are discarded by default; you can use the **-qkeepinlines** option to change this behavior.

Predefined macros
None.

Examples
Using the **-qstaticinline** option causes function `f` in the following declaration to be treated as static, even though it is not explicitly declared as such. A separate function body is created for each definition of the function. Note that this can lead to a substantial increase in code size.

```
inline void f() {/*...*/};
```

Related information
- "Linkage of inline functions" in the *XL C/C++ Language Reference*
- "-qkeepinlines (C++ only)" on page 128

-qstaticlink

Category
Linking

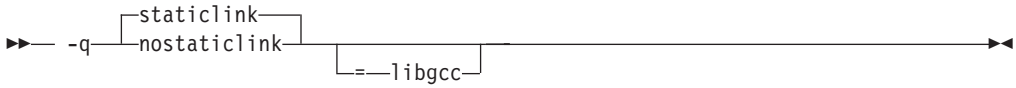
Pragma equivalent
None.

Purpose
Controls how shared and non-shared runtime libraries are linked into an application.

When **-qstaticlink** is in effect, the compiler links only static libraries with the object file named in the invocation. When **-qnostaticlink** is in effect, the compiler links shared libraries with the object file named in the invocation.

This option provides the ability to specify linking rules that are equivalent to those implied by the GNU options **-static**, **-static-libgcc**, and **-shared-libgcc**, used singly and in combination.

Syntax



Defaults
-qstaticlink

Parameters
libgcc
When specified together with **nostaticlink**, the compiler links to the shared version of libgcc. When specified together with **staticlink**, the compiler links to the static version of libgcc.

Usage
The following table shows the equivalent GNU and XL C/C++ options for specifying linkage of shared and non-shared libraries.

Table 21. Option mappings: control of the GNU linker

GNU option	Meaning	XL C/C++ option
-shared	Build a shared object.	-qmkshrobj
-static	Build a static object and prevent linking with shared libraries. Every library linked to must be a static library.	-qstaticlink
-shared-libgcc	Link with the shared version of libgcc.	-qnostaticlink=libgcc
-static-libgcc	Link with the static version of libgcc.	-qstaticlink=libgcc

WARNING: Any use of third-party libraries or products is subject to the provisions in their respective licenses. Using the **-qstaticlink** option can have significant legal consequences for the programs you compile. IBM strongly recommends that you seek legal advice before using this option.

Predefined macros
None.

-qstatsym

Category
Object code control

Pragma equivalent
None.

Purpose
Adds user-defined, nonexternal names that have a persistent storage class, such as initialized and uninitialized static variables, to the symbol table of the object file.

Syntax

Defaults
-qnostatsym: Static variables are not added to the symbol table. However, static functions are added to the symbol table.

Predefined macros
None.

Examples
To compile `myprogram.c` so that static symbols are added to the symbol table, enter:

```
invocation myprogram.c -qstatsym
```

-qstdinc

Category
Input control

Pragma equivalent
#pragma options [no]stdinc

Purpose
Specifies whether the standard include directories are included in the search paths for system and user header files.

When **-qstdinc** is in effect, the compiler searches the following directories for header files:

- The directory specified in the configuration file for the XL C and C++ header files (this is normally /opt/ibmcmp/xlc/cbe/9.0/include/) or by the **-qc_stdinc** and **-qcpp_stdinc** options
- The directory specified in the configuration file for the system header files or by the **-qgcc_c_stdinc** and **-qgcc_cpp_stdinc** options

When **-qnostdinc** is in effect, these directories are excluded from the search paths. The only directories to be searched are:

- directories in which source files containing `#include "filename"` directives are located
- directories specified by the **-I** option
- directories specified by the **-qinclude** option

Syntax

Defaults

-qstdinc

Usage

The search order of header files is described in "Directory search sequence for include files" on page 12.

This option only affects search paths for header files included with a relative name; if a full (absolute) path name is specified, this option has no effect on that path name.

The last valid pragma directive remains in effect until replaced by a subsequent pragma.

Predefined macros

None.

Examples

To compile `myprogram.c` so that *only* the directory `/tmp/myfiles` (in addition to the directory containing `myprogram.c`) is searched for the file included with the `#include "myinc.h"` directive, enter:

```
invocation myprogram.c -qnostdinc -I/tmp/myfiles
```

Related information

- "-qc_stdinc (C only)" on page 67
- "-qcpp_stdinc (C++ only)" on page 68
- "-qgcc_c_stdinc (C only)" on page 97
- "-qgcc_cpp_stdinc (C++ only)" on page 98
- "-I" on page 105
- "Directory search sequence for include files" on page 12

-qstdmain (SPU only)

Category

Linking

Pragma equivalent

None.

Purpose

Links your SPU program with the startup routines required to use C99-style main function arguments.

Syntax

Defaults
By default, the output object is linked with the runtime libraries and startup routines that use an SPU style main function argument list.

Usage
This option is only valid with the SPU invocation commands.

Predefined macros
None.

-qstrict

Category
Optimization and tuning

Pragma equivalent
#pragma options [no]strict

Purpose
Ensures that optimizations done by default at optimization levels **-O3** and higher, and, optionally at **-O2**, do not alter the semantics of a program.

Syntax

Defaults
- **-qstrict**
- **-qnostrict** when **-O3** or higher optimization level is in effect

Usage
-qstrict disables the following optimizations:
- Performing code motion and scheduling on computations such as loads and floating-point computations that may trigger an exception.
- Relaxing conformance to IEEE rules.
- Reassociating floating-point expressions.

This option is only valid with **-O2** or higher optimization levels.

-qstrict sets **-qfloat=norsqrt**. **-qnostrict** sets **-qfloat=rsqrt**. To override these settings, specify the appropriate **-qfloat** suboptions after **-q[no]strict** on the command line.

Predefined macros
None.

Examples
To compile `myprogram.c` so that the aggressive optimizations of **-O3** are turned off, and division by the result of a square root is replaced by multiplying by the reciprocal (**-qfloat=rsqrt**), enter:

```
invocation myprogram.c -O3 -qstrict -qfloat=rsqrt
```

Related information
- "-qfloat" on page 87
- "-O, -qoptimize" on page 159

-qstrict_induction

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Prevents the compiler from performing induction (loop counter) variable optimizations. These optimizations may be unsafe (may alter the semantics of your program) when there are integer overflow operations involving the induction variables.

Syntax

Defaults
- **-qstrict_induction**
- **-qnostrict_induction** when **-O2** or higher optimization level is in effect

Usage
When using **-O2** or higher optimization, you can specify **-qstrict_induction** to prevent optimizations that change the result of a program if truncation or sign extension of a loop induction variable should occur as a result of variable overflow or wrap-around. However, use of **-qstrict_induction** is generally not recommended because it can cause considerable performance degradation.

Predefined macros
None.

Related information
- "-O, -qoptimize" on page 159

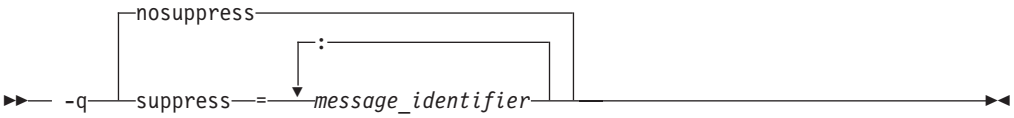
-qsuppress

Category
Listings, messages, and compiler information

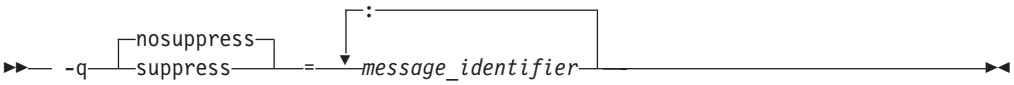
Pragma equivalent
#pragma report (C++ only)

Purpose
Prevents specific informational or warning messages from being displayed or added to the listing file, if one is generated.

Syntax
-qsuppress syntax — C



-qsuppress syntax — C++



Defaults
-qnosuppress: All informational and warning messages are reported, unless set otherwise with the **-qflag** option.

Parameters
message_identifier
Represents a message identifier. The message identifier must be in the following format:

```
15dd-number
```

where:

dd Is the two-digit code representing the compiler component that produces the message. See "Compiler message format" on page 15 for descriptions of these.

number
Is the message number.

Usage
You can only suppress information (I) and warning (W) messages. You cannot suppress other types of messages, such as (S) and (U) level messages. Note that informational and warning messages that supply additional information to a severe error cannot be disabled by this option.

To suppress all informational and warning messages, you can use the **-w** option.

To suppress IPA messages, enter **-qsuppress** before **-qipa** on the command line.

The **-qnosuppress** compiler option cancels previous settings of **-qsuppress**.

Predefined macros
None.

Examples
If your program normally results in the following output:

```
"myprogram.c", line 1.1:1506-224 (I) Incorrect #pragma ignored
```

you can suppress the message by compiling with:

```
invocation myprogram.c -qsuppress=1506-224
```

Related information

- "-qflag" on page 85

-qsymtab (C only)

Category

Error checking and debugging

Pragma equivalent

None.

Purpose

Determines the information that appears in the symbol table.

Syntax

Defaults

Static variables and unreferenced `typedef`, structure, union, and enumeration declarations are not included in the symbol table of the object file.

Parameters

unref

When used with the **-g** option, specifies that debugging information is included for unreferenced `typedef` declarations, `struct`, `union`, and `enum` type definitions in the symbol table of the object file. This suboption is equivalent to **-qdbxextra**.

Using **-qsymtab=unref** may make your object and executable files larger.

static

Adds user-defined, nonexternal names that have a persistent storage class, such as initialized and uninitialized static variables, to the symbol table of the object file. This suboption is equivalent to **-qstatsym**.

Predefined macros

None.

Examples

To compile `myprogram.c` so that static symbols are added to the symbol table, enter:

```
invocation myprogram.c -qsymtab=static
```

To compile `myprogram.c` so that unreferenced `typedef`, structure, union, and enumeration declarations are included in the symbol table for use with a debugger, enter:

```
invocation myprogram.c -g -qsymtab=unref
```

Related information

- "-g" on page 97
- "-qdbxextra (C only)" on page 71
- "-qstatsym" on page 196

-qsyntaxonly (C only)

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Performs syntax checking without generating an object file.

Syntax

Defaults
By default, source files are compiled and linked to generate an executable file.

Usage
The **-P**, **-E**, and **-C** options override the **-qsyntaxonly** option, which in turn overrides the **-c** and **-o** options.

The **-qsyntaxonly** option suppresses only the generation of an object file. All other files, such as listing files, are still produced if their corresponding options are set.

Predefined macros
None.

Examples
To check the syntax of `myprogram.c` without generating an object file, enter:

```
invocation myprogram.c -qsyntaxonly
```

Related information
- "-C, -C!" on page 56
- "-c" on page 56
- "-E" on page 75
- "-o" on page 158
- "-P" on page 164

-t

Category
Compiler customization

Pragma equivalent
None.

Purpose
Applies the prefix specified by the **-B** option to the designated components.

Syntax

Defaults

The default paths for all of the compiler executables are defined in the compiler configuration file.

Parameters

The following table shows the correspondence between **-t** parameters and the component executable names:

Parameter	Description	Executable name
a	Assembler	ppu-as or spu-as
b	Low-level optimizer	xlCcode
c	Compiler front end	xlcentry, xlCentry
C++ C	C++ compiler front end	xlCentry
d	Disassembler	dis
I	High-level optimizer, compile step	ipa
L	High-level optimizer, link step	ipa
l	Linker	ppu-ld or spu-ld
p	Preprocessor	n/a

Usage

This option is intended to be used together with the **-B***prefix* option. If **-B** is specified without the *prefix*, the default prefix is /lib/o. If **-B** is not specified at all, the prefix of the standard program names is /lib/n.

Note that using the **p** suboption causes the source code to be preprocessed separately before compilation, which can change the way a program is compiled.

Predefined macros

None.

Examples

To compile `myprogram.c` so that the name `/u/newones/compilers/` is prefixed to the compiler and assembler program names, enter:

```
invocation myprogram.c -B/u/newones/compilers/ -tca
```

Related information

- "-B" on page 53

-qtabsize

Category
Language element control

Pragma equivalent
#pragma options tabsize

Purpose
Sets the default tab length, for the purposes of reporting the column number in error messages.

Syntax

Defaults
-qtabsize=8

Parameters
number
The number of character spaces representing a tab in your source program.

Usage
This option only affects error messages that specify the column number at which an error occurred.

Predefined macros
None.

Examples
To compile `myprogram.c` so the compiler considers tabs as having a width of one character, enter:

```
invocation myprogram.c -qtabsize=1
```

In this case, you can consider one character position (where each character and each tab equals one position, regardless of tab length) as being equivalent to one character column.

-qtbtable (PPU only)

Category
Object code control

Pragma equivalent
#pragma options tbtable

Purpose
Controls the amount of debugging traceback information that is included in the object files.

Many performance measurement tools require a full traceback table to properly analyze optimized code. If a traceback table is generated, it is placed in the text

segment at the end of the object code, and contains information about each function, including the type of function, as well as stack frame and register information.

Syntax

Defaults

- **-qtbtable=full**
- **-qtbtable=small** when **-O** or higher optimization is in effect

Parameters

full
A full traceback table is generated, complete with name and parameter information.

none
No traceback table is generated. The stack frame cannot be unwound so exception handling is disabled.

small
The traceback table generated has no name or parameter information, but otherwise has full traceback capability. This suboption reduces the size of the program code.

Usage

This option applies only to 64-bit compilations, and is ignored if specified for a 32-bit compilation.

The **#pragma** options directive must be specified before the first statement in the compilation unit.

Predefined macros

None.

Related information

- "-g" on page 97

-qtempinc (C++ only)

Category

Template control

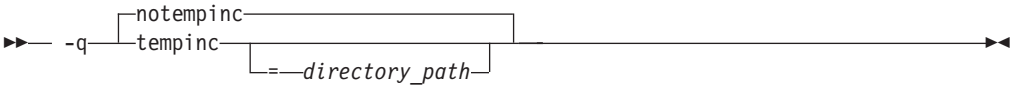
Pragma equivalent

None.

Purpose

Generates separate template include files for template functions and class declarations, and places these files in a directory which can be optionally specified.

Syntax



Defaults
-qnotempinc

Parameters
directory_path
The directory in which the generated template include files are to be placed.

Usage
The **-qtempinc** and **-qtemplateregistry** compiler options are mutually exclusive. Specifying **-qtempinc** implies **-qnotemplateregistry**. Similarly, specifying **-qtemplateregistry** implies **-qnotempinc**. However, specifying **-qnotempinc** does not imply **-qtemplateregistry**.

Specifying either **-qtempinc** or **-qtemplateregistry** implies **-qtmplinst=auto**.

Predefined macros
__TEMPINC__ is predefined to 1 when **-qtempinc** is in effect; otherwise, it is not defined.

Examples
To compile the file `myprogram.C` and place the generated include files for the template functions in the `/tmp/mytemplates` directory, enter:

```
ppuxlc++ myprogram.C -qtempinc=/tmp/mytemplates
```

Related information
- "#pragma implementation (C++ only)" on page 248
- "-qtmplinst (C++ only)" on page 212
- "-qtemplateregistry (C++ only)" on page 208
- "-qtemplaterecompile (C++ only)" on page 207
- "Using C++ templates" in the *XL C/C++ Programming Guide*.

-qtemplatedepth (C++ only)

Category
Template control

Pragma equivalent
None.

Purpose
Specifies the maximum number of recursively instantiated template specializations that will be processed by the compiler.

Syntax

Defaults
-qtemplatedepth=300

Parameters
number
The maximum number of recursive template instantiations. The number can be a value between 1 and INT_MAX. If your code attempts to recursively instantiate more templates than *number*, compilation halts and an error message is issued. If you specify an invalid value, the default value of 300 is used.

Usage
Note that setting this option to a high value can potentially cause an out-of-memory error due to the complexity and amount of code generated.

Predefined macros
None.

Examples
To allow the following code in `myprogram.cpp` to be compiled successfully:

```
template <int n> void foo() {
  foo<n-1>();
}

template <> void foo<0>() {}

   int main() {
   foo<400>();
}
```

Enter:

```
ppuxlc++ myprogram.cpp -qtemplatedepth=400
```

Related information
- ″Using C++ templates″ in the *XL C/C++ Programming Guide*.

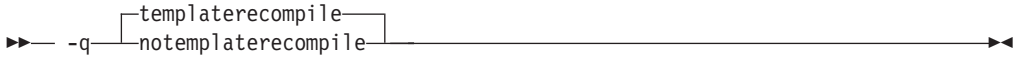
-qtemplaterecompile (C++ only)

Category
Template control

Pragma equivalent
None.

Purpose
Helps manage dependencies between compilation units that have been compiled using the **-qtemplateregistry** compiler option.

Syntax



Defaults
-qtemplaterecompile

Usage
If a source file that has been compiled previously is compiled again, the **-qtemplaterecompile** option consults the template registry to determine whether changes to this source file require the recompile of other compilation units. This can occur when the source file has changed in such a way that it no longer references a given instantiation and the corresponding object file previously contained the instantiation. If so, affected compilation units will be recompiled automatically.

The **-qtemplaterecompile** option requires that object files generated by the compiler remain in the subdirectory to which they were originally written. If your automated build process moves object files from their original subdirectory, use the **-qnotemplaterecompile** option whenever **-qtemplateregistry** is enabled.

Predefined macros
None.

Related information
- "-qtmplinst (C++ only)" on page 212
- "-qtempinc (C++ only)" on page 205
- "-qtemplateregistry (C++ only)"
- "Using C++ templates" in the *XL C/C++ Programming Guide*.

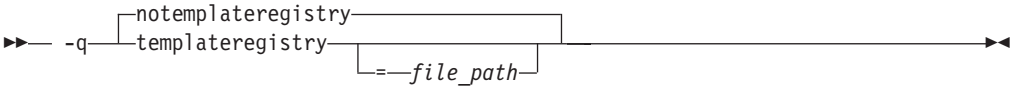
-qtemplateregistry (C++ only)

Category
Template control

Pragma equivalent
None.

Purpose
Maintains records of all templates as they are encountered in the source and ensures that only one instantiation of each template is made.

The first time that the compiler encounters a reference to a template instantiation, that instantiation is generated and the related object code is placed in the current object file. Any further references to identical instantiations of the same template in different compilation units are recorded but the redundant instantiations are not generated. No special file organization is required to use the **-qtemplateregistry** option.

Syntax


Defaults
-qnotemplateregistry

Parameters
file_path
The path for the file that will contain the template instantiation information. If

you do not specify a location the compiler saves all template registry information to the file `templateregistry` stored in the current working directory.

Usage

Template registry files must not be shared between different programs. If there are two or more programs whose source is in the same directory, relying on the default template registry file stored in the current working directory may lead to incorrect results.

The **-qtempinc** and **-qtemplateregistry** compiler options are mutually exclusive. Specifying **-qtempinc** implies **-qnotemplateregistry**. Similarly, specifying **-qtemplateregistry** implies **-qnotempinc**. However, specifying **-qnotemplateregistry** does not imply **-qtempinc**.

Specifying either **-qtempinc** or **-qtemplateregistry** implies **-qtmplinst=auto**.

Predefined macros

None.

Examples

To compile the file `myprogram.C` and place the template registry information into the `/tmp/mytemplateregistry` file, enter:

```
ppuxlc++ myprogram.C -qtemplateregistry=/tmp/mytemplateregistry
```

Related information

- "-qtmplinst (C++ only)" on page 212
- "-qtempinc (C++ only)" on page 205
- "-qtemplaterecompile (C++ only)" on page 207
- "Using C++ templates" in the *XL C/C++ Programming Guide*.

-qtempmax (C++ only)

Category

Template control

Pragma equivalent

None.

Purpose

Specifies the maximum number of template include files to be generated by the **-qtempinc** option for each header file.

Syntax

Defaults

-qtempmax=1

Parameters

number

The maximum number of template include files. The number can be a value between 1 and 99 999.

Usage
This option should be used when the size of files generated by the **-qtempinc** option become very large and take a significant amount of time to recompile when a new instance is created.

Instantiations are spread among the template include files.

Predefined macros
None.

Related information
- "-qtempinc (C++ only)" on page 205
- "Using C++ templates" in the *XL C/C++ Programming Guide*.

-qthreaded (PPU only)

Category
Object code control

Pragma equivalent
None.

Purpose
Indicates to the compiler whether it must generate threadsafe code.

Always use this option when compiling or linking multithreaded applications. This option does not make code threadsafe, but it will ensure that code already threadsafe will remain so after compilation and linking. It also ensures that all optimizations are threadsafe.

Syntax


Defaults
- **-qnothreaded** for all invocation commands except those with the **_r** suffix
- **-qthreaded** for all **_r**-suffixed invocation commands

Usage
This option applies to both compile and linker operations.

To maintain thread safety, a file compiled with the **-qthreaded** option, whether explicitly by option selection or implicitly by choice of **_r** compiler invocation mode, must also be linked with the **-qthreaded** option.

Predefined macros
None.

-qtls (PPU only)

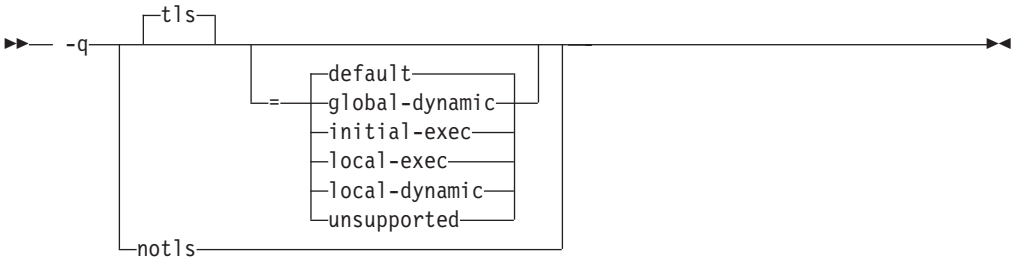
Category
Object code control

Pragma equivalent
None.

Purpose
Enables recognition of the __thread storage class specifier, which designates variables that are to be allocated thread-local storage; and specifies the thread-local storage model to be used.

When this option is in effect, any variables marked with the __thread storage class specifier are treated as local to each thread in a multi-threaded application. At run time, a copy of the variable is created for each thread that accesses it, and destroyed when the thread terminates. Like other high-level constructs that you can use to parallelize your applications, thread-local storage prevents race conditions to global data, without the need for low-level synchronization of threads.

Suboptions allow you to specify thread-local storage models, which provide better performance but are more restrictive in their applicability.

Syntax


Defaults
-qtls=default

Parameters
unsupported
The __thread keyword is not recognized and thread-local storage is not enabled. This suboption is equivalent to **-qnotls**.

global-dynamic
This model is the most general, and can be used for all thread-local variables.

initial-exec
This model provides better performance than the global-dynamic or local-dynamic models, and can be used for thread-local variables defined in dynamically-loaded modules, provided that those modules are loaded at the same time as the executable. That is, it can only be used when all thread-local variables are defined in modules that are not loaded through dlopen.

local-dynamic
This model provides better performance than the global-dynamic model, and can be used for thread-local variables defined in dynamically-loaded modules. However, it can only be used when all references to thread-local variables are contained in the same module in which the variables are defined.

local-exec
This model provides the best performance of all of the models, but can only be used when all thread-local variables are defined and referenced by the main executable.

default
Uses the appropriate model depending on the setting of the **-qpic** compiler option, which determines whether position-independent code is generated or not. When **-qpic** is in effect, this suboption results in **-qtls=global-dynamic**. When **-qnopic** is in effect, this suboption results in **-qtls=initial-exec** (**-qpic** is in effect by default in 64-bit mode, and cannot be disabled).

Specifying **-qtls** with no suboption is equivalent to **-qtls=default**.

Predefined macros
None.

Related information
- "-qpic" on page 170
- "The __thread storage class specifier" in the *XL C/C++ Language Reference*

-qtmplinst (C++ only)

Category
Template control

Pragma equivalent
None.

Purpose
Manages the implicit instantiation of templates.

Syntax


Defaults
-qtmplinst=auto

Parameters
always
Instructs the compiler to always perform implicit instantiation. If specified, **-qtempinc** and **-qtemplateregistry** compiler options are ignored.

auto
Manages the implicit instantiations according to the **-qtempinc** and **-qtemplateregistry** options. If both **-qtempinc** and **-qtemplateregistry** are disabled, implicit instantiation will always be performed; otherwise if one of the options is enabled, the compiler manages the implicit instantiation according to that option.

noinline
Instructs the compiler to not perform any implicit instantiations. If specified, the **-qtempinc** and **-qtemplateregistry** compiler options are ignored.

none
Instructs the compiler to instantiate only inline functions. No other implicit instantiation is performed. If specified, **-qtempinc** and **-qtemplateregistry** compiler options are ignored.

Usage
You can also use **#pragma do_not_instantiate** to suppress implicit instantiation of selected template classes. See "#pragma do_not_instantiate (C++ only)" on page 242.

Predefined macros
None.

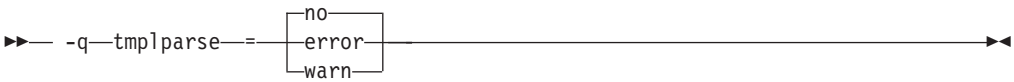
Related information
- "-qtemplateregistry (C++ only)" on page 208
- "-qtempinc (C++ only)" on page 205
- "#pragma do_not_instantiate (C++ only)" on page 242
- "Explicit instantiation in the *XL C/C++ Language Reference*

-qtmplparse (C++ only)

Category
Template control

Pragma equivalent
None.

Purpose
Controls whether parsing and semantic checking are applied to template definitions.

Syntax


Defaults
-qtmplparse=no

Parameters
error
Treats problems in template definitions as errors, even if the template is not instantiated.

no Do not parse template definitions.

warn
Parses template definitions and issues warning messages for semantic errors.

Usage
This option applies to template definitions, not their instantiations. Regardless of the setting of this option, error messages are produced for problems that appear outside definitions. For example, messages are always produced for errors found during the parsing or semantic checking of constructs such as the following:

- return type of a function template

- parameter list of a function template

Predefined macros
None.

Related information
- "Using C++ templates" in the *XL C/C++ Programming Guide*.

-qtocdata
See “-qdataimported, -qdatalocal, -qtocdata (PPU only)” on page 70.

-qtrigraph

Category
Language element control

Pragma equivalent
None.

Purpose
Enables the recognition of trigraph key combinations to represent characters not found on some keyboards.

Syntax

Defaults
-qtrigraph

Usage
A trigraph is a combination of three-key character combinations that let you produce a character that is not available on all keyboards. For details, see "Trigraph sequences" in the *XL C/C++ Language Reference*.

C++ To override the default **-qtrigraph** setting, you must specify **-qnotrigraph** *after* the **-qlanglvl** option on the command line.

Predefined macros
None.

Related information
- "Trigraph sequences" in the *XL C/C++ Language Reference*
- “-qdigraph” on page 72
- “-qlanglvl” on page 132

-qtune

Category
Optimization and tuning

Pragma equivalent
#pragma options tune

Purpose

Tunes instruction selection, scheduling, and other architecture-dependent performance enhancements to run best on a specific hardware architecture.

Syntax

-qtune syntax

Defaults

- **-qtune=cellppu** for compilation targeting the PPU.
- **-qtune=cellspu** for compilation targeting the SPU.

Parameters

auto (SPU only)
Optimizations are tuned for the platform on which the application is compiled.

cellppu (PPU only)
Optimizations are tuned for the PPU.

cellspu (SPU only)
Optimizations are tuned for the SPU.

edp (SPU only)
Optimizations are tuned for the enhanced CBEA-compliant processor with a double precision SPU.

Predefined macros

None.

Related information

- "-qarch" on page 49
- "-q32, -q64 (PPU only)" on page 42

-U

Category

Language element control

Pragma equivalent

None.

Purpose

Undefines a macro defined by the compiler or by the **-D** compiler option.

Syntax

Defaults

Many macros are predefined by the compiler; see Chapter 5, "Compiler predefined macros," on page 273 for those that can be undefined (that is, are not *protected*).

The compiler configuration file also uses the **-D** option to predefine several macro names for specific invocation commands; for details, see the configuration file for your system.

Parameters

name
The macro you want to undefine.

Usage

The **-U** option is *not* equivalent to the `#undef` preprocessor directive. It *cannot* undefine names defined in the source by the `#define` preprocessor directive. It can only undefine names defined by the compiler or by the **-D** option.

The **-U***name* option has a higher precedence than the **-D***name* option.

Predefined macros

None.

Examples

Assume that your operating system defines the name `__unix`, but you do not want your compilation to enter code segments conditional on that name being defined, compile `myprogram.c` so that the definition of the name `__unix` is nullified by entering:

```
invocation myprogram.c  -U__unix
```

Related information

- "-D" on page 69

-qunroll

Category

Optimization and tuning

Pragma equivalent

#pragma options [no]unroll, #pragma unroll

Purpose

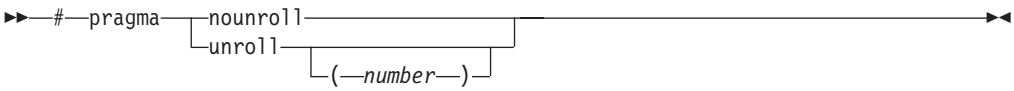
Controls loop unrolling, for improved performance.

When **unroll** is in effect, the optimizer determines and applies the best unrolling factor for each loop; in some cases, the loop control may be modified to avoid unnecessary branching. The compiler remains the final arbiter of whether the loop is actually unrolled. You can use the **#pragma unroll** directive to gain more control over unrolling.

Syntax

Option syntax

Pragma syntax



Defaults

-qunroll=auto

Parameters

auto (option only)
Instructs the compiler to perform basic loop unrolling.

yes (option only)
Instructs the compiler to search for more opportunities for loop unrolling than that performed with **auto**. In general, this suboption has more chances to increase compile time or program size than **auto** processing, but it may also improve your application's performance.

no (option only)
Instructs the compiler to not unroll loops.

number **(pragma only)**
Forces *number* − 1 replications of the designated loop body or full unrolling of the loop, whichever occurs first. The value of *number* is unbounded and must be a positive integer. Specifying **#pragma unroll(1)** effectively disables loop unrolling, and is equivalent to specifying **#pragma nounroll**. If *number* is not specified and if **-qhot** or **-O4** or higher is specified, the optimizer determines an appropriate unrolling factor for each nested loop.

Specifying **-qunroll** without any suboptions is equivalent to **-qunroll=yes**.

-qnounroll is equivalent to **-qunroll=no**.

Usage

The pragma overrides the **-q[no]unroll** compiler option setting for a designated loop. However, even if **#pragma unroll** is specified for a given loop, the compiler remains the final arbiter of whether the loop is actually unrolled.

Only one pragma may be specified on a loop. The pragma must appear immediately before the loop or the **#pragma block_loop** directive to have effect.

The pragma affects only the loop that follows it. An inner nested loop requires a **#pragma unroll** directive to precede it if the desired loop unrolling strategy is different from that of the prevailing **-q[no]unroll** option.

The **#pragma unroll** and **#pragma nounroll** directives can only be used on `for` loops or **#pragma block_loop** directives. They cannot be applied to `do while` and `while` loops.

The loop structure must meet the following conditions:

- There must be only one loop counter variable, one increment point for that variable, and one termination variable. These cannot be altered at any point in the loop nest.
- Loops cannot have multiple entry and exit points. The loop termination must be the only means to exit the loop.

- Dependencies in the loop must not be ″backwards-looking″. For example, a statement such as `A[i][j] = A[i -1][j + 1] + 4)` must not appear within the loop.

Predefined macros
None.

Examples
In the following example, the **#pragma unroll(3)** directive on the first `for` loop requires the compiler to replicate the body of the loop three times. The **#pragma unroll** on the second `for` loop allows the compiler to decide whether to perform unrolling.

```
#pragma unroll(3)
for( i=0;i < n; i++)
{
      a[i] = b[i] * c[i];
}

#pragma unroll
for( j=0;j < n; j++)
{
      a[j] = b[j] * c[j];

}
```

In this example, the first **#pragma unroll(3)** directive results in:

```
i=0;
if (i>n-2) goto remainder;
for (; i<n-2; i+=3) {
  a[i]=b[i] * c[i];
  a[i+1]=b[i+1] * c[i+1];
  a[i+2]=b[i+2] * c[i+2];
}
if (i<n) {
  remainder:
  for (; i<n; i++) {
    a[i]=b[i] * c[i];
  }
}
```

Related information
- “#pragma block_loop” on page 236
- “#pragma loopid” on page 250
- “#pragma stream_unroll” on page 266
- “#pragma unrollandfuse” on page 268

-qunwind

Category
Optimization and tuning

Pragma equivalent
None.

Purpose
Specifies whether the call stack can be unwound by code looking through the saved registers on the stack.

Specifying **-qnounwind** asserts to the compiler that the stack will not be unwound, and can improve optimization of non-volatile register saves and restores.

Syntax

Defaults
-qunwind

Usage
The `setjmp` and `longjmp` families of library functions are safe to use with **-qnounwind**.

C++ Specifying **-qnounwind** also implies **-qnoeh**.

Predefined macros
None.

Related information
- "-qeh (C++ only) (PPU only)" on page 76

-qupconv (C only)

Category
Portability and migration

Pragma equivalent
#pragma options [no]upconv

Purpose
Specifies whether the `unsigned` specification is preserved when integral promotions are performed.

When **noupconv** is in effect, any `unsigned` type smaller than an `int` is converted to `int` during integral promotions. When **upconv** is in effect, these types are converted to `unsigned int` during integral promotions.

Syntax

Defaults
- **-qnoupconv** for all language levels except **classic** or **extended**
- **-qupconv** when the **classic** or **extended** language levels are in effect

Usage
Sign preservation is provided for compatibility with older dialects of C. The ANSI C standard requires value preservation as opposed to sign preservation.

Predefined macros
None.

Examples
To compile `myprogram.c` so that all `unsigned` types smaller than `int` are converted to `unsigned int`, enter:

```
invocation myprogram.c -qupconv
```

The following short listing demonstrates the effect of **-qupconv**:

```
#include <stdio.h>
int main(void) {
  unsigned char zero = 0;
  if (-1 <zero)
    printf("Value-preserving rules in effect\n");
  else
    printf("Unsignedness-preserving rules in effect\n");
  return 0;
}
```

Related information
- "Integral and floating-point promotions" in the *XL C/C++ Language Reference*
- "-qlanglvl" on page 132

-qutf

Category
Language element control

Pragma equivalent
None.

Purpose
Enables recognition of UTF literal syntax.

Syntax

Defaults
- C -qnoutf
- C++ -qutf

Usage
The compiler uses **iconv** to convert the source file to Unicode. If the source file cannot be converted, the compiler will ignore the **-qutf** option and issue a warning.

Predefined macros
None.

Related information
- "UTF literals"in the *XL C/C++ Language Reference*

-v, -V

Category
Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Reports the progress of compilation, by naming the programs being invoked and the options being specified to each program.

When the **-v** option is in effect, information is displayed in a comma-separated list. When the **-V** option is in effect, information is displayed in a space-separated list.

Syntax

Defaults
The compiler does not display the progress of the compilation.

Usage
The **-v** and **-V** options are overridden by the **-#** option.

Predefined macros
None.

Examples
To compile `myprogram.c` so you can watch the progress of the compilation and see messages that describe the progress of the compilation, the programs being invoked, and the options being specified, enter:

```
invocation myprogram.c -v
```

Related information
- "-# (pound sign)" on page 41

-qversion

Category
Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Displays the version and release of the compiler being invoked.

Syntax

Defaults
-qnoversion

Parameters

verbose
Additionally displays information about the version, release, and level of each compiler component installed.

Usage

When you specify **-qversion**, the compiler displays the version information and exits; compilation is stopped

-qversion specified without the **verbose** suboption shows compiler information in the format:

```
product_name
Version: VV.RR.MMMM.LLLL
```

where:

V Represents the version.
R Represents the release.
M Represents the modification.
L Represents the level.

Example:

```
IBM XL C/C++ for Multicore Acceleration for Linux, V9.0
Version: 09.00.0000.0001
```

-qversion=verbose shows component information in the following format:

```
component_name Version: VV.RR(product_name) Level: component_level
```

where:

component_name
Specifies an installed component, such as the low-level optimizer.
component_level
Represents the level of the installed component.

Example:

```
IBM XL C/C++ for Multicore Acceleration for Linux, V9.0
Version: 09.00.0000.0001
Driver Version: 09.00(C/C++) Level: 060414
C Front End Version: 09.00(C/C++) Level: 060419
C++ Front End Version: 09.00(C/C++) Level: 060420
High Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran) Level: 060411
Low Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran) Level: 060418
```

If you want to save this information to the output object file, you can do so with the **-qsaveopt -c** options.

Predefined macros

None.

Related information

- "-qsaveopt" on page 187

-qvrsave (PPU only)

Category

Object code control

Pragma equivalent
#pragma altivec_vrsave

Purpose
Enables code in function prologs and epilogs to maintain the VRSAVE register.

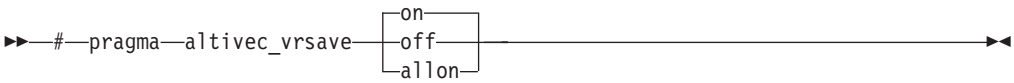
Each bit in the VRSAVE register corresponds to a vector register and, if set to 1, indicates that the corresponding vector register contains data to be saved when a context switch occurs. Use **-qvrsave** to indicate to the compiler that functions in the compilation unit include code needed to maintain the VRSAVE register. Use **-qnovrsave** to indicate to the compiler that functions in the compilation unit do not include code needed to maintain the VRSAVE register.

You can use the pragma to override the current setting of the compiler option for individual functions within your program source.

Syntax

Option syntax

Pragma syntax



Defaults
vrsave: The VRSAVE register is always maintained.

Parameters
on (pragma only)
Function prologs and epilogs include code to maintain the VRSAVE register.

off (pragma only)
Function prologs and epilogs do not include code to maintain the VRSAVE register.

allon (pragma only)
The function containing pragma sets all bits of the VRSAVE register to 1, indicating that all vectors are used and should be saved if a context switch occurs.

Usage
This option and pragma are only supported when **-qaltivec** is in effect.

The pragma can be used only within a function, and its effects apply only to the function in which it appears. Specifying this pragma with different settings within the same function will create an error condition.

Predefined macros
None.

Related information
- "-qaltivec" on page 49

-w

Category
Listings, messages, and compiler information

Pragma equivalent
None.

Purpose
Suppresses informational, language-level and warning messages.

C This option is equivalent to specifying **-qflag=e : e**. C++ This option is equivalent to specifying **-qflag=s : s**.

Syntax

Defaults
All informational and warning messages are reported.

Usage
Informational and warning messages that supply additional information to a severe error are not disabled by this option.

Predefined macros
None.

Examples
To compile `myprogram.c` so that no warning messages are displayed, enter:

```
invocation myprogram.c -w
```

The following example shows how informational messages that result from a severe error, in this case caused by problems with overload resolution in C++, are not disabled :

```
void func(int a){}
void func(int a, int b){}
int main(void)
{
func(1,2,3);
return 0;
}
```

The output is as follows:

```
"x.cpp", line 6.4: 1540-0218 (S) The call does not match any parameter list for "func".
"x.cpp", line 1.6: 1540-1283 (I) "func(int)" is not a viable candidate.
"x.cpp", line 6.4: 1540-0215 (I) The wrong number of arguments have been specified for "func(int)".
"x.cpp", line 2.6: 1540-1283 (I) "func(int, int)" is not a viable candidate.
"x.cpp", line 6.4: 1540-0215 (I) The wrong number of arguments have been specified for "func(int, int)".
```

Related information
- "-qflag" on page 85
- "-qsuppress" on page 199

-W

Category
Compiler customization

Pragma equivalent
None.

Purpose
Passes the listed options to a component that is executed during compilation.

Syntax

Parameters

option
Any option that is valid for the component to which it is being passed. Spaces must not appear before the *option*.

The following table shows the correspondence between **-W** parameters and the component executable names:

Parameter	Description	Executable name
a	Assembler	ppu-as or spu-as
b	Low-level optimizer	xlCcode
c	Compiler front end	xlcentry, xlCentry
C++ C	C++ compiler front end	xlCentry
d	Disassembler	dis
I	High-level optimizer, compile step	ipa
L	High-level optimizer, link step	ipa
l	Linker	ppu-ld or spu-ld
p	Preprocessor	n/a

Usage
In the string following the **-W** option, use a comma as the separator for each option, and do not include any spaces. If you need to include a character that is special to the shell in the option string, precede the character with a backslash. For example, if you use the **-W** option in the configuration file, you can use the escape sequence backslash comma (\,) to represent a comma in the parameter string.

You do not need the **-W** option to pass most options to the linker **ld**: unrecognized command-line options, except **-q** options, are passed to it automatically. Only linker options with the same letters as compiler options, such as **-v** or **-S**, strictly require **-W**.

Predefined macros
None.

Examples
To compile the file `file.c` and pass the linker option **-berok** to the linker, enter the following command:

```
invocation -Wl,-berok file.c
```

To compile the file `uses_many_symbols.c` and the assembly file `produces_warnings.s` so that `produces_warnings.s` is assembled with the assembler option **-x** (issue warnings and produce cross-reference), and the object files are linked with the option **-s** (write list of object files and strip final executable file), issue the following command:.

```
invocation -Wa,-x -Wl,-s produces_warnings.s uses_many_symbols.c
```

Related information
- "Invoking the compiler" on page 1

-qwarn64 (PPU only)

Category
Error checking and debugging

Pragma equivalent
None.

Purpose
Enables checking for possible data conversion problems between 32-bit and 64-bit compiler modes.

When **-qwarn64** is in effect, informational messages are displayed where data conversion may cause problems in 64-bit compilation mode, such as:

- Truncation due to explicit or implicit conversion of `long` types into `int` types
- Unexpected results due to explicit or implicit conversion of `int` types into `long` types
- Invalid memory references due to explicit conversion by cast operations of pointer types into `int` types
- Invalid memory references due to explicit conversion by cast operations of `int` types into pointer types
- Problems due to explicit or implicit conversion of constants into `long` types
- Problems due to explicit or implicit conversion by cast operations of constants into pointer types

Syntax

Defaults
-qnowarn64

Usage
This option functions in either 32-bit or 64-bit compiler modes. In 32-bit mode, it functions as a preview aid to discover possible 32-bit to 64-bit migration problems.

Predefined macros
None.

Related information
- -q32, -q64
- "Compiler messages" on page 15

-qxcall

Category
Object code control

Pragma equivalent
None.

Purpose
Generates code to treat static functions within a compilation unit as if they were external functions.

Syntax


Defaults
-qnoxcall

Usage
-qxcall generates slower code than **-qnoxcall**.

Predefined macros
None.

Examples
To compile `myprogram.c` so that all static functions are compiled as external functions, enter:

```
invocation myprogram.c -qxcall
```

-qxref

Category
Listings, messages, and compiler information

Pragma equivalent
#pragma options [no]xref

Purpose

Produces a compiler listing that includes the cross-reference component of the attribute and cross-reference section of the listing.

When **xref** is in effect, a listing file is generated with a .lst suffix for each source file named on the command line. For details of the contents of the listing file, see "Compiler listings" on page 17.

Syntax

Defaults

-qnoxref

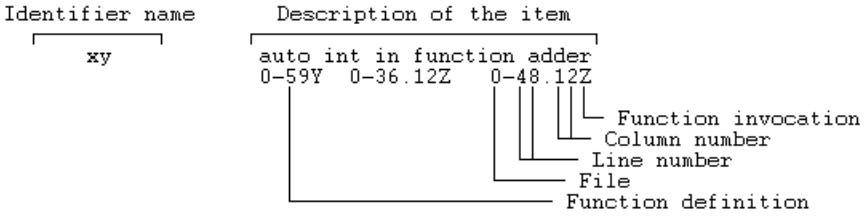
Parameters

full

Reports all identifiers in the program. If you specify **xref** without this suboption, only those identifiers that are used are reported.

Usage

A typical cross-reference listing has the form:



The listing uses the following character codes:

Table 22. Cross-reference listing codes

Character	Meaning
X	Function is declared.
Y	Function is defined.
Z	Function is called.
$	Type is defined, variable is declared/defined.
#	Variable is assigned to.
&	Variable is defined and initialized.
[blank]	Identifier is referenced.

The **-qnoprint** option overrides this option.

Any function defined with the **#pragma mc_func** directive is listed as being defined on the line of the pragma directive.

Predefined macros

None.

Examples
To compile `myprogram.c` and produce a cross-reference listing of all identifiers, whether they are used or not, enter:

```
invocation myprogram.c -qxref=full
```

Related information
- "-qattr" on page 53
- "#pragma mc_func" on page 253

-y

Category
Floating-point and integer control

Pragma equivalent
None.

Purpose
Specifies the rounding mode for the compiler to use when evaluating constant floating-point expressions at compile time.

Syntax

Defaults
- **-yn**
- **-yz** for compilation targeting the SPU, for single-precision arithmetic only

Parameters
m Round toward minus infinity.

Note: This suboption is not supported on the SPU for single-precision arithmetic.

n Round to the nearest representable number, ties to even.

Note: This suboption is not supported on the SPU for single-precision arithmetic.

p Round toward plus infinity.

Note: This suboption is not supported on the SPU for single-precision arithmetic.

z Round toward zero.

Usage
If your program contains operations involving long doubles, the rounding mode must be set to **-yn** (round-to-nearest representable number, ties to even).

For single-precision arithmetic operations, the SPU supports only round-to-zero mode. Therefore, compile-time folding will be done in round-to-zero, regardless of

the setting of the **-y** option. However, for compile-time single/double precision conversions, as well as evaluation of single- (and double-) precision literals, the SPU does respond to the rounding mode specified by the **-y** option.

Predefined macros
None.

Examples
To compile `myprogram.c` so that constant floating-point expressions are rounded toward zero at compile time, enter:

```
invocation myprogram.c -yz
```

-Z

Category
Linking

Pragma equivalent
None.

Purpose
Specifies a prefix for the library search path to be used by the linker.

Syntax

Defaults
By default, the linker searches the /usr/lib/ directory for library files.

Parameters
string
Represents the prefix to be added to the directory search path for library files.

Predefined macros
None.

Chapter 4. Compiler pragmas reference

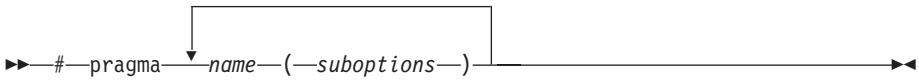
The following sections describe the pragmas available in XL C/C++:

Pragma directive syntax

XL C/C++ supports three forms of pragma directives:

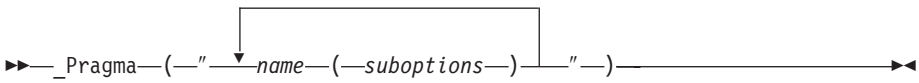
#pragma options *option_name*
: These pragmas use exactly the same syntax as their command-line option equivalent. The exact syntax and list of supported pragmas of this type are provided in "#pragma options" on page 255.

#pragma *name*
: This form uses the following syntax:



The *name* is the pragma directive name, and the *suboptions* are any required or optional suboptions that can be specified for the pragma, where applicable.

_Pragma ("*name***")**
: This form uses the following syntax:



For example, the statement:

```
_Pragma ( "pack(1)" )
```

is equivalent to:

```
#pragma pack(1)
```

For all forms of pragma statements, you can specify more than one *name* and *suboptions* in a single **#pragma** statement.

The *name* on a pragma is subject to macro substitutions, unless otherwise stated. The compiler ignores unrecognized pragmas, issuing an informational message indicating this.

If you have any pragmas that are not common to both C and C++ in code that will be compiled by both compilers, you may add conditional compilation directives around the pragmas. (This is not strictly necessary since unrecognized pragmas are

ignored.) For example, **#pragma object_model** is only recognized by the C++ compiler, so you may decide to add conditional compilation directives around the pragma.

```
#ifdef __cplusplus
#pragma object_model(pop)
#endif
```

Scope of pragma directives

Many pragma directives can be specified at any point within the source code in a compilation unit; others must be specified before any other directives or source code statements. In the individual descriptions for each pragma, the "Usage" section describes any constraints on the pragma's placement.

In general, if you specify a pragma directive before any code in your source program, it applies to the entire compilation unit, including any header files that are included. For a directive that can appear anywhere in your source code, it applies from the point at which it is specified, until the end of the compilation unit.

You can further restrict the scope of a pragma's application by using complementary pairs of pragma directives around a selected section of code. For example, using **#pragma options source** and **#pragma options nosource** directives as follows requests that only the selected parts of your source code be included in your compiler listing:

```
#pragma options source

/*  Source code between the source and nosource pragma
    options is included in the compiler listing               */

#pragma options nosource
```

Many pragmas provide "pop" or "reset" suboptions that allow you to enable and disable pragma settings in a stack-based fashion; examples of these are provided in the relevant pragma descriptions.

Summary of compiler pragmas by functional category

The XL C/C++ pragmas available are grouped into the following categories:

- Language element control
- C++ template pragmas
- Floating-point and integer control
- Error checking and debugging
- Listings, messages and compiler information
- Optimization and tuning
- Object code control
- Portability and migration
- Compiler customization

For descriptions of these categories, see “Summary of compiler options by functional category” on page 27.

Language element control

Table 23. Language element control pragmas

Pragma	Description
#pragma langlvl (C only)	Determines whether source code and compiler options should be checked for conformance to a specific language standard, or subset or superset of a standard.
#pragma mc_func	Allows you to embed a short sequence of machine instructions ″inline″ within your program source code.
#pragma options	Specifies compiler options in your source program.

C++ template pragmas

Table 24. C++ template pragmas

Pragma	Description
#pragma define, #pragma instantiate (C++ only)	Provides an alternative method for explicitly instantiating a template class.
#pragma do_not_instantiate (C++ only)	Prevents the specified template declaration from being instantiated.
#pragma implementation (C++ only)	For use with the **-qtempinc** compiler option, supplies the name of the file containing the template definitions corresponding to the template declarations contained in a header file.

Floating-point and integer control

Table 25. Floating-point and integer control pragmas

Pragma	Description
#pragma chars	Determines whether all variables of type `char` are treated as either `signed` or `unsigned`.
#pragma enum	Specifies the amount of storage occupied by enumerations.

Error checking and debugging

Table 26. Error checking and debugging pragmas

Pragma	Description
#pragma ibm snapshot	Specifies a location at which a breakpoint can be set and defines a list of variables that can be examined when program execution reaches that location.
#pragma info	Produces or suppresses groups of informational messages.

Listings, messages and compiler information

Table 27. Listings, messages and compiler information pragmas

Pragma	Description
“#pragma report (C++ only)” on page 264	Controls the generation of diagnostic messages.

Optimization and tuning

Table 28. Optimization and tuning pragmas

Pragma	Description
#pragma block_loop	Marks a block with a scope-unique identifier.
#pragma STDC cx_limited_range	Instructs the compiler that complex division and absolute value are only invoked with values such that intermediate calculation will not overflow or lose significance.
#pragma disjoint	Lists identifiers that are not aliased to each other within the scope of their use.
#pragma execution_frequency	Marks program source code that you expect will be either very frequently or very infrequently executed.
#pragma expected_value	Specifies the value that a parameter passed in a function call is most likely to take at run time. The compiler can use this information to perform certain optimizations, such as function cloning and inlining.
#pragma isolated_call	Specifies functions in the source file that have no side effects other than those implied by their parameters.
#pragma leaves	Informs the compiler that a named function never returns to the instruction following a call to that function.
#pragma loopid	Marks a block with a scope-unique identifier.
#pragma nosimd	When used with **-qhot=simd**, disables the generation of SIMD instructions for the next loop.
#pragma novector	When used with **-qhot=novector**, disables auto-vectorization of the next loop.
#pragma option_override	Allows you to specify optimization options at the subprogram level that override optimization options given on the command line.
#pragma reachable	Informs the compiler that the point in the program after a named function can be the target of a branch from some unknown location.
#pragma reg_killed_by	Specifies registers that may be altered by functions specified by **#pragma mc_func**.
#pragma stream_unroll	When optimization is enabled, breaks a stream contained in a `for` loop into multiple streams.
#pragma unroll	Controls loop unrolling, for improved performance.
#pragma unrollandfuse	Instructs the compiler to attempt an unroll and fuse operation on nested `for` loops.

Object code control

Table 29. Object code control pragmas

Pragma	Description
#pragma alloca (C only)	Provides an inline definition of system function `alloca` when it is called from source code that does not include the `alloca.h` header.
#pragma comment	Places a comment into the object module.
#pragma hashome (C++ only)	Informs the compiler that the specified class has a home module that will be specified by **#pragma ishome**.

Table 29. Object code control pragmas (continued)

Pragma	Description
#pragma ishome (C++ only)	Informs the compiler that the specified class's home module is the current compilation unit.
#pragma map	Converts all references to an identifier to another, externally defined identifier.
#pragma pack	Sets the alignment of all aggregate members to a specified byte boundary.
#pragma priority (C++ only)	Specifies the priority level for the initialization of static objects.
#pragma reg_killed_by	Specifies registers that may be altered by functions specified by **#pragma mc_func**.
#pragma strings	Specifies the storage type for string literals.
#pragma weak	Prevents the linker from issuing error messages if it encounters a symbol multiply-defined during linking, or if it does not find a definition for a symbol.

Portability and migration

Table 30. Portability and migration pragmas

Pragma	Description
#pragma align	Specifies the alignment of data objects in storage, which avoids performance problems with misaligned data.

Compiler customization

Table 31. Compiler customization pragmas

Pragma	Description
#pragma complexgcc	Specifies whether to use GCC parameter-passing conventions for complex data types (equivalent to enabling **-qfloat=complexgcc**).

Individual pragma descriptions

This section contains descriptions of individual pragmas available in XL C/C++.

For each pragma, the following information is given:

Category
The functional category to which the pragma belongs is listed here.

Purpose
This section provides a brief description of the effect of the pragma, and why you might want to use it.

Syntax
This section provides the syntax for the pragma. For convenience, the **#pragma** *name* form of the directive is used in each case. However, it is perfectly valid to use the alternate C99-style `_Pragma` operator syntax; see "Pragma directive syntax" on page 231 for details.

Parameters
This section describes the suboptions that are available for the pragma, where applicable.

Usage This section describes any rules or usage considerations you should be aware of when using the pragma. These can include restrictions on the pragma's applicability, valid placement of the pragma, and so on.

Examples
Where appropriate, examples of pragma directive use are provided in this section.

#pragma align

See "-qalign" on page 46.

#pragma alloca (C only)

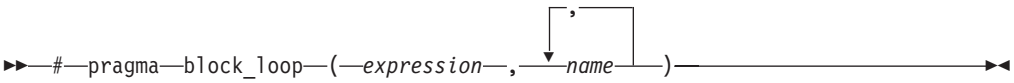
See "-qalloca, -ma (C only)" on page 47.

#pragma block_loop

Category
Optimization and tuning

Purpose
Marks a block with a scope-unique identifier.

Syntax



Parameters

expression
An integer expression representing the size of the iteration group.

name
An identifier that is unique within the scoping unit. If you do not specify a *name*, blocking occurs on the first `for` loop or loop following the **#pragma block_loop** directive.

Usage
For loop blocking to occur, a **#pragma block_loop** directive must precede a `for` loop.

If you specify **#pragma unroll**, **#pragma unrollandfuse** or **#pragma stream_unroll** for a blocking loop, the blocking loop is unrolled, unrolled and fused or stream unrolled respectively, if the blocking loop is actually created. Otherwise, this directive has no effect.

If you specify **#pragma unrollandfuse**, **#pragma unroll** or **#pragma stream_unroll** directive for a blocked loop, the directive is applied to the blocked loop after the blocking loop is created. If the blocking loop is not created, this directive is applied to the loop intended for blocking, as if the corresponding **#pragma block_loop** directive was not specified.

You must not specify **#pragma block_loop** more than once, or combine the directive with **#pragma nounroll**, **#pragma unroll**, **#pragma nounrollandfuse**, **#pragma unrollandfuse**, or **#pragma stream_unroll** directives for the same `for` loop. Also, you should not apply more than one **#pragma unroll** directive to a single block loop directive.

Processing of all **#pragma block_loop** directives is always completed before performing any unrolling indicated by any of the unroll directives

Examples

The following two examples show the use of **#pragma block_loop** and **#pragma loop_id** for loop tiling:

```
#pragma block_loop(50, mymainloop)
#pragma block_loop(20, myfirstloop, mysecondloop)
#pragma loopid(mymainloop)
  for (i=0; i < n; i++)
  {
#pragma loopid(myfirstloop)
    for (j=0; j < m; j++)
    {
#pragma loopid(mysecondloop)
      for (k=0; k < m; k++)
      {
         ...
      }
    }
  }
```

```
#pragma block_loop(50, mymainloop)
#pragma block_loop(20, myfirstloop, mysecondloop)
#pragma loopid(mymainloop)
       for (i=0; i < n; n++)
       {
#pragma loopid(myfirstloop)
              for (j=0; j < m; j++)
              {
#pragma loopid(mysecondloop)
                     for (k=0; k < m; k++)
                     {
                            ...
                     }
              }
       }
```

The following example shows the use **#pragma block_loop** and **#pragma loop_id** for loop interchange.

```
       for (i=0; i < n; i++)
       {
              for (j=0; j < n; j++)
              {
#pragma block_loop(1,myloop1)
                     for (k=0; k < m; k++)
                     {
#pragma loopid(myloop1)
                            for (l=0; l < m; l++)
                            {
                                   ...
                            }
                     }
              }
       }
```

The following example shows the use of **#pragma block_loop** and **#pragma loop_id** for loop tiling for multi-level memory hierarchy:

```
#pragma block_loop(l3factor, first_level_blocking)
  for (i=0; i < n; i++)
  {
#pragma loopid(first_level_blocking)
#pragma block_loop(l2factor, inner_space)
    for (j=0; j < n; j++)
    {
#pragma loopid(inner_space)
      for (k=0; k < m; k++)
      {
        for (l=0; l < m; l++)
        {
          ...
        }
      }
    }
  }
```

The following example uses **#pragma unrollandfuse** and **#pragma block_loop** to unroll and fuse a blocking loop.

```
#pragma unrollandfuse
#pragma block_loop(10)
   for (i = 0; i < N; ++i) {
   }
```

In this case, if the block loop directive is ignored, the unroll directives have no effect.

The following example shows the use of **#pragma unroll** and **#pragma block_loop** to unroll a blocked loop.

```
#pragma block_loop(10)
#pragma unroll(2)
  for (i = 0; i < N; ++i) {
  }
```

In this case, if the block loop directive is ignored, the unblocked loop is still subjected to unrolling. If blocking does happen, the unroll directive is applied to the blocked loop.

The following examples show invalid uses of the directive. The first example shows **#pragma block_loop** used on an undefined loop identifier:

```
#pragma block_loop(50, myloop)
  for (i=0; i < n; i++)
  {
  }
```

Referencing `myloop` is not allowed, since it is not in the nest and may not be defined.

In the following example, referencing `myloop` is not allowed, since it is not in the same loop nest:

```
  for (i=0; i < n; i++)
  {
#pragma loopid(myLoop)
    for (j=0; j < i; j++)
    {
      ...
    }
  }
```

```
#pragma block_loop(myLoop)
  for (i=0; i < n; i++)
  {
    ...
  }
```

The following examples are invalid since the unroll directives conflict with each other:

```
#pragma unrollandfuse(5)
#pragma unroll(2)
  #pragma block_loop(10)
             for (i = 0; i < N; ++i) {
         }
#pragma block_loop(10)
#pragma unroll(5)
#pragma unroll(10)
  for (i = 0; i < N; ++i) {
  }
```

Related information

- "#pragma loopid" on page 250
- "-qunroll" on page 216
- "#pragma unrollandfuse" on page 268
- "#pragma stream_unroll" on page 266

#pragma chars

See "-qchars" on page 59.

#pragma comment

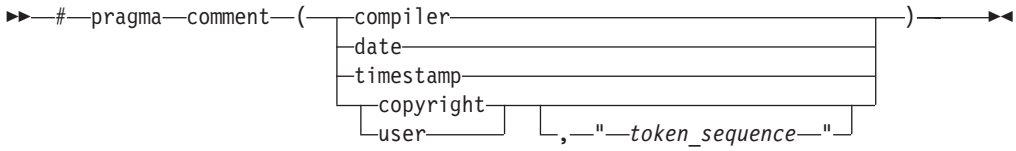
Category

Object code control

Purpose

Places a comment into the object module.

Syntax



Parameters

compiler
Appends the name and version of the compiler at the end of the generated object module.

date
The date and time of the compilation are appended at the end of the generated object module.

timestamp
Appends the date and time of the last modification of the source at the end of the generated object module.

copyright
Places the text specified by the *token_sequence*, if any, into the generated object module. The *token_sequence* is included in the generated executable and loaded into memory when the program is run.

user
Places the text specified by the *token_sequence*, if any, into the generated object module. The *token_sequence* is included in the generated executable but is *not* loaded into memory when the program is run.

token_sequence
The characters in this field, if specified, must be enclosed in double quotation marks ("). If the string literal specified in the *token_sequence* exceeds 32 767 bytes, an information message is emitted and the pragma is ignored.

Usage
More than one **comment** directive can appear in a translation unit, and each type of **comment** directive can appear more than once, with the exception of **copyright**, which can appear only once.

You can display the object-file comments by using the operating system **strings** command.

Examples
Assume that following program code is compiled to produce output file `a.out`:

```
#pragma comment(date)
#pragma comment(compiler)
#pragma comment(timestamp)
#pragma comment(copyright,"My copyright")

int main() {

return 0;
}
```

Issuing the command:

```
strings a.out
```

will cause the comment information embedded in `a.out` to be displayed, along with any other strings that may be found in `a.out`. For example, assuming the program code shown above:

```
Mon Mar 1 10:28:03 2007
XL C/C++ for Multicore Acceleration Compiler Version 9.0
Mon Mar 1 10:28:09 2007
My copyright
```

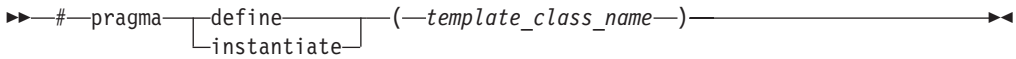
#pragma complexgcc
See “-qcomplexgccincl” on page 64.

#pragma define, #pragma instantiate (C++ only)

Category
Template control

Purpose
Provides an alternative method for explicitly instantiating a template class.

Syntax



Parameters

template_class_name
The name of the template class to be instantiated.

Usage

This pragma provides equivalent functionality to standard C++ explicit instantiation, and is provided for backwards compatibility purposes only. New applications should use standard C++ explicit instantiation.

The pragma can appear anywhere an explicit instantiation statement can appear.

Examples

The following directive:

```
#pragma define(Array<char>)
```

is equivalent to the following explicit instantiation:

```
template class Array<char>;
```

Related information

- "Explicit instantiation" in the *XL C/C++ Language Reference*
- "#pragma do_not_instantiate (C++ only)" on page 242

#pragma disjoint

Category

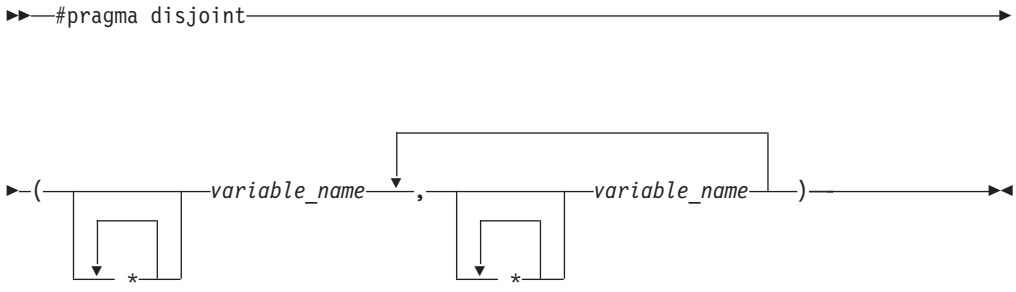
Optimization and tuning

Purpose

Lists identifiers that are not aliased to each other within the scope of their use.

By informing the compiler that none of the identifiers listed in the pragma shares the same physical storage, the pragma provides more opportunity for optimizations.

Syntax



Parameters

variable_name
The name of a variable. It must not refer to any of the following:

- A member of a structure, class, or union
- A structure, union, or enumeration tag
- An enumeration constant
- A `typedef` name
- A label

Usage

The **#pragma disjoint** directive asserts that none of the identifiers listed in the pragma share physical storage; if any the identifiers *do* actually share physical storage, the pragma may give incorrect results.

The pragma can appear anywhere in the source program that a declaration is allowed. An identifier in the directive must be visible at the point in the program where the pragma appears.

You must declare the identifiers before using them in the pragma. Your program must not dereference a pointer in the identifier list nor use it as a function argument before it appears in the directive.

This pragma can be disabled with the **-qignprag** compiler option.

Examples

The following example shows the use of **#pragma disjoint**.

```
int a, b, *ptr_a, *ptr_b;

#pragma disjoint(*ptr_a, b)   /* *ptr_a never points to b */
#pragma disjoint(*ptr_b, a)   /* *ptr_b never points to a */
one_function()
{
     b = 6;
     *ptr_a = 7;   /* Assignment will not change the value of b  */

   another_function(b);    /* Argument "b" has the value 6  */
}
```

External pointer `ptr_a` does not share storage with and never points to the external variable `b`. Consequently, assigning 7 to the object to which `ptr_a` points will not change the value of `b`. Likewise, external pointer `ptr_b` does not share storage with and never points to the external variable `a`. The compiler can assume that the argument to `another_function` has the value 6 and will not reload the variable from memory.

#pragma do_not_instantiate (C++ only)

Category

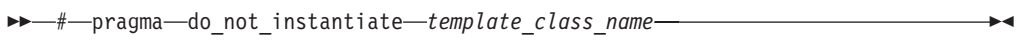
Template control

Purpose

Prevents the specified template declaration from being instantiated.

You can use this pragma to suppress the implicit instantiation of a template for which a definition is supplied.

Syntax



Parameters

template_class_name
The name of the template class that should not be instantiated.

Usage

If you are handling template instantiations manually (that is, **-qnotempinc** and **-qnotemplateregistry** are specified), and the specified template instantiation already exists in another compilation unit, using **#pragma do_not_instantiate** ensures that you do not get multiple symbol definitions during the link step.

You can also use the **-qtmplinst** option to suppress implicit instantiation of template declarations for multiple compilation units. See "-qtmplinst (C++ only)" on page 212.

Examples

The following shows the usage of the pragma:

```
#pragma do_not_instantiate Stack < int >
```

Related information

- "#pragma define, #pragma instantiate (C++ only)" on page 240
- "-qtmplinst (C++ only)" on page 212
- "Explicit instantiation in the *XL C/C++ Language Reference*
- "-qtempinc (C++ only)" on page 205
- "-qtemplateregistry (C++ only)" on page 208

#pragma enum

See "-qenum" on page 77.

#pragma execution_frequency

Category

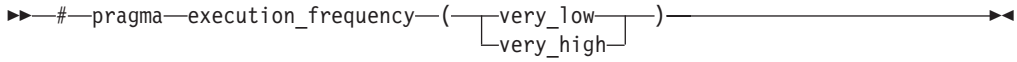
Optimization and tuning

Purpose

Marks program source code that you expect will be either very frequently or very infrequently executed.

When optimization is enabled, the pragma is used as a hint to the optimizer.

Syntax



Parameters

very_low
Marks source code that you expect will be executed very infrequently.

very_high
Marks source code that you expect will be executed very frequently.

Usage

Use this pragma in conjunction with an optimization option; if optimization is not enabled, the pragma has no effect.

The pragma must be placed within block scope, and acts on the closest point of branching.

Examples

In the following example, the pragma is used in an `if` statement block to mark code that is executed infrequently.

```
int *array = (int *) malloc(10000);

if (array == NULL) {
    /* Block A */
    #pragma execution_frequency(very_low)
    error();
}
```

In the next example, the code block `Block B` is marked as infrequently executed and `Block C` is likely to be chosen during branching.

```
if (Foo > 0) {
    #pragma execution_frequency(very_low)
    /* Block B */
    doSomething();
} else {
    /* Block C */
    doAnotherThing();
}
```

In this example, the pragma is used in a `switch` statement block to mark code that is executed frequently.

```
while (counter > 0) {
    #pragma execution_frequency(very_high)
    doSomething();
} /* This loop is very likely to be executed.    */

switch (a) {
    case 1:
        doOneThing();
        break;
    case 2:
        #pragma execution_frequency(very_high)
        doTwoThings();
        break;
    default:
        doNothing();
}    /* The second case is frequently chosen.   */
```

The following example shows how the pragma must be applied at block scope and affects the closest branching.

```
int a;
#pragma execution_frequency(very_low)
int b;

int foo(boolean boo) {
    #pragma execution_frequency(very_low)
    char c;

    if (boo) {
        /* Block A */
        doSomething();
        {
```

```
            /* Block C */
            doSomethingAgain();
            #pragma execution_frequency(very_low)
            doAnotherThing();
        }
    } else {
        /* Block B */
        doNothing();
    }

    return 0;
}

#pragma execution_frequency(very_low)
```

#pragma expected_value

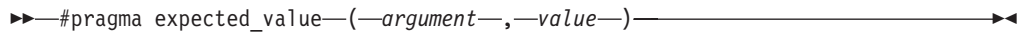
Category

Optimization and tuning

Purpose

Specifies the value that a parameter passed in a function call is most likely to take at run time. The compiler can use this information to perform certain optimizations, such as function cloning and inlining.

Syntax



Parameters

argument
: The name of the parameter for which you want to provide the expected value. The parameter must be of a simple built-in integral, Boolean, character, or floating-point type.

value
: A constant literal representing the value that you expect will most likely be taken by the parameter at run time. *value* can be an expression as long as it is a compile time constant expression.

Usage

The directive must appear inside the body of a function definition, before the first statement (including declaration statements). It is not supported within nested functions.

If you specify an expected value of a type different from that of the declared type of the parameter variable, the value will be implicitly converted only if allowed. Otherwise, a warning is issued.

For each parameter that will be provided the expected value there is a limit of one directive. Parameters that will not be provided the expected value do not require a directive.

Examples

The following example tells the compiler that the most likely values for parameters `a` and `b` are 1 and 0, respectively:

```
int func(int a,int b)
{
#pragma expected_value(a,1)
#pragma expected_value(b,0)
...
...
}
```

Related information

- "#pragma execution_frequency" on page 243

#pragma hashome (C++ only)

Category

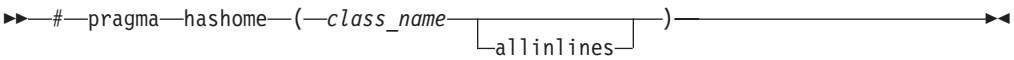
Object code control

Purpose

Informs the compiler that the specified class has a home module that will be specified by **#pragma ishome**.

This class's virtual function table, along with certain inline functions, will not be generated as static. Instead, they will be referenced as externals in the compilation unit of the class in which **#pragma ishome** is specified.

Syntax



Parameters

class_name
The name of a class to be referenced externally. *class_name* must be a class and it must be defined.

allinlines
Specifies that all inline functions from within *class_name* should be referenced as being external.

Usage

A warning will be produced if there is a **#pragma ishome** without a matching **#pragma hashome**.

Examples

In the following example, compiling the code samples will generate virtual function tables and the definition of `S::foo()` only for compilation unit `a.o`, but not for `b.o`. This reduces the amount of code generated for the application.

```
// a.h
struct S
{
   virtual void foo() {}

   virtual void bar();
};



// a.C
#pragma ishome(S)
```

```
#pragma hashome (S)

#include "a.h"

int main()
{
   S s;
   s.foo();
   s.bar();
}



// b.C
#pragma hashome(S)
#include "a.h"

void S::bar() {}
```

Related information
- "#pragma ishome (C++ only)" on page 248

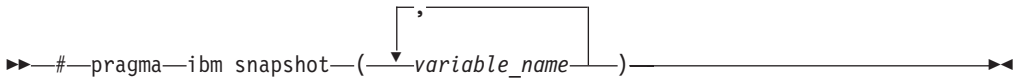
#pragma ibm snapshot

Category
Error checking and debugging

Purpose
Specifies a location at which a breakpoint can be set and defines a list of variables that can be examined when program execution reaches that location.

You can use this pragma to facilitate debugging optimized code produced by the compiler.

Syntax



Parameters
variable_name
A variable name. It must not refer to structure, class, or union members.

Usage
During a debugging session, you can place a breakpoint on the line at which the directive appears, to view the values of the named variables. When you compile with optimization and the **-g** option, the named variables are guaranteed to be visible to the debugger.

This pragma does not consistently preserve the contents of variables with a static storage class at high optimization levels. Variables specified in the directive should be considered read-only while being observed in the debugger, and should not be modified. Modifying these variables in the debugger may result in unpredictable behavior.

Examples
```
#pragma ibm snapshot(a, b, c)
```

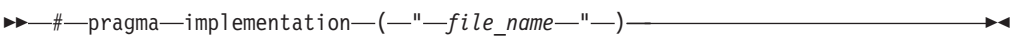
Related information
- “-g” on page 97
- “-O, -qoptimize” on page 159

#pragma implementation (C++ only)

Category
Template control

Purpose
For use with the **-qtempinc** compiler option, supplies the name of the file containing the template definitions corresponding to the template declarations contained in a header file.

Syntax



Parameters
file_name
The name of the file containing the definitions for members of template classes declared in the header file.

Usage
This pragma is not normally required if your template implementation file has the same name as the header file containing the template declarations, and a .c extension. You only need to use the pragma if the template implementation file does not conform to this file-naming convention. For more information about using template implementation files, see "Using C++ Templates" in the *XL C/C++ Programming Guide*.

#pragma implementation is only effective if the **-qtempinc** option is in effect. Otherwise, the pragma has no meaning and is ignored.

The pragma can appear in the header file containing the template declarations, or in a source file that includes the header file. It can appear anywhere that a declaration is allowed.

Related information
- “-qtempinc (C++ only)” on page 205
- "Using C++ Templates" in the *XL C/C++ Programming Guide*

#pragma info
See “-qinfo” on page 110.

#pragma ishome (C++ only)

Category
Object code control

Purpose
Informs the compiler that the specified class’s home module is the current compilation unit.

The home module is where items, such as the virtual function table, are stored. If an item is referenced from outside of the compilation unit, it will not be generated outside its home. This can reduce the amount of code generated for the application.

Syntax

Parameters

class_name
The name of the class whose home will be the current compilation unit.

Usage

A warning will be produced if there is a **#pragma ishome** without a matching **#pragma hashome**.

Examples

See "#pragma hashome (C++ only)" on page 246

Related information

- "#pragma hashome (C++ only)" on page 246

#pragma isolated_call

See "-qisolated_call" on page 126.

#pragma langlvl (C only)

See "-qlanglvl" on page 132.

#pragma leaves

Category

Optimization and tuning

Purpose

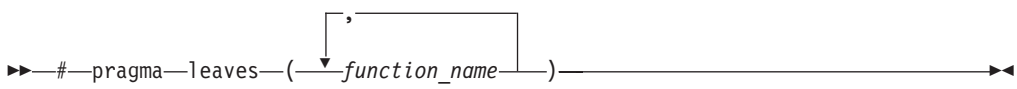
Informs the compiler that a named function never returns to the instruction following a call to that function.

By informing the compiler that it can ignore any code after the function, the directive allows for additional opportunities for optimization.

This pragma is commonly used for custom error-handling functions, in which programs can be terminated if a certain error is encountered.

Note: The compiler automatically inserts **#pragma leaves** directives for calls to the `longjmp` family of functions (`longjmp`, `_longjmp`, `siglongjmp`, and `_siglongjmp`) when you include the setjmp.h header.

Syntax



Parameters

function_name
The name of the function that does not return to the instruction following the call to it.

Defaults
Not applicable.

Examples
```
#pragma leaves(handle_error_and_quit)
void test_value(int value)
{
 if (value == ERROR_VALUE)
 {
  handle_error_and_quit(value);
  TryAgain(); // optimizer ignores this because
    // never returns to execute it
 }
}
```

Related information
- "#pragma reachable" on page 262.

#pragma loopid

Category
Optimization and tuning

Purpose
Marks a block with a scope-unique identifier.

Syntax

Parameters

name
An identifier that is unique within the scoping unit.

Usage
The **#pragma loopid** directive must immediately precede a **#pragma block_loop** directive or `for` loop. The specified name can be used by **#pragma block_loop** to control transformations on that loop. It can also be used to provide information on loop transformations through the use of the **-qreport** compiler option.

You must not specify **#pragma loopid** more than once for a given loop.

Examples
For examples of **#pragma loopid** usage, see "#pragma block_loop" on page 236.

Related information
- "-qunroll" on page 216
- "#pragma block_loop" on page 236
- "#pragma unrollandfuse" on page 268

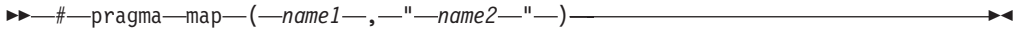
#pragma map

Category
Object code control

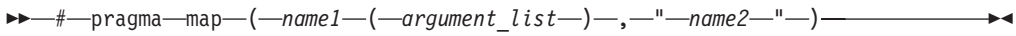
Purpose
Converts all references to an identifier to another, externally defined identifier.

Syntax

#pragma map syntax – C



#pragma map syntax – C++



Parameters

name1

The name used in the source code. C *name1* can represent a data object or function with external linkage. C++ *name1* can represent a data object, a non-overloaded or overloaded function, or overloaded operator, with external linkage. If the name to be mapped is not in the global namespace, it must be fully qualified.

name1 should be declared in the same compilation unit in which it is referenced, but should not be defined in any other compilation unit. *name1* must not be used in another **#pragma map** directive or any assembly label declaration anywhere in the program.

C++ *argument_list*

The list of arguments for the overloaded function or operator function designated by *name1*. If *name1* designates an overloaded function, the function must be parenthesized and must include its argument list if it exists. If *name1* designates a non-overloaded function, only *name1* is required, and the parentheses and argument list are optional.

name2

The name that will appear in the object code. C *name2* can represent a data object or function with external linkage.

C++ *name2* can represent a data object, a non-overloaded or overloaded function, or overloaded operator, with external linkage. *name2* must specified using its mangled name. To obtain C++ mangled names, compile your source to object files only, using the **-c** compiler option, and use the **nm** operating system command on the resulting object file. (See also "Name mangling" in the *XL C/C++ Language Reference* for details on using the `extern "C"` linkage specifier on declarations to prevent name mangling.)

If the name exceeds 65535 bytes, an informational message is emitted and the pragma is ignored.

name2 may or may not be declared in the same compilation unit in which *name1* is referenced, but must not be defined in the same compilation unit. Also, *name2* should not be referenced anywhere in the compilation unit where

name1 is referenced. *name2* must not be the same as that used in another **#pragma map** directive or any assembly label declaration in the same compilation unit.

Usage

The **#pragma map** directive can appear anywhere in the program. Note that in order for a function to be actually mapped, the map target function (*name2*) must have a definition available at link time (from another compilation unit), and the map source function (*name1*) must be called in your program.

You cannot use **#pragma map** with compiler built-in functions.

Examples

The following is an example of **#pragma map** used to map a function name (using the mangled name for the map name in C++):

```
/* Compilation unit 1: */

#include <stdio.h>

void foo();
extern void bar(); /* optional */

#if __cplusplus
#pragma map (foo, "_Z3barv")
#else
#pragma map (foo, "bar")
#endif

int main()
{
foo();
}

/* Compilation unit 2: */

#include <stdio.h>

void bar()
{
printf("Hello from foo bar!\n");
}
```

The call to `foo` in compilation unit 1 resolves to a call to `bar`:

```
Hello from foo bar!
```

C++ The following is an example of **#pragma map** used to map an overloaded function name (using C linkage, to avoid using the mangled name for the map name):

```
// Compilation unit 1:

#include <iostream>
#include <string>

using namespace std;

void foo();
void foo(const string&);
extern "C" void bar(const string&); // optional

#pragma map (foo(const string&), "bar")

int main()
```

```
{
foo("Have a nice day!");
}

// Compilation unit 2:

#include <iostream>
#include <string>

using namespace std;

extern "C" void bar(const string& s)
{
cout << "Hello from foo bar!" << endl;
cout << s << endl;
}
```

The call to `foo(const string&)` in compilation unit 1 resolves to a call to `bar(const string&)`:

```
Hello from foo bar!
Have a nice day!
```

Related information

- "Assembly labels" in the *XL C/C++ Language Reference*

#pragma mc_func

Category

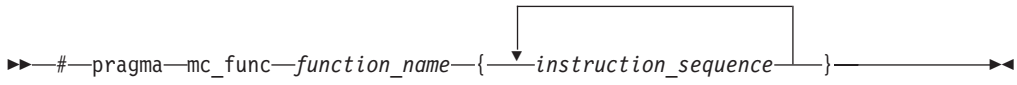
Language element control

Purpose

Allows you to embed a short sequence of machine instructions ″inline″ within your program source code.

The pragma instructs the compiler to generate specified instructions in place rather than the usual linkage code. Using this pragma avoids performance penalties associated with making a call to an assembler-coded external function. This pragma is similar in function to inline `asm` statements supported in this and other compilers; see "Inline assembly statements" in the *XL C/C++ Language Reference* for more information.

Syntax



Parameters

function_name
The name of a previously-defined function containing machine instructions. If the function is not previously-defined, the compiler will treat the pragma as a function definition.

instruction_sequence
A string containing a sequence of zero or more hexadecimal digits. The number of digits must comprise an integral multiple of 32 bits. If the string exceeds 16384 bytes, a warning message is emitted and the pragma is ignored.

Usage

This pragma defines a function and should appear in your program source only where functions are ordinarily defined.

The compiler passes parameters to the function in the same way as to any other function. For example, in functions taking integer-type arguments, the first parameter is passed to GPR3, the second to GPR4, and so on. Values returned by the function will be in GPR3 for integer values, and FPR1 for float or double values.

Code generated from *instruction_sequence* may use any and all volatile registers available on your system unless you use **#pragma reg_killed_by** to list a specific register set for use by the function. See "#pragma reg_killed_by" on page 263 for a list of volatile registers available on your system.

Inlining options do not affect functions defined by **#pragma mc_func**. However, you may be able to improve runtime performance of such functions with **#pragma isolated_call**.

Examples

In the following example, **#pragma mc_func** is used to define a function called `add_logical`. The function consists of machine instructions to add 2 integers with so-called *end-around carry*; that is, if a carry out results from the add then add the carry to the sum. This formula is frequently used in checksum computations.

```
int add_logical(int, int);
#pragma mc_func add_logical {"7c632014" "7c630194"}
                /*   addc       r3 <- r3, r4           */
                /*   addze      r3 <- r3, carry bit    */


main() {

      int i,j,k;

      i = 4;
      k = -4;
      j = add_logical(i,k);
      printf("\n\nresult = %d\n\n",j);
}
```

The result of running the program is:

```
result = 1
```

Related information

- "-qisolated_call" on page 126
- "#pragma reg_killed_by" on page 263
- "Inline assembly statements" in the *XL C/C++ Language Reference*

#pragma nosimd

See "-qhot" on page 103.

#pragma novector

See "-qhot" on page 103.

#pragma options

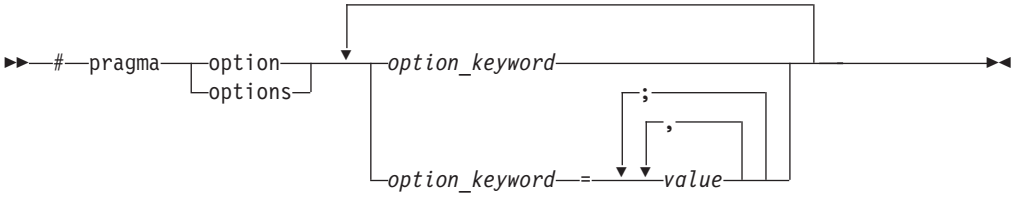
Category

Language element control

Purpose

Specifies compiler options in your source program.

Syntax



Parameters

The settings in the table below are valid *options* for **#pragma options**. For more information, refer to the pages of the equivalent compiler option.

Valid settings for #pragma options *option_keyword*	**Compiler option equivalent**
align=*option*	-qalign
[no]attr attr=full	-qattr
chars=*option*	-qchars
[no]check	-qcheck
[no]compact	-qcompact
[no]dbcs	-qmbcs, -qdbcs
[no]digraph	-qdigraph
[no]dollar	-qdollar
enum=*option*	-qenum
flag=*option*	-qflag
float=[no]*option*	-qfloat
[no]flttrap=*option*	-qflttrap (PPU only)
[no]fullpath	-qfullpath
halt	-qhalt
[no]idirfirst	-qidirfirst
[no]ignerrno	-qignerrno
ignprag=*option*	-qignprag
[no]info=*option*	-qinfo
initauto=*value*	-qinitauto
isolated_call=*names*	-qisolated_call
C langlvl	-qlanglvl
[no]libansi	-qlibansi
[no]list	-qlist
[no]longlong	-qlonglong
[no]maxmem=*number*	-qmaxmem
[no]mbcs	-qmbcs, -qdbcs
[no]optimize optimize=*number*	-O, -qoptimize
C++ priority=*number*	-qpriority (C++ only)
proclocal, procimported, procunknown	-qprocimported, -qproclocal, -qprocunknown (PPU only)
C [no]proto	-qproto (C only)
[no]ro	-qro (PPU only)
[no]roconst	-qroconst (PPU only)
[no]showinc	-qshowinc
[no]source	-qsource
spill=*number*	-qspill
[no]stdinc	-qstdinc
[no]strict	-qstrict

Valid settings for #pragma options *option_keyword*	Compiler option equivalent
tbtable=*option*	-qtbtable (PPU only)
tune=*option*	-qtune
[no]unroll unroll=*number*	-qunroll
C [no]upconv	-qupconv (C only)
[no]xref	-qxref

Usage

Most **#pragma options** directives must come before any statements in your source program; only comments, blank lines, and other pragma specifications can precede them. For example, the first few lines of your program can be a comment followed by the **#pragma options** directive:

```
/* The following is an example of a #pragma options directive: */

#pragma options langlvl=stdc89 halt=s spill=1024 source

/* The rest of the source follows ... */
```

To specify more than one compiler option with the **#pragma options** directive, separate the options using a blank space. For example:

```
#pragma options langlvl=stdc89 halt=s spill=1024 source
```

#pragma option_override

Category

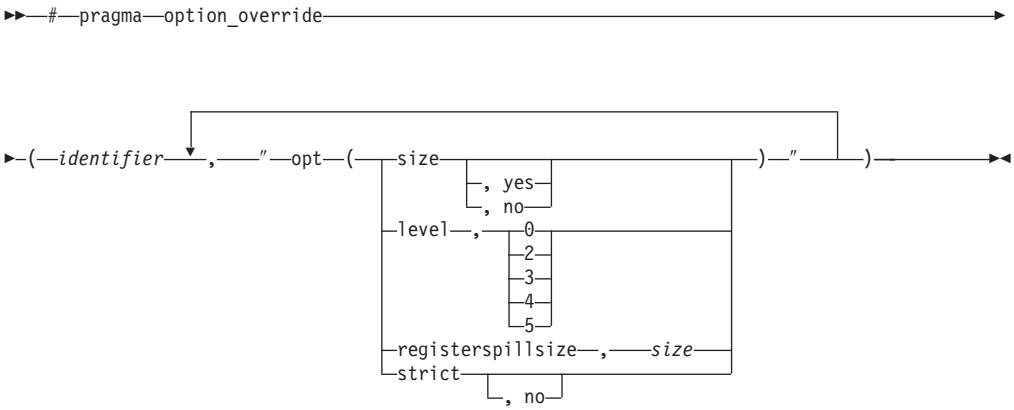
Optimization and tuning

Purpose

Allows you to specify optimization options at the subprogram level that override optimization options given on the command line.

This enables finer control of program optimization, and can help debug errors that occur only under optimization.

Syntax



Parameters

identifier
The name of a function for which optimization options are to be overridden.

The following table shows the equivalent command line option for each pragma suboption.

#pragma option_override value	Equivalent compiler option
level, 0	-O
level, 2	-O2
level, 3	-O3
level, 4	-O4
level, 5	-O5
registerspillsize, *size*	-qspill=*size*
size	-qcompact
size, yes	
size, no	-qnocompact
strict	-qstrict
strict, no	-qnostrict

Defaults

See the descriptions of the options listed in the table above for default settings.

Usage

The pragma takes effect only if optimization is already enabled by a command-line option. You can only specify an optimization level in the pragma *lower* than the level applied to the rest of the program being compiled.

The **#pragma option_override** directive only affects functions that are defined in the same compilation unit. The pragma directive can appear anywhere in the translation unit. That is, it can appear before or after the function definition, before or after the function declaration, before or after the function has been referenced, and inside or outside the function definition.

C++ This pragma cannot be used with overloaded member functions.

Examples

Suppose you compile the following code fragment containing the functions `foo` and `faa` using **-O2**. Since it contains the `#pragma option_override(faa, "opt(level, 0)")`, function `faa` will not be optimized.

```
foo(){
     .
     .
     .
     }

#pragma option_override(faa, "opt(level, 0)")

faa(){
     .
     .
     .
     }
```

Related information
- "-O, -qoptimize" on page 159
- "-qcompact" on page 63
- "-qspill" on page 192
- "-qstrict" on page 198

#pragma pack

Category
Object code control

Purpose
Sets the alignment of all aggregate members to a specified byte boundary.

If the byte boundary number is smaller than the natural alignment of a member, padding bytes are removed, thereby reducing the overall structure or union size.

Syntax

Defaults
Members of aggregates (structures, unions, and classes) are aligned on their natural boundaries and a structure ends on its natural boundary. The alignment of an aggregate is that of its strictest member (the member with the largest alignment requirement).

Parameters
nopack
Disables packing. Note that this parameter is not recognized when **-qpack_semantic=gnu** is in effect; a warning message is issued and the pragma is ignored.

number
is one of the following:

1 Aligns structure members on 1-byte boundaries, or on their natural alignment boundary, whichever is less.

2 Aligns structure members on 2-byte boundaries, or on their natural alignment boundary, whichever is less.

4 Aligns structure members on 4-byte boundaries, or on their natural alignment boundary, whichever is less.

8 Aligns structure members on 8-byte boundaries, or on their natural alignment boundary, whichever is less.

16 Aligns structure members on 16-byte boundaries, or on their natural alignment boundary, whichever is less.

pop
Sets the packing rule to that which was in effect before the current setting.

Usage

The **#pragma pack** directive applies to the definition of an aggregate type, rather than to the declaration of an instance of that type; it therefore automatically applies to all variables declared of the specified type.

The **#pragma pack** directive modifies the current alignment rule for only the members of structures whose declarations follow the directive. It does not affect the alignment of the structure directly, but by affecting the alignment of the members of the structure, it may affect the alignment of the overall structure.

The **#pragma pack** directive cannot increase the alignment of a member, but rather can decrease the alignment. For example, for a member with data type of `short`, a **#pragma pack(1)** directive would cause that member to be packed in the structure on a 1-byte boundary, while a **#pragma pack(4)** directive would have no effect.

The **#pragma pack** directive causes bit fields to cross bit field container boundaries.

```
#pragma pack(2)
struct A{
int a:31;
int b:2;
}x;

int main(){
printf("size of S = %d\n", sizeof(s));
}

When compiled and run, the output is:
size of S = 6

But if you remove the #pragma pack directive, you get this output:
size of S = 8
```

The **#pragma pack** directive applies only to complete declarations of structures or unions; this excludes forward declarations, in which member lists are not specified. For example, in the following code fragment, the alignment for `struct S` is 4, since this is the rule in effect when the member list is declared:

```
#pragma pack(1)
struct S;
#pragma pack(4)
struct S { int i, j, k; };
```

A nested structure has the alignment that precedes its declaration, not the alignment of the structure in which it is contained, as shown in the following example:

```
#pragma pack (4)               // 4-byte alignment
         struct nested {
           int  x;
           char y;
           int  z;
         };

         #pragma pack(1)           // 1-byte alignment
         struct packedcxx{            char   a;
            short  b;
            struct nested  s1;     // 4-byte alignment
         };
```

If more than one **#pragma pack** directive appears in a structure defined in an inlined function, the **#pragma pack** directive in effect at the beginning of the structure takes precedence.

Examples

The following example shows how the **#pragma pack** directive can be used to set the alignment of a structure definition:

```
//  header file file.h

   #pragma pack(1)

   struct jeff{           //    this structure is packed
     short bill;          //    along 1-byte boundaries
     int *chris;
   };
   #pragma pack(pop)       //   reset to previous alignment rule
// source file anyfile.c

   #include "file.h"

   struct jeff j;           //   uses the alignment specified
                            //   by the pragma pack directive
                            //   in the header file and is
                            //   packed along 1-byte boundaries
```

This example shows how a **#pragma pack** directive can affect the size and mapping of a structure:

```
struct s_t {
 char a;
 int b;
 short c;
 int d;
}S;
```

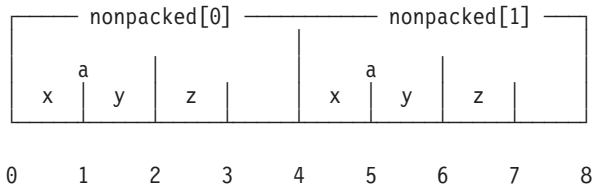
Default mapping:	**With #pragma pack(1):**
size of `s_t` = 16	size of `s_t` = 11
offset of `a` = 0	offset of `a` = 0
offset of `b` = 4	offset of `b` = 1
offset of `c` = 8	offset of `c` = 5
offset of `d` = 12	offset of `d` = 7
alignment of `a` = 1	alignment of `a` = 1
alignment of `b` = 4	alignment of `b` = 1
alignment of `c` = 2	alignment of `c` = 1
alignment of `d` = 4	alignment of `d` = 1

The following example defines a union `uu` containing a structure as one of its members, and declares an array of 2 unions of type `uu`:

```
union uu {
  short    a;
  struct {
    char x;
    char y;
    char z;
  } b;
};

union uu nonpacked[2];
```

Since the largest alignment requirement among the union members is that of `short a`, namely, 2 bytes, one byte of padding is added at the end of each union in the array to enforce this requirement:



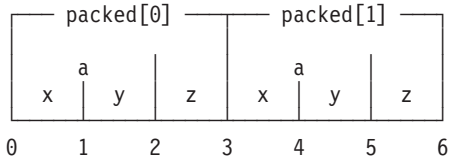
The next example uses **#pragma pack(1)** to set the alignment of unions of type `uu` to 1 byte:

```
#pragma pack(1)

union uu {
  short    a;
  struct {
    char x;
    char y;
    char z;
  } b;
};

union uu pack_array[2];
```

Now, each union in the array `packed` has a length of only 3 bytes, as opposed to the 4 bytes of the previous case:



Related information

- "-qalign" on page 46
- "Using alignment modifiers"in the *XL C/C++ Programming Guide*

#pragma priority (C++ only)

See "-qpriority (C++ only)" on page 173.

#pragma reachable

Category

Optimization and tuning

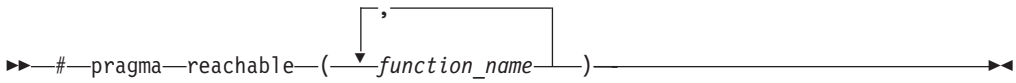
Purpose

Informs the compiler that the point in the program after a named function can be the target of a branch from some unknown location.

By informing the compiler that the instruction after the specified function can be reached from a point in your program other than the return statement in the named function, the pragma allows for additional opportunities for optimization.

Note: The compiler automatically inserts **#pragma reachable** directives for the `setjmp` family of functions (`setjmp`, `_setjmp`, `sigsetjmp`, and `_sigsetjmp`) when you include the setjmp.h header file.

Syntax



Parameters

function_name
The name of a function preceding the instruction which is reachable from a point in the program other than the function's return statement.

Defaults

Not applicable.

Related information

- "#pragma leaves" on page 249

#pragma reg_killed_by

Category

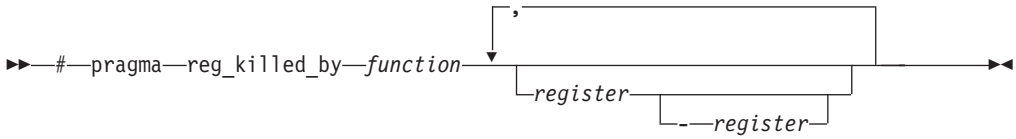
Optimization and tuning

Purpose

Specifies registers that may be altered by functions specified by **#pragma mc_func**.

Ordinarily, code generated for functions specified by **#pragma mc_func** may alter any or all volatile registers available on your system. You can use **#pragma reg_killed_by** to explicitly list a specific set of volatile registers to be altered by such functions. Registers not in this list will not be altered.

Syntax



Parameters

function
The name of a function previously defined using the **#pragma mc_func** directive.

register
The symbolic name(s) of either a single register or a range of registers to be altered by the named *function*. The symbolic name must be a valid register name on the target platform. Valid registers for the PPU are:

cr0, cr1, and cr5 to cr7
Condition registers

ctr Count register

gr0 and gr3 to gr12
General purpose registers

fp0 to fp13
Floating-point registers

fs Floating point and status control register

lr Link register

vr0 to vr31
Vector registers

xer Fixed-point exception register

Valid registers for the SPU are 0 to 127, or v0 to v127.

You can identify a range of registers by providing the symbolic names of both starting and ending registers, separated by a dash.

If no *register* is specified, no volatile registers will be killed by the named *function*.

Examples

The following example shows how to use **#pragma reg_killed_by** to list a specific set of volatile registers to be used by the function defined by **#pragma mc_func**.

```
int add_logical(int, int);
#pragma mc_func add_logical {"7c632014" "7c630194"}
                /*   addc       r3 <- r3, r4           */
                /*   addze      r3 <- r3, carry bit    */

#pragma reg_killed_by add_logical gr3, xer
                /* only gpr3 and the xer are altered by this function */


main() {

      int i,j,k;

      i = 4;
      k = -4;
      j = add_logical(i,k);
      printf("\n\nresult = %d\n\n",j);
}
```

Related information

- "#pragma mc_func" on page 253

#pragma report (C++ only)

Category

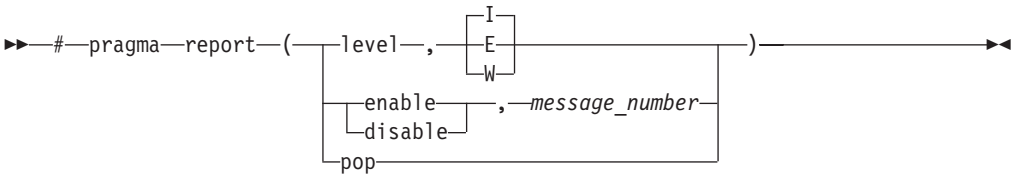
Listings, messages and compiler information

Purpose

Controls the generation of diagnostic messages.

The pragma allows you to specify a minimum severity level for a message for it to display, or allows you to enable or disable a specific message regardless of the prevailing report level.

Syntax



Defaults

The default report level is Informational (**I**), which displays messages of all types.

Parameters

level
Indicates that the pragma is set according to the minimum severity level of diagnostic messages to display.

E Indicates that only error messages will display. Error messages are of the highest severity. This is equivalent to the **-qflag=e:e** compiler option.

W Indicates that warning and error messages will display. This is equivalent to the **-qflag=w:w** compiler option.

I Indicates that all diagnostic messages will display: warning, error and informational messages. Informational messages are of the lowest severity. This is equivalent to the **-qflag=i:i** compiler option.

enable
Enables the specified *message_number*.

disable
Disables the specified *message_number*.

message_number
Represents a message identifier, which consists of a prefix followed by the message number; for example, CCN1004.

pop
Reverts the report level to that which was previously in effect. If no previous report level has been specified, a warning is issued, and the report level remains unchanged.

Usage

The pragma takes precedence over **#pragma info** and most compiler options. For example, if you use **#pragma report** to disable a compiler message, that message will not be displayed with any **-qflag** compiler option setting.

Related information

- "-qflag" on page 85

#pragma STDC cx_limited_range

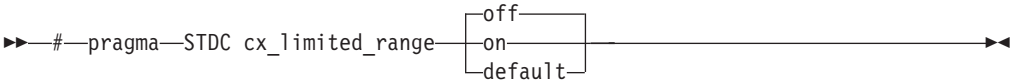
Category

Optimization and tuning

Purpose

Instructs the compiler that complex division and absolute value are only invoked with values such that intermediate calculation will not overflow or lose significance.

Syntax



Usage

Using values outside the limited range may generate wrong results, where the limited range is defined such that the "obvious symbolic definition" will not overflow or run out of precision.

The pragma is effective from its first occurrence until another **cx_limited_range** pragma is encountered, or until the end of the translation unit. When the pragma occurs inside a compound statement (including within a nested compound statement), it is effective from its first occurrence until another **cx_limited_range** pragma is encountered, or until the end of the compound statement.

Examples

The following example shows the use of the pragma for complex division:

```
#include <complex.h>

_Complex double a, b, c, d;
void p() {

d = b/c;

{

#pragma STDC CX_LIMITED_RANGE ON

a = b / c;

}
}
```

The following example shows the use of the pragma for complex absolute value:

```
#include <complex.h>

_Complex double cd = 10.10 + 10.10*I;
int p() {

#pragma STDC CX_LIMITED_RANGE ON

double d = cabs(cd);
}
```

Related information

- "Standard pragmas" in the *XL C/C++ Language Reference*

#pragma stream_unroll

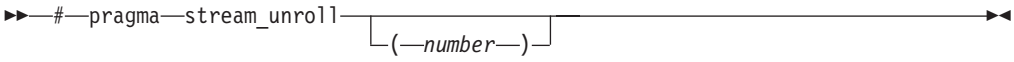
Category

Optimization and tuning

Purpose

When optimization is enabled, breaks a stream contained in a `for` loop into multiple streams.

Syntax



Parameters

number

A loop unrolling factor. C The value of *number* is a positive integral constant expression. C++ The value of *number* is a positive scalar integer or compile-time constant initialization expression.

An unroll factor of 1 disables unrolling.

If *number* is not specified, the optimizer determines an appropriate unrolling factor for each nested loop.

Usage

To enable stream unrolling, you must specify **-qhot** and **-qstrict**, , or use optimization level **-O4** or higher. If **-qstrict** is in effect, no stream unrolling takes place.

For stream unrolling to occur, the **#pragma stream_unroll** directive must be the last pragma specified preceding a `for` loop. C Specifying **#pragma stream_unroll** more than once for the same `for` loop or combining it with other loop unrolling pragmas (**#pragma unroll**, **#pragma nounroll**, **#pragma unrollandfuse**, **#pragma nounrollandfuse**) results in a warning. C++ The compiler silently ignores all but the last of multiple loop unrolling pragmas specified on the same `for` loop.

Examples

The following is an example of how **#pragma stream_unroll** can increase performance.

```
int i, m, n;
int a[1000][1000];
int b[1000][1000];
int c[1000][1000];


....

#pragma stream_unroll(4)
for (i=1; i<n; i++) {
    a[i] = b[i] * c[i];
}
```

The unroll factor of 4 reduces the number of iterations from `n` to `n/4`, as follows:

```
for (i=1; i<n/4; i++) {
    a[i] = b[i] + c[i];
    a[i+m] = b[i+m] + c[i+m];
    a[i+2*m] = b[i+2*m] + c[i+2*m];
    a[i+3*m] = b[i+3*m] + c[i+3*m];
}
```

Related information

- "-qunroll" on page 216
- "#pragma unrollandfuse" on page 268

#pragma strings

See “-qro (PPU only)” on page 182.

#pragma unroll

See “-qunroll” on page 216.

#pragma unrollandfuse

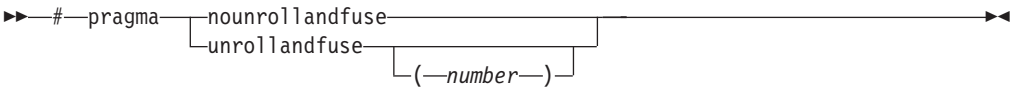
Category

Optimization and tuning

Purpose

Instructs the compiler to attempt an unroll and fuse operation on nested `for` loops.

Syntax



Parameters

number

A loop unrolling factor. C The value of *number* is a positive integral constant expression. C++ The value of *number* is a positive scalar integer or compile-time constant initialization expression.

If *number* is not specified, the optimizer determines an appropriate unrolling factor for each nested loop.

Usage

The **#pragma unrollandfuse** directive applies only to the outer loops of nested `for` loops that meet the following conditions:

- There must be only one loop counter variable, one increment point for that variable, and one termination variable. These cannot be altered at any point in the loop nest.
- Loops cannot have multiple entry and exit points. The loop termination must be the only means to exit the loop.
- Dependencies in the loop must not be "backwards-looking". For example, a statement such as `A[i][j] = A[i -1][j + 1] + 4)` must not appear within the loop.

For loop unrolling to occur, the **#pragma unrollandfuse** directive must precede a `for` loop. You must not specify **#pragma unrollandfuse** for the innermost `for` loop.

You must not specify **#pragma unrollandfuse** more than once, or combine the directive with **#pragma nounrollandfuse**, **#pragma nounroll**, **#pragma unroll**, or **#pragma stream_unroll** directives for the same `for` loop.

Predefined macros

None.

Examples

In the following example, a **#pragma unrollandfuse** directive replicates and fuses the body of the loop. This reduces the number of cache misses for array b.

```
int i, j;
int a[1000][1000];
int b[1000][1000];
int c[1000][1000];


....

#pragma unrollandfuse(2)
for (i=1; i<1000; i++) {
    for (j=1; j<1000; j++) {
        a[j][i] = b[i][j] * c[j][i];
    }
}
```

The for loop below shows a possible result of applying the **#pragma unrollandfuse(2)** directive to the loop shown above:

```
for (i=1; i<1000; i=i+2) {
    for (j=1; j<1000; j++) {
        a[j][i] = b[i][j] * c[j][i];
        a[j][i+1] = b[i+1][j] * c[j][i+1];
    }
}
```

You can also specify multiple **#pragma unrollandfuse** directives in a nested loop structure.

```
int i, j, k;
int a[1000][1000];
int b[1000][1000];
int c[1000][1000];
int d[1000][1000];
int e[1000][1000];


....

#pragma unrollandfuse(4)
for (i=1; i<1000; i++) {
#pragma unrollandfuse(2)
    for (j=1; j<1000; j++) {
   for (k=1; k<1000; k++) {
            a[j][i] = b[i][j] * c[j][i] + d[j][k] * e[i][k];
        }
    }
}
```

Related information

- "-qunroll" on page 216
- "#pragma stream_unroll" on page 266

#pragma weak

Category

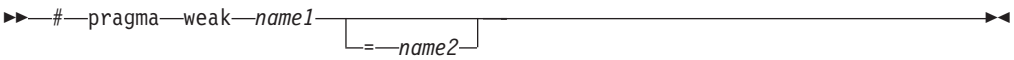
Object code control

Purpose

Prevents the linker from issuing error messages if it encounters a symbol multiply-defined during linking, or if it does not find a definition for a symbol.

The pragma can be used to allow a program to call a user-defined function that has the same name as a library function. By marking the library function definition as "weak", the programmer can reference a "strong" version of the function and cause the linker to accept multiple definitions of a global symbol in the object code. While this pragma is intended for use primarily with functions, it will also work for most data objects.

Syntax



Parameters

name1
A name of a data object or function with external linkage.

name2
A name of a data object or function with external linkage.

C++ *name2* must not be a member function. If *name2* is a template function, you must explicitly instantiate the template function.

C++ Names must be specified using their mangled names. To obtain C++ mangled names, compile your source to object files only, using the **-c** compiler option, and use the **nm** operating system command on the resulting object file. (See also "Name mangling" in the *XL C/C++ Language Reference* for details on using the `extern "C"` linkage specifier on declarations to prevent name mangling.)

Usage

There are two forms of the **weak** pragma:

#pragma weak *name1*
This form of the pragma marks the definition of the *name1* as "weak" in a given compilation unit. If *name1* is referenced from anywhere in the program, the linker will use the "strong" version of the definition (that is, the definition not marked with **#pragma weak**), if there is one. If there is no strong definition, the linker will use the weak definition; if there are multiple weak definitions, it is unspecified which weak definition the linker will select (typically, it uses the definition found in the first object file specified on the command line during the link step). *name1* must be defined in the same compilation unit as **#pragma weak**. If *name1* is referenced, but no definition of it can be found, it is assigned a value of 0.

#pragma weak *name1*=*name2*
This form of the pragma creates a weak definition of the *name1* for a given compilation unit, and an alias for *name2*. If *name1* is referenced from anywhere in the program, the linker will use the "strong" version of the definition (that is, the definition not marked with **#pragma weak**), if there is one. If there is no strong definition, the linker will use the weak definition, which resolves to the definition of *name2*. If there are multiple weak definitions, it is unspecified which weak definition the linker will select (typically, it uses the definition found in the first object file specified on the command line during the link step).

name2 must be defined in the same compilation unit as **#pragma weak**. *name1* may or may not be declared in the same compilation unit as the **#pragma weak**, but must never be defined in the compilation unit. If

name1 is declared in the compilation unit, *name1*'s declaration must be compatible to that of *name2*. For example, if *name2* is a function, *name1* must have the same return and argument types as *name2*.

This pragma should not be used with uninitialized global data, or with shared library data objects that are exported to executables.

Examples

The following is an example of the **#pragma weak** *name1* form:

```
// Compilation unit 1:

#include <stdio.h>

void foo();

int main()
{
       foo();
}

// Compilation unit 2:

#include <stdio.h>

#if __cplusplus
#pragma weak
#else
#pragma weak foo
#endif

void foo()
{
       printf("Foo called from compilation unit 2\n");
}

// Compilation unit 3:

#include <stdio.h>

void foo()
{
       printf("Foo called from compilation unit 3\n");
}
```

If all three compilation units are compiled and linked together, the linker will use the strong definition of `foo` in compilation unit 3 for the call to `foo` in compilation unit 1, and the output will be:

```
Foo called from compilation unit 3
```

If only compilation unit 1 and 2 are compiled and linked together, the linker will use the weak definition of `foo` in compilation unit 2, and the output will be:

```
Foo called from compilation unit 2
```

The following is an example of the **#pragma weak** *name1*=*name2* form:

```
// Compilation unit 1:

#include <stdio.h>

void foo();

int main()
{
```

```
foo();
}

// Compilation unit 2:

#include <stdio.h>

void foo(); // optional

#if __cplusplus
#pragma weak
#else
#pragma weak foo = foo2
#endif

void foo2()
{
printf("Hello from foo2!\n");
}

// Compilation unit 3:

#include <stdio.h>

void foo()
{
printf("Hello from foo!\n");
}
```

If all three compilation units are compiled and linked together, the linker will use the strong definition of `foo` in compilation unit 3 for the call to `foo` from compilation unit 1, and the output will be:

```
Hello from foo!
```

If only compilation unit 1 and 2 are compiled and linked together, the linker will use the weak definition of `foo` in compilation unit 2, which is an alias for `foo2`, and the output will be:

```
Hello from foo2!
```

Related information

- "The weak variable attribute" in the *XL C/C++ Language Reference*
- "The weak function attribute" in the *XL C/C++ Language Reference*
- “#pragma map” on page 251

Chapter 5. Compiler predefined macros

Predefined macros can be used to conditionally compile code for specific compilers, specific versions of compilers, specific environments and/or specific language features.

Predefined macros fall into several categories:

- "General macros"
- "Macros related to the platform" on page 274
- "Macros related to compiler features" on page 275

"Examples of predefined macros" on page 282 show how you can use compiler macros in your code.

General macros

The following predefined macros are always predefined by the compiler. Unless noted otherwise, all the following macros are *protected*, which means that the compiler will issue a warning if you try to undefine or redefine them.

Table 32. General predefined macros

Predefined macro name	Description	Predefined value
__BASE_FILE__	Indicates the name of the primary source file.	The fully qualified file name of the primary source file.
__FUNCTION__	Indicates the name of the function currently being compiled.	A character string containing the name of the function currently being compiled.
__SIZE_TYPE__	Indicates the underlying type of `size_t` on the current platform. Not protected.	`unsigned int` in 32-bit compilation mode. `unsigned long` in 64-bit compilation mode.
__TIMESTAMP__	Indicates the date and time when the source file was last modified. The value changes as the compiler processes any include files that are part of your source program.	A character string literal in the form *"Day Mmm dd hh:mm:ss yyyy"*, where:: *Day* Represents the day of the week (`Mon`, `Tue`, `Wed`, `Thu`, `Fri`, `Sat`, or `Sun`). *Mmm* Represents the month in an abbreviated form (`Jan`, `Feb`, `Mar`, `Apr`, `May`, `Jun`, `Jul`, `Aug`, `Sep`, `Oct`, `Nov`, or `Dec`). *dd* Represents the day. If the day is less than 10, the first `d` is a blank character. *hh* Represents the hour. *mm* Represents the minutes. *ss* Represents the seconds. *yyyy* Represents the year.

Macros indicating the XL C/C++ compiler product

Macros related to the XL C/C++ compiler are always predefined, and are protected (the compiler will issue a warning if you try to undefine or redefine them).

Table 33. Compiler product predefined macros

Predefined macro name	Description	Predefined value
C __IBMC__	Indicates the level of the XL C compiler.	An integer in the format *VRM*, where : *V* Represents the version number *R* Represents the release number *M* Represents the modification number In XL C/C++ V9.0, the value of the macro is 900.
C++ __IBMCPP__	Indicates the level of the XL C++ compiler.	An integer in the format *VRM*, where : *V* Represents the version number *R* Represents the release number *M* Represents the modification number In XL C/C++ V9.0, the value of the macro is 900.
C __xlc__	Indicates the level of the XL C compiler.	A string in the format "*V.R.M.F*", where: *V* Represents the version number *R* Represents the release number *M* Represents the modification number *F* Represents the fix level In XL C/C++ V9.0, the value of the macro is "9.0.0.0".
__xlC__	Indicates the level of the XL C++ compiler. Using the XL C compiler also automatically defines this macro.	A four-digit hexadecimal integer in the format 0x*VVRM*, where: *V* Represents the version number *R* Represents the release number *M* Represents the modification number In XL C/C++ V9.0, the value of the macro is 0x0900.

Macros related to the platform

The following predefined macros are provided to facilitate porting applications between platforms. All platform-related predefined macros are unprotected and may be undefined or redefined without warning unless otherwise specified.

Table 34. Platform-related predefined macros

Predefined macro name	Description	Predefined value	Predefined under the following conditions
_BIG_ENDIAN, __BIG_ENDIAN__	Indicates that the platform is big-endian (that is, the most significant byte is stored at the memory location with the lowest address).	1	Always predefined.

Table 34. Platform-related predefined macros (continued)

Predefined macro name	Description	Predefined value	Predefined under the following conditions
__ELF__	Indicates that the ELF object model is in effect.	1	Always predefined for the Linux platform.
C++ __GXX_WEAK__	Indicates that weak symbols are supported (used for template instantiation by the linker).	1	Always predefined.
_LP32, __LP32__	Indicates that the target platform uses 32 bits for `int`, `long int`, and pointer types.	1	Predefined when the target platform uses 32-bit `int`, `long int`, and pointer types.
__powerpc, __powerpc__	Indicates that the target architecture is PowerPC.	1	Predefined when compilation targets the PPU.
__powerpc64__	Indicates that the target architecture is PowerPC and that 64-bit compilation mode is enabled.	1	Predefined when compilation targets the PPU and **-q64** is in effect.
__PPC, __PPC__	Indicates that the target architecture is PowerPC.	1	Predefined when compilation targets the PPU.
__PPC64__	Indicates that the target architecture is PowerPC and that 64-bit compilation mode is enabled.	1	Predefined when compilation targets the PPU and **-q64** is in effect.
__THW_CBEA__	Indicates that the target architecture is Cell Broadband Engine.	1	Always predefined.

Macros related to compiler features

Feature-related macros are predefined according to the setting of specific compiler options or pragmas. Unless noted otherwise, all feature-related macros are protected (the compiler will issue a warning if you try to undefine or redefine them).

Feature-related macros are discussed in the following sections:

- "Macros related to compiler option settings"
- "Macros related to architecture settings" on page 277
- "Macros related to language levels" on page 278

Macros related to compiler option settings

The following macros can be tested for various features, including source input characteristics, output file characteristics, optimization, and so on. All of these macros are predefined by a specific compiler option or suboption, or any invocation or pragma that implies that suboption. If the suboption enabling the feature is not in effect, then the macro is undefined.

Table 35. General option-related predefined macros

Predefined macro name	Description	Predefined value	Predefined when the following compiler option or equivalent pragma is in effect:
__ALTIVEC__	Indicates support for vector data types. (unprotected)	1	-qaltivec

Table 35. General option-related predefined macros (continued)

Predefined macro name	Description	Predefined value	Predefined when the following compiler option or equivalent pragma is in effect:
__64BIT__	Indicates that 64-bit compilation mode is in effect.	1	-q64
_CHAR_SIGNED, __CHAR_SIGNED__	Indicates that the default character type is `signed char`.	1	-qchars=signed
_CHAR_UNSIGNED, __CHAR_UNSIGNED__	Indicates that the default character type is `unsigned char`.	1	-qchars=unsigned
C++ __EXCEPTIONS	Indicates that C++ exception handling is enabled.	1	-qeh
__IBM_GCC_ASM	Indicates support for GCC inline `asm` statements.	1	C **-qasm=gcc** and **-qlanglvl=extc99 | extc89 | extended** or**-qkeyword=asm** C++ **-qasm=gcc** and**-qlanglvl=extended**
		0	C **-qnoasm** and **-qlanglvl=extc99 | extc89 | extended** or**-qkeyword=asm** C++ **-qnoasm** and**-qlanglvl=extended**
C++ __IBM_STDCPP_ASM	Indicates that support for GCC inline `asm` statements is disabled.	0	**-qnoasm=stdcpp**
__IBM_UTF_LITERAL	Indicates support for UTF-16 and UTF-32 string literals.	1	-qutf
C++ __IGNERRNO__	Indicates that system calls do not modify `errno`, thereby enabling certain compiler optimizations.	1	-qignerrno
C++ __INITAUTO__	Indicates the value to which automatic variables which are not explicitly initialized in the source program are to be initialized.	The two-digit hexadecimal value specified in the **-qinitauto** compiler option.	-qinitauto=*hex value*

Table 35. General option-related predefined macros (continued)

Predefined macro name	Description	Predefined value	Predefined when the following compiler option or equivalent pragma is in effect:
C++ __INITAUTO_W__	Indicates the value to which automatic variables which are not explicitly initialized in the source program are to be initialized.	An eight-digit hexadecimal corresponding to the value specified in the **-qinitauto** compiler option repeated 4 times.	-qinitauto=*hex value*
C++ __LIBANSI__	Indicates that calls to functions whose names match those in the C Standard Library are in fact the C library functions, enabling certain compiler optimizations.	1	-qlibansi
__LONGDOUBLE64	Indicates that the size of a `long double` type is 64 bits.	1	Always predefined for the SPU.
__LONGDOUBLE128, __LONG_DOUBLE_128__	Indicates that the size of a `long double` type is 128 bits.	1	Always predefined for the PPU.
__OPTIMIZE__	Indicates the level of optimization in effect.	2	-O | -O2
		3	-O3 | -O4 | -O5
__OPTIMIZE_SIZE__	Indicates that optimization for code size is in effect.	1	-O | -O2 | -O3 | -O4 | -O5 and -qcompact
C++ __RTTI_DYNAMIC_CAST__	Indicates that runtime type identification information for the `dynamic_cast` operator is generated.	1	-qrtti
C++ __RTTI_TYPE_INFO__	Indicates that runtime type identification information for the `typeid` operator is generated.	1	-qrtti
C++ __NO_RTTI__	Indicates that runtime type identification information is disabled.	1	-qnortti
C++ __TEMPINC__	Indicates that the compiler is using the template-implementation file method of resolving template functions.	1	-qtempinc
__VEC__	Indicates support for vector data types.	10205	-qaltivec

Macros related to architecture settings

The following macros can be tested for target architecture settings. All of these macros are predefined to a value of 1 by a **-qarch** compiler option setting, or any

other compiler option that implies that setting. If the **-qarch** suboption enabling the feature is not in effect, then the macro is undefined.

Table 36. **-qarch***-related macros*

Macro name	Description	Predefined by the following -qarch suboptions
_ARCH_CELLPPU	Indicates that the application is targeted to run on the PPU.	cellppu
_ARCH_CELLSPU	Indicates that the application is targeted to run on the SPU.	cellspu
_ARCH_CELLSPU_EDP	Indicates that the application is targeted to run on the enhanced CBEA-compliant processor with a double precision SPU.	edp
_ARCH_COM	Indicates that the application is targeted to run on any PowerPC processor.	cellppu
_ARCH_PPC	Indicates that the application is targeted to run on any PowerPC processor.	cellppu
_ARCH_PPC64	Indicates that the application is targeted to run on PowerPC processors with 64-bit support.	cellppu
_ARCH_PPCGR	Indicates that the application is targeted to run on PowerPC processors with graphics support.	cellppu
_ARCH_PPC64GR	Indicates that the application is targeted to run on PowerPC processors with 64-bit and graphics support.	cellppu
_ARCH_PPC64GRSQ	Indicates that the application is targeted to run on PowerPC processors with 64-bit, graphics, and square root support.	cellppu
_ARCH_PPC64V	Indicates that the application is targeted to run on PowerPC processors with 64-bit and vector processing support.	cellppu
__PPU__	Indicates that the application is targeted to run on the PPU.	cellppu
__SPU__	Indicates that the application is targeted to run on the SPU.	cellspu
__SPU_EDP__	Indicates that the application is targeted to run on the enhanced CBEA-compliant processor with a double precision SPU.	edp

Macros related to language levels

The following macros can be tested for C99 features, features related to GNU C or C++, and other IBM language extensions. All of these macros are predefined to a value of 1 by a specific language level, represented by a suboption of the **-qlanglvl** compiler option, or any invocation or pragma that implies that suboption. If the suboption enabling the feature is not in effect, then the macro is undefined. For descriptions of the features related to these macros, see the *XL C/C++ Language Reference*.

Table 37. Predefined macros for language features

Predefined macro name	Description	Predefined when the following language level is in effect
C++ __BOOL__	Indicates that the `bool` keyword is accepted.	Always defined except when **-qnokeyword=bool** is in effect.
C __C99_BOOL	Indicates support for the `_Bool` data type.	stdc99 | extc99 | extc89 | extended
C __C99_COMPLEX	Indicates support for complex data types.	stdc99 | extc99 | extc89 | extended
C++ __C99_COMPLEX_HEADER__	Indicates support for C99-style complex headers.	c99complexheader
C __C99_CPLUSCMT	Indicates support for C++ style comments	stdc99 | extc99 (also **-qcpluscmt**)
C __C99_COMPOUND_LITERAL	Indicates support for compound literals.	stdc99 | extc99 | extc89 | extended
C __C99_DESIGNATED_INITIALIZER	Indicates support for designated initialization.	stdc99 | extc99 | extc89 | extended
C __C99_DUP_TYPE_QUALIFIER	Indicates support for duplicated type qualifiers.	stdc99 | extc99 | extc89 | extended
__C99_EMPTY_MACRO_ARGUMENTS	Indicates support for empty macro arguments.	C stdc99 | extc99 | extc89 | extended C++ extended
C __C99_FLEXIBLE_ARRAY_MEMBER	Indicates support for flexible array members.	stdc99 | extc99 | extc89 | extended
__C99__FUNC__	Indicates support for the `__func__` predefined identifier.	C stdc99 | extc99 | extc89 | extended C++ extended | c99__func__
__C99_HEX_FLOAT_CONST	Indicates support for hexadecimal floating constants.	C stdc99 | extc99 | extc89 | extended C++ extended | c99hexfloat
C __C99_INLINE	Indicates support for the `inline` function specifier.	stdc99 | extc99 (also **-qkeyword=inline**)
C __C99_LLONG	Indicates support for C99-style `long long` data types.	stdc99 | extc99
__C99_MACRO_WITH_VA_ARGS	Indicates support for function-like macros with variable arguments.	C stdc99 | extc99 | extc89 | extended C++ extended | varargmacros
C __C99_MAX_LINE_NUMBER	Indicates that the maximum line number is 2147483647.	stdc99 | extc99 | extc89 | extended
C __C99_MIXED_DECL_AND_CODE	Indicates support for mixed declaration and code.	stdc99 | extc99 | extc89 | extended

Table 37. Predefined macros for language features (continued)

Predefined macro name	Description	Predefined when the following language level is in effect
C __C99_MIXED_STRING_CONCAT	Indicates support for concatenation of wide string and non-wide string literals.	stdc99 | extc99 | extc89 | extended
C __C99_NON_LVALUE_ARRAY_SUB	Indicates support for non-lvalue subscripts for arrays.	stdc99 | extc99 | extc89 | extended
C __C99_NON_CONST_AGGR_INITIALIZER	Indicates support for non-constant aggregate initializers.	stdc99 | extc99 | extc89 | extended
__C99_PRAGMA_OPERATOR	Indicates support for the `_Pragma` operator.	C stdc99 | extc99 | extc89 | extended C++ extended
C __C99_REQUIRE_FUNC_DECL	Indicates that implicit function declaration is not supported.	stdc99
__C99_RESTRICT	Indicates support for the C99 `restrict` qualifier.	C stdc99 | extc99 (also **-qkeyword=restrict**) C++ extended (also **-qkeyword=restrict**)
C __C99_STATIC_ARRAY_SIZE	Indicates support for the `static` keyword in array parameters to functions.	stdc99 | extc99 | extc89 | extended
C __C99_STD_PRAGMAS	Indicates support for standard pragmas.	stdc99 | extc99 | extc89 | extended
C __C99_TGMATH	Indicates support for type-generic macros in tgmath.h	stdc99 | extc99 | extc89 | extended
__C99_UCN	Indicates support for universal character names.	C stdc99 | extc99 | ucs C++ ucs
C __C99_VAR_LEN_ARRAY	Indicates support for variable length arrays.	stdc99 | extc99 | extc89 | extended
C++ __C99_VARIABLE_LENGTH_ARRAY	Indicates support for variable length arrays.	extended | c99vla
__DIGRAPHS__	Indicates support for digraphs.	C stdc99 | extc99 | extc89 | extended (also **-qdigraph**) C++ extended (also **-qdigraph**)
C __EXTENDED__	Indicates that language extensions are supported.	extended

Table 37. Predefined macros for language features (continued)

Predefined macro name	Description	Predefined when the following language level is in effect
__IBM__ALIGN	Indicates support for the `__align` specifier.	C++ Always defined except when **-qnokeyword=__alignof** is specified
__IBM_ALIGNOF__	Indicates support for the `__alignof__` operator.	C extc99 | extc89 | extended C++ extended
__IBM_ALLOW_OVERRIDE_PLACEMENT_NEW	Indicates support for pre-V9 default behavior.	C++ extended
__IBM_ATTRIBUTES	Indicates support for type, variable, and function attributes.	C extc99 | extc89 | extended C++ extended
__IBM_COMPUTED_GOTO	Indicates support for computed `goto` statements.	C extc99 | extc89 | extended C++ extended | gnu_computedgoto
__IBM_EXTENSION_KEYWORD	Indicates support for the `__extension__` keyword.	C extc99 | extc89 | extended C++ extended
__IBM_GCC__INLINE__	Indicates support for the GCC `__inline__` specifier.	C extc99 | extc89 | extended C++ extended
C __IBM_DOLLAR_IN_ID	Indicates support for dollar signs in identifiers.	extc99 | extc89 | extended
C __IBM_GENERALIZED_LVALUE	Indicates support for generalized lvalues.	extc99 | extc89 | extended
__IBM_INCLUDE_NEXT	Indicates support for the `#include_next` preprocessing directive.	C Always defined C++ Always defined except when **-qlanglvl=nognu_include_next** is in effect.
__IBM_LABEL_VALUE	Indicates support for labels as values.	C extc99 | extc89 | extended C++ extended | gnu_labelvalue

Table 37. Predefined macros for language features (continued)

Predefined macro name	Description	Predefined when the following language level is in effect
__IBM_LOCAL_LABEL	Indicates support for local labels.	C extc99 | extc89 | extended C++ extended | gnu_locallabel
__IBM_MACRO_WITH_VA_ARGS	Indicates support for variadic macro extensions.	C extc99 | extc89 | extended C++ extended | gnu_varargmacros
C _IBM_NESTED_FUNCTION	Indicates support for nested functions.	extc99 | extc89 | extended
C __IBM_PP_PREDICATE	Indicates support for `#assert`, `#unassert`, `#cpu`, `#machine`, and `#system` preprocessing directives.	extc99 | extc89 | extended
C __IBM_PP_WARNING	Indicates support for the `#warning` preprocessing directive.	extc99 | extc89 | extended
C __IBM_REGISTER_VARS	Indicates support for variables in specified registers.	Always defined.
C++ __IBM_REGISTER_VARIABLES	Indicates support for variables in specified registers.	Always defined.
__IBM__TYPEOF__	Indicates support for the `__typeof__` or `typeof` keyword.	C always defined C++ extended (Also **-qkeyword=typeof**)
_LONG_LONG	Indicates support for IBM `long long` data types.	C extended | extc89 (also -qlonglong) C++ extended (also **-qlonglong**)

Examples of predefined macros

This example illustrates use of the __FUNCTION__ and the __C99__FUNC__ macros to test for the availability of the C99 `__func__` identifier to return the current function name:

```
#include <stdio.h>

#if defined(__C99__FUNC__)
#define PRINT_FUNC_NAME() printf (" In function %s \n", __func__);
#elif defined(__FUNCTION__)
#define PRINT_FUNC_NAME() printf (" In function %s \n", __FUNCTION__);
#else
#define PRINT_FUNC_NAME() printf (" Function name unavailable\n");
#endif

void foo(void);
```

```
int main(int argc, char **argv)
{
   int k = 1;
   PRINT_FUNC_NAME();
   foo();
   return 0;
}

void foo (void)
{
   PRINT_FUNC_NAME();
   return;
}
```

The output of this example is:

```
In function main
In function foo
```

C++ This example illustrates use of the __FUNCTION__ macro in a C++ program with virtual functions.

```
#include <stdio.h>
class X { public: virtual void func() = 0;};

class Y : public X {
   public: void func() { printf("In function %s \n", __FUNCTION__);}
};

int main() {
  Y aaa;
  aaa.func();
}
```

The output of this example is:

```
In function Y::func()
```

Chapter 6. Compiler built-in functions

A built-in function is a coding extension to C and C++ that allows a programmer to use the syntax of C function calls and C variables to access the instruction set of the processor of the compiling machine. IBM PowerPC architectures have special instructions that enable the development of highly optimized applications. Access to some PowerPC instructions cannot be generated using the standard constructs of the C and C++ languages. Other instructions can be generated through standard constructs, but using built-in functions allows exact control of the generated code. Inline assembly language programming, which uses these instructions directly, is not fully supported by XL C/C++ and other compilers. Furthermore, the technique can be time-consuming to implement.

As an alternative to managing hardware registers through assembly language, XL C/C++ built-in functions provide access to the optimized PowerPC instruction set and allow the compiler to optimize the instruction scheduling.

C++ To call any of the XL C/C++ built-in functions in C++, you must include the header file builtins.h in your source code.

The following tables describe the available built-in functions.
- "Fixed-point built-in functions"
- "Floating-point built-in functions" on page 290
- "Synchronization and atomic built-in functions (PPU only)" on page 297
- "Cache-related built-in functions (PPU only)" on page 303
- "Block-related built-in functions" on page 305
- "Miscellaneous built-in functions" on page 305

For code compiled to target the PPU, the compiler supports all vector processing functions defined by the AltiVec specification. For detailed descriptions of all of these built-in functions, see the *AltiVec Technology Programming Interface Manual*, available at http://www.freescale.com/files/32bit/doc/ref_manual/ALTIVECPIM.pdf.

The compiler additionally supports built-in functions specific to the Cell Broadband Engine Architecture Synergistic Processing Unit (SPU). To call any of these functions, you must include the header file spu_intrinsics.h in your source. For detailed descriptions of the SPU built-in functions, see the document *IBM C/C++ Language Extensions for Cell Broadband Engine Architecture*, available at http://www.ibm.com/developerworks/power/cell/documents.html.

Fixed-point built-in functions

Fixed-point built-in functions are grouped into the following categories:
- Absolute value functions
- Assert functions
- Count zero functions
- Load functions
- Multiply functions
- Population count functions
- Rotate functions

- Store functions
- Trap functions

Absolute value functions

__labs, __llabs

Purpose: Absolute Value Long, Absolute Value Long Long

Returns the absolute value of the argument.

Prototype:

```
signed long __labs (signed long);

signed long long __llabs (signed long long);
```

Assert functions

__assert1, __assert2 (PPU only)

Purpose: Generates trap instructions.

Prototype:

```
int __assert1 (int, int, int);

void __assert2 (int);
```

Count zero functions

__cntlz4, __cntlz8

Purpose: Count Leading Zeros, 4/8-byte integer

Prototype:

```
unsigned int __cntlz4 (unsigned int);

unsigned int __cntlz8 (unsigned long long);
```

__cnttz4, __cnttz8

Purpose: Count Trailing Zeros, 4/8-byte integer

Prototype:

```
unsigned int __cnttz4 (unsigned int);

unsigned int __cnttz8 (unsigned long long);
```

Load functions

__load2r, __load4r, __load8r (PPU only)

Purpose: Load Halfword Byte Reversed, Load Word Byte Reversed, Load Doubleword Byte Reversed

Prototype:

```
unsigned short __load2r (unsigned short*);

unsigned int __load4r (unsigned int*);

unsigned long long __load8r (unsigned long long*);
```

Multiply functions

__mulhd, __mulhdu (PPU only)

Purpose: Multiply High Doubleword Signed, Multiply High Doubleword Unsigned

Returns the highorder 64 bits of the 128bit product of the two parameters.

Prototype:

```
long long int __mulhd ( long int, long int);

unsigned long long int __mulhdu (unsigned long int, unsigned long int);
```

Usage: Valid only in 64-bit mode.

__mulhw, __mulhwu (PPU only)

Purpose: Multiply High Word Signed, Multiply High Word Unsigned

Returns the highorder 32 bits of the 64bit product of the two parameters.

Prototype:

```
int __mulhw (int, int);

unsigned int __mulhwu (unsigned int, unsigned int);
```

Population count functions

__popcnt4, __popcnt8

Purpose: Population Count, 4/8-byte integer

Returns the number of bits set for a 32/64-bit integer.

Prototype:

```
int __popcnt4 (unsigned int);

int __popcnt8 (unsigned long long);
```

__popcntb

Purpose: Population Count Byte

Counts the 1 bits in each byte of the parameter and places that count into the corresponding byte of the result.

Prototype:

```
unsigned long __popcntb(unsigned long);
```

__poppar4, __poppar8

Purpose: Population Parity, 4/8-byte integer

Checks whether the number of bits set in a 32/64-bit integer is an even or odd number.

Prototype:

```
int __poppar4(unsigned int);

int __poppar8(unsigned long long);
```

Return value: Returns 1 if the number of bits set in the input parameter is odd. Returns 0 otherwise.

Rotate functions

__rdlam (PPU only)

Purpose: Rotate Double Left and AND with Mask

Rotates the contents of *rs* left *shift* bits, and ANDs the rotated data with the *mask*.

Prototype:

```
unsigned long long __rdlam (unsigned long long rs, unsigned int shift,
unsigned long long mask);
```

Parameters:

mask
Must be a constant that represents a contiguous bit field.

__rldimi, __rlwimi (PPU only)

Purpose: Rotate Left Doubleword Immediate then Mask Insert, Rotate Left Word Immediate then Mask Insert

Rotates *rs* left *shift* bits then inserts *rs* into *is* under bit mask *mask*.

Prototype:

```
unsigned long long __rldimi (unsigned long long rs, unsigned long long is,
unsigned int shift, unsigned long long mask);
```

unsigned int __rlwimi (unsigned int *rs*, unsigned int *is*, unsigned int *shift*, unsigned int *mask*);

Parameters:

shift
A constant value 0 to 63 (`__rldimi`) or 31 (`__rlwimi`).

mask
Must be a constant that represents a contiguous bit field.

__rlwnm (PPU only)

Purpose: Rotate Left Word then AND with Mask

Rotates *rs* left *shift* bits, then ANDs *rs* with bit mask *mask*.

Prototype:

unsigned int __rlwnm (unsigned int *rs*, unsigned int *shift*, unsigned int *mask*);

Parameters:

mask
Must be a constant that represents a contiguous bit field.

__rotatel4, __rotatel8 (PPU only)

Purpose: Rotate Left Word, Rotate Left Doubleword

Rotates *rs* left *shift* bits.

Prototype:

unsigned int __rotatel4 (unsigned int *rs*, unsigned int *shift*);

unsigned long long __rotatel8 (unsigned long long *rs*, unsigned long long *shift*);

Store functions

__store2r, __store4r, __store8r (PPU only)

Purpose: Store 2/4/8-byte Register

Prototype:

void __store2r (unsigned short, unsigned short*);

void __store4r (unsigned int, unsigned int*);

void __store8r (unsigned long long, unsigned long long*);

Trap functions

__tdw, __tw (PPU only)

Purpose: Trap Doubleword, Trap Word

Compares parameter *a* with parameter *b*. This comparison results in five conditions which are ANDed with a 5-bit constant *TO*. If the result is not 0 the system trap handler is invoked.

Prototype:

```
void __tdw ( long a, long b, unsigned int TO);

void __tw (int a, int b, unsigned int TO);
```

Parameters:

TO
A value of 0 to 31 inclusive. Each bit position, if set, indicates one or more of the following possible conditions:

0 (high-order bit)
a is less than *b*, using signed comparison.

1 *a* is greater than *b*, using signed comparison.

2 *a* is equal to *b*

3 *a* is less than *b*, using unsigned comparison.

4 (low-order bit)
a is greater than *b*, using unsigned comparison.

Usage: `__tdw` is valid only in 64-bit mode.

__trap, __trapd (PPU only)

Purpose: Trap if the Parameter is not Zero, Trap if the Parameter is not Zero Doubleword

Prototype:

```
void __trap (int);

void __trapd ( long);
```

Usage: `__trapd` is valid only in 64-bit mode.

Floating-point built-in functions

Floating-point built-in functions are grouped into the following categories:

- Absolute value functions
- Conversion functions
- FPSCR functions
- Multiply-add/subtract functions
- Reciprocal estimate functions
- Select functions
- Square root functions
- Software division functions

Absolute value functions

__fabss

Purpose: Floating Absolute Value Single

Returns the absolute value of the argument.

Prototype:

```
float __fabss (float);
```

__fnabs (PPU only)

Purpose: Floating Negative Absolute Value, Floating Negative Absolute Value Single

Returns the negative absolute value of the argument.

Prototype:

```
double __fnabs (double);

float __fnabss (float);
```

Conversion functions

__cmplx, __cmplxf, __cmplxl

Purpose: Converts two real parameters into a single complex value.

Prototype:

```
double _Complex __cmplx (double, double);

float _Complex __cmplxf (float, float);

long double _Complex __cmplxl (long double, long double);
```

__fcfid (PPU only)

Purpose: Floating Convert from Integer Doubleword

Converts a 64-bit signed integer stored in a double to a double-precision floating-point value.

Prototype:

```
double __fcfid (double);
```

__fctid (PPU only)

Purpose: Floating Convert to Integer Doubleword

Converts a double-precision argument to a 64-bit signed integer, using the current rounding mode, and returns the result in a double.

Prototype:

```
double __fctid (double);
```

__fctidz (PPU only)

Purpose: Floating Convert to Integer Doubleword with Rounding towards Zero

Converts a double-precision argument to a 64-bit signed integer, using the rounding mode round-toward-zero, and returns the result in a double.

Prototype:

```
double __fctidz (double);
```

__fctiw (PPU only)

Purpose: Floating Convert to Integer Word

Converts a double-precision argument to a 32-bit signed integer, using the current rounding mode, and returns the result in a double.

Prototype:

```
double __fctiw (double);
```

__fctiwz (PPU only)

Purpose: Floating Convert to Integer Word with Rounding towards Zero

Converts a double-precision argument to a 32-bit signed integer, using the rounding mode round-toward-zero, and returns the result in a double.

Prototype:

```
double __fctiwz (double);
```

__ibm2gccldbl, __ibm2gccldbl_cmplx (PPU only)

Purpose: Converts IBM-style long double data types to GCC long doubles.

Prototype:

```
long double __ibm2gccldbl (long double);

_Complex long double __ibm2gccldbl_cmplx (_Complex long double);
```

Return value: The translated result conforms to GCC requirements for long doubles. However, long double computations performed in IBM-compiled code may not produce bitwise identical results to those obtained purely by GCC.

FPSCR functions

__mtfsb0 (PPU only)

Purpose: Move to Floating Point Status/Control Register (FPSCR) Bit 0

Sets bit *bt* of the FPSCR to 0.

Prototype:

void __mtfsb0 (unsigned int *bt*);

Parameters:

bt Must be a constant with a value of 0 to 31.

__mtfsb1 (PPU only)

Purpose: Move to FPSCR Bit 1

Sets bit *bt* of the FPSCR to 1.

Prototype:

void __mtfsb1 (unsigned int *bt*);

Parameters:

bt Must be a constant with a value of 0 to 31.

__mtfsf (PPU only)

Purpose: Move to FPSCR Fields

Places the contents of *frb* into the FPSCR under control of the field mask specified by *flm*. The field mask *flm* identifies the 4bit fields of the FPSCR affected.

Prototype:

void __mtfsf (unsigned int *flm*, unsigned int *frb*);

Parameters:

flm
Must be a constant 8-bit mask.

__mtfsfi (PPU only)

Purpose: Move to FPSCR Field Immediate

Places the value of *u* into the FPSCR field specified by *bf*.

Prototype:

void __mtfsfi (unsigned int *bf*, unsigned int *u*);

Parameters:

bf Must be a constant with a value of 0 to 7.

u Must be a constant with a value of 0 to 15.

__readflm (PPU only)

Purpose: Returns a 64-bit double precision floating point, whose 32 low order bits contain the contents of the FPSCR. The 32 low order bits are bits 32 - 63 counting from the highest order bit.

Prototype:

```
double __readflm (void);
```

__setflm (PPU only)

Purpose: Takes a double precision floating point number and places the lower 32 bits in the FPSCR. The 32 low order bits are bits 32 - 63 counting from the highest order bit. Returns the previous contents of the FPSCR.

Prototype:

```
double __setflm (double);
```

__setrnd (PPU only)

Purpose: Sets the rounding mode.

Prototype:

```
double __setrnd (int mode);
```

Parameters: The allowable values for *mode* are:

- 0 — round to nearest
- 1 — round to zero
- 2 — round to +infinity
- 3 — round to -infinity

Multiply-add/subtract functions

__fmadd, __fmadds (PPU only)

Purpose: Floating Multiply-Add, Floating Multiply-Add Single

Multiplies the first two arguments, adds the third argument, and returns the result.

Prototype:

```
double __fmadd (double, double, double);

float __fmadds (float, float, float);
```

__fmsub, __fmsubs (PPU only)

Purpose: Floating Multiply-Subtract, Floating Multiply-Subtract Single

Multiplies the first two arguments, subtracts the third argument and returns the result.

Prototype:

```
double __fmsub (double, double, double);

float __fmsubs (float, float, float);
```

__fnmadd, __fnmadds (PPU only)

Purpose: Floating Negative Multiply-Add, Floating Negative Multiply-Add Single

Multiplies the first two arguments, adds the third argument, and negates the result.

Prototype:

```
double __fnmadd (double, double, double);

float __fnmadds (float, float, float);
```

__fnmsub, __fnmsubs (PPU only)

Purpose: Floating Negative Multiply-Subtract

Multiplies the first two arguments, subtracts the third argument, and negates the result.

Prototype:

```
double __fnmsub (double, double, double);

float __fnmsubs (float, float, float);
```

Reciprocal estimate functions

See also "Square root functions" on page 296.

__fres (PPU only)

Purpose: Floating Reciprocal Estimate Single

Prototype:

```
float __fres (float);
```

Select functions

__fsel, __fsels (PPU only)

Purpose: Floating Select, Floating Select Single

Returns the second argument if the first argument is greater than or equal to zero; returns the third argument otherwise.

Prototype:

```
double __fsel (double, double, double);

float __fsels (float, float, float);
```

Square root functions

__frsqrte (PPU only)

Purpose: Floating Reciprocal Square Root Estimate

Prototype:

```
double __frsqrte (double);
```

__fsqrt, __fsqrts

Purpose: Floating Square Root, Floating Square Root Single

Prototype:

```
double __fsqrt (double);

float __fsqrts (float);
```

Software division functions

__swdiv, __swdivs

Purpose: Software Divide, Software Divide Single

Divides the first argument by the second argument and returns the result.

Prototype:

```
double __swdiv (double, double);

float __swdivs (float, float);
```

__swdiv_nochk, __swdivs_nochk

Purpose: Software Divide No Check, Software Divide No Check Single

Divides the first argument by the second argument, without performing range checking, and returns the result.

Prototype:

```
double __swdiv_nochk (double a, double b);

float __swdivs_nochk (float a, float b);
```

Parameters:

a Must not equal infinity. When **-qstrict** is in effect, *a* must have an absolute value greater than 2^{-970} and less than infinity.

b Must not equal infinity, zero, or denormalized values. When **-qstrict** is in effect, *b* must have an absolute value greater than 2^{-1022} and less than 2^{1021}.

Return value: The result must not be equal to positive or negative infinity. When **-qstrict** in effect, the result must have an absolute value greater than 2^{-1021} and less than 2^{1023}.

Usage: This function can provide better performance than the normal divide operator or the `__swdiv` built-in function in situations where division is performed repeatedly in a loop and when arguments are within the permitted ranges.

Store functions

__stfiw (PPU only)

Purpose: Store Floating Point as Integer Word

Stores the contents of the loworder 32 bits of *value*, without conversion, into the word in storage addressed by *addr*.

Prototype:

```
void __stfiw (const int* addr, double value);
```

Synchronization and atomic built-in functions (PPU only)

Synchronization and atomic built-in functions are grouped into the following categories:

- Check lock functions
- Clear lock functions
- Compare and swap functions
- Fetch functions
- Load functions
- Store functions
- Synchronization functions

Check lock functions

__check_lock_mp, __check_lockd_mp

Purpose: Check Lock on Multiprocessor Systems, Check Lock Doubleword on Multiprocessor Systems

Conditionally updates a single word or doubleword variable atomically.

Prototype:

```
unsigned int __check_lock_mp (const int* addr, int old_value, int new_value);

unsigned int __check_lockd_mp (const long* addr, long old_value, long
new_value);
```

Parameters:

addr
The address of the variable to be updated. Must be aligned on a 4-byte boundary for a single word or on an 8-byte boundary for a doubleword.

old_value
The old value to be checked against the current value in *addr*.

new_value
The new value to be conditionally assigned to the variable in *addr*,

Return value: Returns false (0) if the value in *addr* was equal to *old_value* and has been set to the *new_value*. Returns true (1) if the value in *addr* was not equal to *old_value* and has been left unchanged.

Usage: `__check_lockd_mp` is valid only in 64-bit mode.

__check_lock_up, __check_lockd_up

Purpose: Check Lock on Uniprocessor Systems, Check Lock Doubleword on Uniprocessor Systems

Conditionally updates a single word or doubleword variable atomically.

Prototype:

unsigned int __check_lock_up (const int* *addr*, int *old_value*, int *new_value*);

unsigned int __check_lockd_up (const long* *addr*, long *old_value*, long *new_value*);

Parameters:

addr
The address of the variable to be updated. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

old_value
The old value to be checked against the current value in *addr*.

new_value
The new value to be conditionally assigned to the variable in *addr*,

Return value: Returns false (0) if the value in *addr* was equal to *old_value* and has been set to the new value. Returns true (1) if the value in *addr* was not equal to *old_value* and has been left unchanged.

Usage: `__check_lockd_up` is valid only in 64-bit mode.

Clear lock functions

__clear_lock_mp, __clear_lockd_mp

Purpose: Clear Lock on Multiprocessor Systems, Clear Lock Doubleword on Multiprocessor Systems

Atomic store of the *value* into the variable at the address *addr*.

Prototype:

void __clear_lock_mp (const int* *addr*, int *value*);

void __clear_lockd_mp (const long* *addr*, long *value*);

Parameters:

addr
The address of the variable to be updated. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

value
The new value to be assigned to the variable in *addr*,

Usage: `__clear_lockd_mp` is only valid in 64-bit mode.

__clear_lock_up, __clear_lockd_up

Purpose: Clear Lock on Uniprocessor Systems, Clear Lock Doubleword on Uniprocessor Systems

Atomic store of the *value* into the variable at the address *addr*.

Prototype:

void __clear_lock_up (const int* *addr*, int *value*);

void __clear_lockd_up (const long* *addr*, long *value*);

Parameters:

addr
The address of the variable to be updated. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

value
The new value to be assigned to the variable in *addr*.

Usage: `__clear_lockd_up` is only valid in 64-bit mode.

Compare and swap functions

__compare_and_swap, __compare_and_swaplp

Purpose: Conditionally updates a single word or doubleword variable atomically.

Prototype:

int __compare_and_swap (volatile int* *addr*, int* *old_val_addr*, int *new_val*);

int __compare_and_swaplp (volatile long* *addr*, long* *old_val_addr*, long *new_val*);

Parameters:

addr
The address of the variable to be copied. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

old_val_addr
The memory location into which the value in *addr* is to be copied.

new_val
The value to be conditionally assigned to the variable in *addr*,

Return value: Returns true (1) if the value in *addr* was equal to *old_value* and has been set to the new value. Returns false (0) if the value in *addr* was not equal to *old_value* and has been left unchanged. In either case, the contents of the memory location specified by *addr* are copied into the memory location specified by *old_val_addr*.

Usage: The `__compare_and_swap` function is useful when a single word value must be updated only if it has not been changed since it was last read. If you use `__compare_and_swap` as a locking primitive, insert a call to the `__isync` built-in function at the start of any critical sections.

`__compare_and_swaplp` is valid only in 64-bit mode.

Fetch functions

__fetch_and_and, __fetch_and_andlp

Purpose: Clears bits in the word or doubleword specified by*addr* by AND-ing that value with the value specified by *val*, in a single atomic operation, and returns the original value of *addr*.

Prototype:

```
unsigned int __fetch_and_and (volatile unsigned int* addr, unsigned int val);

unsigned long __fetch_and_andlp (volatile unsigned long* addr, unsigned
long val);
```

Parameters:

addr
The address of the variable to be ANDed. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

value
The value by which the value in *addr* is to be ANDed.

Usage: This operation is useful when a variable containing bit flags is shared between several threads or processes.

`__fetch_and_andlp` is valid only in 64-bit mode.

__fetch_and_or, __fetch_and_orlp

Purpose: Sets bits in the word or doubleword specified by *addr* by OR-ing that value with the value specified *val*, in a single atomic operation, and returns the original value of *addr*.

Prototype:

```
unsigned int __fetch_and_or (volatile unsigned int* addr, unsigned int val);

unsigned long __fetch_and_orlp (volatile unsigned long* addr, unsigned long
val);
```

Parameters:

addr
The address of the variable to be ORed. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

value
The value by which the value in *addr* is to be ORed.

Usage: This operation is useful when a variable containing bit flags is shared between several threads or processes.

`__fetch_and_orlp` is valid only in 64-bit mode.

__fetch_and_swap, __fetch_and_swaplp

Purpose: Sets the word or doubleword specified by *addr* to the value of *val* and returns the original value of *addr*, in a single atomic operation.

Prototype:

unsigned int __fetch_and_swap (volatile unsigned int* *addr*, unsigned int *val*);

unsigned long __fetch_and_swaplp (volatile unsigned long* *addr*, unsigned long *val*);

Parameters:

addr
The address of the variable to be updated. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

value
The value which is to be assigned to *addr*.

Usage: This operation is useful when a variable is shared between several threads or processes, and one thread needs to update the value of the variable without losing the value that was originally stored in the location.

`__fetch_and_swaplp` is valid only in 64-bit mode.

Load functions

__ldarx, __lwarx

Purpose: Load Doubleword and Reserve Indexed, Load Word and Reserve Indexed

Loads the value from the memory location specified by *addr* and returns the result. For `__lwarx`, in 64-bit mode, the compiler returns the sign-extended result.

Prototype:

long __ldarx (volatile long* *addr*);

int __lwarx (volatile int* *addr*);

Parameters:

addr
The address of the value to be loaded. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

Usage: This function can be used with a subsequent `__stdcx` (or `__stwcx`) built-in function to implement a read-modify-write on a specified memory location. The two built-in functions work together to ensure that if the store is successfully performed, no other processor or mechanism can modify the target doubleword

between the time the __ldarx function is executed and the time the __stdcx function completes. This has the same effect as inserting __fence built-in functions before and after the __ldarx built-in function and can inhibit compiler optimization of surrounding code (see "Miscellaneous built-in functions" on page 305 for a description of the __fence built-in function).

__ldarx is valid only in 64-bit mode.

Store functions

__stdcx, __stwcx

Purpose: Store Doubleword Conditional Indexed, Store Word Conditional Indexed

Stores the value specified by *val* into the memory location specified by *addr*.

Prototype:

```
int __stdcx(volatile long* addr, long val);

int __stwcx(volatile int* addr, int val);
```

Parameters:

addr
The address of the variable to be updated. Must be aligned on a 4-byte boundary for a single word and on an 8-byte boundary for a doubleword.

value
The value which is to be assigned to *addr*.

Return value: Returns 1 if the update of *addr* is successful and 0 if it is unsuccessful.

Usage: This function can be used with a preceding __ldarx (or __lwarx) built-in function to implement a read-modify-write on a specified memory location. The two built-in functions work together to ensure that if the store is successfully performed, no other processor or mechanism can modify the target doubleword between the time the __ldarx function is executed and the time the __stdcx function completes. This has the same effect as inserting __fence built-in functions before and after the __stdcx built-in function and can inhibit compiler optimization of surrounding code.

__stdcx is valid only in 64-bit mode.

Synchronization functions

__eieio, __iospace_eioio

Purpose: Enforce In-order Execution of Input/Output

Ensures that all I/O storage access instructions preceding the call to __eioeio complete in main memory before I/O storage access instructions following the function call can execute.

Prototype:

void __eieio (void);

void __iospace_eieio (void);

Usage: This function is useful for managing shared data instructions where the execution order of load/store access is significant. The function can provide the necessary functionality for controlling I/O stores without the cost to performance that can occur with other synchronization instructions.

__isync, __iospace_sync

Purpose: Instruction Synchronize

Waits for all previous instructions to complete and then discards any prefetched instructions, causing subsequent instructions to be fetched (or refetched) and executed in the context established by previous instructions.

Prototype:

void __isync (void);

void __iospace_sync (void);

__lwsync, __iospace_lwsync

Purpose: Load Word Synchronize

Ensures that all store instructions preceding the call to `__lwsync` complete before any new instructions can be executed on the processor that executed the function. This allows you to synchronize between multiple processors with minimal performance impact, as `__lwsync` does not wait for confirmation from each processor.

Prototype:

void __lwsync (void);

void __iospace_lwsync (void);

__sync

Purpose: Synchronize

Ensures that all instructions preceding the function the call to `__sync` complete before any instructions following the function call can execute.

Prototype:

void __sync (void);

Cache-related built-in functions (PPU only)

Cache-related built-in functions are grouped into the following categories:

- Data cache functions
- Prefetch functions

Data cache functions

__dcbf

Purpose: Data Cache Block Flush

Copies the contents of a modified block from the data cache to main memory and flushes the copy from the data cache.

Prototype: void __dcbf(const void* *addr*);

__dcbst

Purpose: Data Cache Block Store

Copies the contents of a modified block from the data cache to main memory.

Prototype: void __dcbst(const void* *addr*);

__dcbt

Purpose: Data Cache Block Touch

Loads the block of memory containing the specified address into the L1 data cache.

Prototype:

void __dcbt (void* *addr*);

__dcbtst

Purpose: Data Cache Block Touch for Store

Fetches the block of memory containing the specified address into the data cache.

Prototype: void __dcbtst(void* *addr*);

__dcbz

Purpose: Data Cache Block set to Zero

Sets a cache line containing the specified address in the data cache to zero (0).

Prototype:

void __dcbz (void* *addr*);

Prefetch functions

__prefetch_by_load

Purpose: Touches a memory location by using an explicit load.

Prototype:

void __prefetch_by_load (const void*);

__prefetch_by_stream

Purpose: Touches a memory location by using an explicit stream.

Prototype:

```
void __prefetch_by_stream (const int, const void*);
```

Block-related built-in functions

__bcopy

Purpose

Block copy

Prototype

```
void __bcopy (char*, char*, size_t);
```

Miscellaneous built-in functions

Miscellaneous functions are grouped into the following categories:

- Optimization-related functions
- Move to/from register functions
- Memory-related functions

Optimization-related functions

__align_hint (SPU only)

Purpose: Allows for optimizations such as automatic vectorization by informing the compiler that the data pointed to by *pointer* is aligned at a known compile-time offset.

Prototype:

```
void __align_hint (const void* pointer, int base, int offset);
```

Parameters:

base
Must be a constant integer with a value greater than zero and of a power of two.

offset
Must be less than *base* or zero.

Usage: To use this function, you must include the header file spu_intrinsics.h in your source.

__alignx

Purpose: Allows for optimizations such as automatic vectorization by informing the compiler that the data pointed to by *pointer* is aligned at a known compile-time offset.

Prototype:

void __alignx (int *alignment*, const void* *pointer*);

Parameters:

alignment
Must be a constant integer with a value greater than zero and of a power of two.

__builtin_expect

Purpose: Indicates that an expression is likely to evaluate to a specified value. The compiler may use this knowledge to direct optimizations.

Prototype:

long __builtin_expect (long *expression*, long *value*);

Parameters:

expression
Should be an integral-type expression.

value
For code targeting the PPU, *value* must be a constant literal. For code targeting the SPU, it can be an integral-type expression.

Usage: If the *expression* does not actually evaluate at run time to the predicted value, performance may suffer. Therefore, this built-in function should be used with caution.

__fence

Purpose: Acts as a barrier to compiler optimizations that involve code motion, or reordering of machine instructions. Compiler optimizations will not move machine instructions past the location of the `__fence` call.

Prototype:

void __fence (void);

Examples: This function is useful to guarantee the ordering of instructions in the object code generated by the compiler when optimization is enabled.

Move to/from register functions

__mftb (PPU only)

Purpose: Move from Time Base

In 32-bit compilation mode, returns the lower word of the time base register. In 64-bit mode, returns the entire doubleword of the time base register.

Prototype:

unsigned long __mftb (void);

Usage: In 32-bit mode, this function can be used in conjunction with the__mftbu built-in function to read the entire time base register. In 64-bit mode, the entire doubleword of the time base register is returned, so separate use of __mftbu is unnecessary

It is recommended that you insert the __fence built-in function before and after the __mftb built-in function.

__mftbu (PPU only)

Purpose: Move from Time Base Upper

Returns the upper word of the time base register.

Prototype:

```
unsigned int __mftbu (void);
```

Usage: In 32-bit mode you can use this function in conjunction with the __mftb built-in function to read the entire time base register

It is recommended that you insert the __fence built-in function before and after the __mftbu built-in function.

__mfmsr (PPU only)

Purpose: Move from Machine State Register

Moves the contents of the machine state register (MSR) into bits 32 to 63 of the designated general-purpose register.

Prototype:

```
unsigned long __mfmsr (void);
```

Usage: Execution of this instruction is privileged and restricted to supervisor mode only.

__mfspr (PPU only)

Purpose: Move from Special-Purpose Register

Returns the value of given special purpose register.

Prototype:

```
unsigned long __mfspr (const int registerNumber);
```

Parameters:

registerNumber
The number of the special purpose register whose value is to be returned. The *registerNumber* must be known at compile time.

__mtmsr (PPU only)

Purpose: Move to Machine State Register

Moves the contents of bits 32 to 63 of the designated GPR into the MSR.

Prototype:

```
void __mtmsr (unsigned long);
```

Usage: Execution of this instruction is privileged and restricted to supervisor mode only.

__mtspr (PPU only)

Purpose: Move to Special-Purpose Register

Sets the value of a special purpose register.

Prototype:

```
void __mtspr (const int registerNumber, unsigned long value);
```

Parameters:

registerNumber
The number of the special purpose register whose value is to be set. The *registerNumber* must be known at compile time.

value
Must be known at compile time.

Memory-related functions

__alloca

Purpose: Allocates space for an object. The allocated space is put on the stack and freed when the calling function returns.

Prototype:

```
void* __alloca (size_t size)
```

Parameters:

size
An integer representing the amount of space to be allocated, measured in bytes.

__builtin_frame_address, __builtin_return_address

Purpose: Returns the address of the stack frame, or return address, of the current function, or of one of its callers.

Prototype:

```
void* __builtin_frame_address (unsigned int level);

void* __builtin_return_address (unsigned int level);
```

Parameters:

level

A constant literal indicating the number of frames to scan up the call stack. The *level* must range from 0 to 63. A value of 0 returns the frame or return address of the current function, a value of 1 returns the frame or return address of the caller of the current function and so on.

Return value: Returns 0 when the top of the stack is reached. Optimizations such as inlining may affect the expected return value by introducing extra stack frames or fewer stack frames than expected. If a function is inlined, the frame or return address corresponds to that of the function that is returned to.

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