IBM XL C/C++ Advanced Edition V8.0 for Linux

Compiler Reference

SC09-8013-00

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Note!

Before using this information and the product it supports, be sure to read the information in “Notices” on page 307.

First Edition (November 2005)

This edition applies to XL C/C++ Advanced Edition V8.0 for Linux (Program number 5724-M16) and to all subsequent releases and modifications until otherwise indicated in new editions.

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Contents

About this document

This document contains information on setting up the compilation environment, how to compile, link, and run programs that are written in the C or C++ languages and how to specify compiler options, pragmas, macros and built-in functions in your application. The guide also contains extensive cross-references to the relevant sections of the other reference guides in the XL C/C++ documentation suite.

Who should read this document

This document is for anyone who wants to work with the XL C/C++ compiler and is familiar with the Linux operating system, and who has some previous C or C++ programming experience. However, users new to C or C++ can still use this document to find information on the capabilities and features unique to XL C/C++ compiler. This guide can help you understand what the features of the compiler are, especially the options, and how to use them for effective software development.

How to use this document

Throughout these pages, the **xlc** and **xlc++** command invocations are used to describe the actions of the compiler. You can, however, substitute other forms of the compiler invocation command if your particular environment requires it, and compiler option usage will remain the same unless otherwise specified.

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.

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

- For information on C or C++ languages: see *XL C/C++ Language Reference* for information on the syntax, semantics, and IBM® implementation of the C and C++ programming languages.
- For information on programming topics: see *XL C/C++ Programming Guide* for program portability and optimization.

How this document is organized

Chapter 1, “Configuring the compiler,” on page 1 discusses topics related to setting up the compilation environment, including setting environment variables and customizing the configuration file.

Chapter 2, “Compiling and linking applications,” on page 11 discusses topics related to compilation tasks, including invoking the compiler, preprocessor, and link-editor; 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; and compiler listings and messages.

Chapter 3, "Compiler options reference," on page 31 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. Each option description provides examples and a list of related topics.

Chapter 4, "Reusing GNU C/C++ compiler options with glxc and glxc++," on page 211 contains information on how to reuse GNU C/C++ compiler options through the use of the compiler utilities **gxlc** and **gxlc++**.

Chapter 5, "Compiler pragmas reference," on page 215 contains individual descriptions of pragmas, including OpenMP directives.

Chapter 6, "Predefined macros," on page 279 provides a list of compiler macros.

Chapter 7, "Built-in functions for POWER and PowerPC architectures," on page 283 contains individual descriptions of XL C/C++built-in functions for POWER™ and PowerPC® architectures, categorized by their functionality.

Appendix A, "Redistributable libraries," on page 301 lists the redistributable libraries shipped with XL C/C++.

Appendix B, "ASCII character set," on page 303 lists the ASCII character sets.

Conventions used in this document

The following sections discuss the conventions used in this document:

- "Typographical conventions"
- "Icons" on page ix
- "How to read syntax diagrams" on page ix
- "Examples" on page xi

Typographical conventions

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

Table 1. Typographical conventions

Typeface	Indicates	Example
bold	Commands, executable names, compiler options and pragma directives.	Use the **-qmkshrobj** compiler option to create a shared object from the generated object files.
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.
`monospace`	Programming keywords and library functions, compiler built-in functions, file and directory names, examples of program code, compiler messages, 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:

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

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

How to read syntax 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.

  Diagrams of syntactical units other than complete commands, directives, or statements start with the ▶—— symbol and end with the ——▶ symbol.
- Required items appear on the horizontal line (the main path).

```
▶▶—keyword—required_item————————————————————————————————————————————▶◀
```

- Optional items are shown below the main path.

```
▶▶—keyword—┬─────────────┬──────────────────────────────────────────▶◀
           └optional_item┘
```

- 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.

```
▶▶—keyword—┬required_choice1┬───────────────────────────────────────▶◀
           └required_choice2┘
```

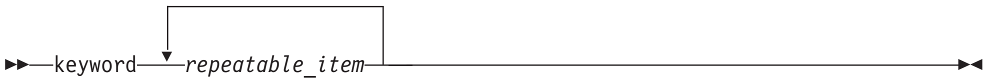
  If choosing one of the items is optional, the entire stack is shown below the main path.

```
▶▶—keyword—┬────────────────┬───────────────────────────────────────▶◀
           ├optional_choice1┤
           └optional_choice2┘
```

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

```
           ┌default_item──┐
▶▶—keyword─┴alternate_item┴─────────────────────────────────────────▶◀
```

- An arrow returning to the left above the main line indicates an item that can be repeated.

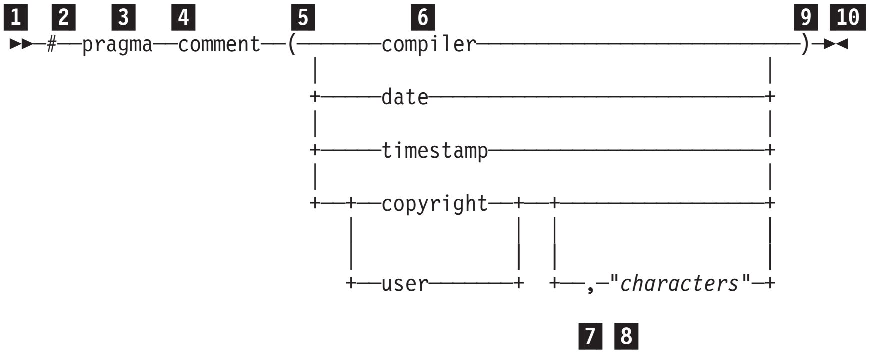


A repeat arrow above a stack indicates that you can make more than one choice from the stacked items, or repeat a single choice.

- Keywords are shown in nonitalic letters and should be entered exactly as shown (for example, `extern`).

  Variables are shown in italicized lowercase letters (for example, *identifier*). 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.

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



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

IBM XL C/C++ publications

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

- Readme files

  Readme files contain late-breaking information, including changes and corrections to the product documentation. Readme files are located by default in the /opt/ibmcmp/vacpp/8.0/ directory and in the root directory of the installation CD.

- 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++ Advanced Edition V8.0 for Linux Installation Guide*.

- Information center

  The information center of searchable HTML files can be launched on a network and accessed remotely or locally. Instructions for installing and accessing the information center are provided in the *XL C/C++ Advanced Edition V8.0 for Linux Installation Guide*. The information center is also viewable on the Web at:

  http://publib.boulder.ibm.com/infocenter/lnxpcomp/index.jsp.

- PDF documents

  PDF documents are located by default in the `/opt/ibmcmp/vacpp/8.0/doc/`*`language`*`/pdf` directory, where *language* can be any of the following supported languages:

  – en_US

  – ja_JP

  – zh_CN

  The PDF documents are also available on the Web at:

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

  In addition to this document, the following files comprise the full set of XL C/C++ product documentations:

Table 2. XL C/C++ PDF files

Document title	PDF file name	Description
XL C/C++ Advanced Edition V8.0 for Linux Installation Guide, GC09-7999-00	install.pdf	Contains information for installing XL C/C++ and configuring your environment for basic compilation and program execution.
Getting Started with XL C/C++ Advanced Edition V8.0 for Linux, SC09-7997-00	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.

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

Document title	PDF file name	Description
XL C/C++ Advanced Edition V8.0 for Linux Language Reference, SC09-7998-00	language.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.
XL C/C++ Advanced Edition V8.0 for Linux Programming Guide, SC09-7996-00	proguide.pdf	Contains information on advanced programming topics, such as application porting, interlanguage calls with Fortran code, library development, application optimization and parallelization, and the XL C/C++ high-performance libraries.

These PDF files are viewable and printable from Adobe Reader. If you do not have the Adobe Reader installed, you can download it from www.adobe.com.

Additional documentation

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

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

Related publications

You might want to consult the following publications, which are also referenced throughout this document:

- *OpenMP Application Program Interface Version 2.5*, available at http://www.openmp.org
- *AltiVec Technology Programming Interface Manual*, available at http://www.freescale.com

Technical support

Additional technical support is available from the XL C/C++ Support page. This page provides a portal with search capabilities to a large selection of technical support FAQs and other support documents. You can find the XL C/C++ Support page on the Web at:

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

If you cannot find what you need, you can e-mail:

compinfo@ca.ibm.com

For the latest information about XL C/C++, visit the product information site at:

www.ibm.com/software/awdtools/xlcpp

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. Configuring the compiler

Before you can use XL C/C++ to compile C or C++ programs, you must set up the environment variables the compiler requires, and the compiler configuration file must exist on your system. Normally, the configuration file used by the compiler is automatically generated during the installation procedure (for more information, see the *XL C/C++ Installation Guide*), and you may have already set some of the basic environment variables during the installation process.

"Setting environment variables" provides a complete list of the required and optional environment variables you can set or reset after installing the compiler, including those used for parallel processing.

If you want to customize the default or additional configuration files that you have generated after installation, to specify alternate library paths, default compiler options, and so on, you can consult "Customizing the configuration file" on page 8, which provides a description of the structure and content of the default configuration file.

Setting environment variables

The Bourne Again SHell (**bash**) on Linux® systems is similar to the Bourne Shell (**bsh**) found on AIX® systems. Use the **bash** interface to set the environment variables required by the XL C/C++ compiler, either through the command line or with a command file script.

The following statements, either typed at the command line or inserted into a command file script, show how you can set environment variables in the Bourne Again SHell. Paths shown assume that you are installing the compiler in the default installation location.

```
LANG=en_US
NLSPATH=$NLSPATH:/opt/ibmcmp/msg/%L/%N:/opt/ibmcmp/vacpp/8.0/msg/%L/%N
export LANG NLSPATH
```

To set the variables so that all users have access to them, 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. The environment variables are set each time the user logs in.

The following sections discuss the environment variables you can set for the compiler:

- "General environment variables"
- "Environment variables for parallel processing" on page 2

General environment variables

Before using the compiler, ensure the following environment variables are set:

LD_LIBRARY_PATH
Specifies the directory search path for dynamically loaded libraries. Used by the GNU linker at link time and at run time.

LD_RUN_PATH
Specifies the directory search path for dynamically loaded libraries. Used at run time only.

LANG
: Specifies the national language for message and help files.

The LANG environment variable can be set to any of the locales provided on the system.

The national language code for United States English is **en_US**. If the appropriate message catalogs have been installed on your system, any other valid national language code can be substituted for **en_US**.

To determine the current setting of the national language on your system, use the following **echo** command:

```
echo $LANG
```

MANPATH
: Optionally specifies the directory search path for finding man pages. MANPATH must contain `/opt/ibmcmp/vacpp/8.0/man/EN_US/` before the default man path.

NLSPATH
: Specifies the path name of the message and help files.

To determine the current setting of NLSPATH variable on your system, use the following **echo** command:

```
echo $NLSPATH
```

PATH
: Specifies the directory search path for the executable files of the compiler. Executables are in `/opt/ibmcmp/vacpp/8.0/bin/` if installed to the default location.

PDFDIR
: Optionally specifies the directory in which the profile data file is created. The default value is unset, and the compiler places the profile data file in the current working directory. Setting this variable to an absolute path is recommended for profile-directed feedback.

TMPDIR
: Optionally specifies the directory in which temporary files are created. The default location, `/tmp/`, may be inadequate at high levels of optimization, where paging and temporary files can require significant amounts of disk space.

XL_NOCLONEARCH
: Instructs the program to only execute the generic code, where generic code is the code that is not versioned for an architecture. The XL_NOCLONEARCH environment variable is not set by default; you can set it for debugging purposes in your application.

Note: The LANG and NLSPATH environment variables are initialized when the operating system is installed, and might differ from the ones you want to use.

Related information

- "Message catalog errors" on page 28
- "-qpdf1, -qpdf2" on page 154
- "-qipa" on page 106

Environment variables for parallel processing

The XLSMPOPTS environment variable sets options for program run time using loop parallelization. Suboptions for the XLSMPOPTS environment variables are discussed in detail in "Suboptions of the XLSMPOPTS environment variable for parallel processing" on page 3.

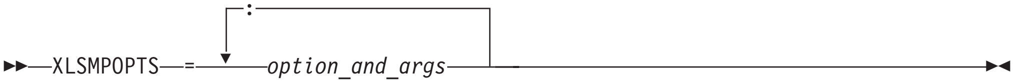
If you are using OpenMP constucts for parallelization, you can also specify runtime options using OMP environment variables, as discussed in "OpenMP environment variables for parallel processing" on page 6.

When runtime options specified by OMP- and XLSMPOPTS environment variables conflict, OMP options will prevail.

Note: You must use thread-safe compiler mode invocations when compiling parallelized program code.

Suboptions of the XLSMPOPTS environment variable for parallel processing

Runtime options affecting parallel processing can be specified with the XLSMPOPTS environment variable. This environment variable must be set before you run an application, and uses basic syntax of the form:



For example, to have a program run time create 4 threads and use dynamic scheduling with chunk size of 5, you would set the XLSMPOPTS environment variable as shown below:

```
XLSMPOPTS=PARTHDS=4:SCHEDULE=DYNAMIC=5
```

Runtime option settings for the XLSMPOPTS environment variable are shown below, grouped by category:

Scheduling algorithm options:

XLSMPOPTS environment variable option	**Description**
schedule=*algorithm*=[*n*]	This option specifies the scheduling algorithm used for loops not explicitly assigned a scheduling algorithm. Valid options for *algorithm* are: • guided • affinity • dynamic • static If specified, the chunk size *n* must be an integer value of 1 or greater. The default scheduling algorithm is **static**.

Parallel environment options:

XLSMPOPTS environment variable option	Description
parthds=*num*	*num* represents the number of parallel threads requested, which is usually equivalent to the number of processors available on the system. Some applications cannot use more threads than the maximum number of processors available. Other applications can experience significant performance improvements if they use more threads than there are processors. This option gives you full control over the number of user threads used to run your program. The default value for *num* is the number of processors available on the system.
usrthds=*num*	*num* represents the number of user threads expected. This option should be used if the program code explicitly creates threads, in which case *num* should be set to the number of threads created. The default value for *num* is 0.
stack=*num*	*num* specifies the largest amount of space required for a thread's stack. The default value for *num* is 2097152. The `glibc` library is compiled by default to allow a stack size of 2 Mb. Setting num to a value greater than this will cause the default stack size to be used. If larger stack sizes are required, you should link the program to a `glibc` library compiled with the FLOATING_STACKS parameter turned on.

Performance tuning options:

XLSMPOPTS environment variable option	Description
spins=*num*	*num* represents the number of loop spins, or iterations, before a yield occurs. When a thread completes its work, the thread continues executing in a tight loop looking for new work. One complete scan of the work queue is done during each busy-wait state. An extended busy-wait state can make a particular application highly responsive, but can also harm the overall responsiveness of the system unless the thread is given instructions to periodically scan for and yield to requests from other applications. A complete busy-wait state for benchmarking purposes can be forced by setting both **spins** and **yields** to 0. The default value for *num* is 100.
startproc=*CPU ID*	Enables thread binding and specifies the *CPU ID* to which the first thread binds. If the value provided is outside the range of available processors, the SMP run time issues a warning message and no threads are bound.

XLSMPOPTS environment variable option	Description
stride=*Number*	Specifies the increment used to determine the *CPU ID* to which subsequent threads bind. *Number* must be greater than or equal to 1. If the value provided would cause a thread to be bound to a CPU outside the range of available processors, a warning message is issued and no threads are bound.
yields=*num*	*num* represents the number of yields before a sleep occurs. When a thread sleeps, it completely suspends execution until another thread signals that there is work to do. This provides better system utilization, but also adds extra system overhead for the application. The default value for *num* is 100.
delays=*num*	*num* represents a period of do-nothing delay time between each scan of the work queue. Each unit of delay is achieved by running a single no-memory-access delay loop. The default value for *num* is 500.

Dynamic profiling options:

XLSMPOPTS environment variable option	Description
profilefreq=*num*	*num* represents the sampling rate at which each loop is revisited to determine appropriateness for parallel processing. The runtime library uses dynamic profiling to dynamically tune the performance of automatically-parallelized loops. Dynamic profiling gathers information about loop running times to determine if the loop should be run sequentially or in parallel the next time through. Threshold running times are set by the **parthreshold** and **seqthreshold** dynamic profiling options, described below. If *num* is 0, all profiling is turned off, and overheads that occur because of profiling will not occur. If *num* is greater than 0, running time of the loop is monitored once every *num* times through the loop. The default for *num* is 16. The maximum sampling rate is 32. Values of *num* exceeding 32 are changed to 32.
parthreshold=*mSec*	*mSec* specifies the expected running time in milliseconds below which a loop must be run sequentially. *mSec* can be specified using decimal places. If **parthreshold** is set to 0, a parallelized loop will never be serialized by the dynamic profiler. The default value for *mSec* is 0.2 milliseconds.

XLSMPOPTS environment variable option	Description
seqthreshold=*mSec*	*mSec* specifies the expected running time in milliseconds beyond which a loop that has been serialized by the dynamic profiler must revert to being run in parallel mode again. *mSec* can be specified using decimal places. The default value for *mSec* is 5 milliseconds.

Related information
- "Summary of OpenMP pragma directives" on page 216
- "Built-in functions for parallel processing" on page 298

OpenMP environment variables for parallel processing

OpenMP runtime options affecting parallel processing are set by specifying OMP environment variables. These environment variables, use syntax of the form:

```
►►──env_variable──=──option_and_args──────────────────────────────────────►◄
```

If an OMP environment variable is not explicitly set, its default setting is used.

OpenMP runtime options fall into different categories as described below:

Scheduling algorithm environment variable:

OMP_SCHEDULE=*algorithm*	This option specifies the scheduling algorithm used for loops not explictly assigned a scheduling algorithm with the **omp schedule** directive. For example: `OMP_SCHEDULE="guided, 4"` Valid options for *algorithm* are: • dynamic[, *n*] • guided[, *n*] • runtime • static[, *n*] If specifying a chunk size with *n*, the value of *n* must be an integer value of 1 or greater. The default scheduling algorithm is **static**.

Parallel environment variables:

OMP_NUM_THREADS=*num*

num represents the number of parallel threads requested, which is usually equivalent to the number of processors available on the system.

This number can be overridden during program execution by calling the **omp_set_num_threads( )** runtime library function.

Some applications cannot use more threads than the maximum number of processors available. Other applications can experience significant performance improvements if they use more threads than there are processors. This option gives you full control over the number of user threads used to run your program.

The default value for *num* is the number of processors available on the system.

You can override the setting of OMP_NUM_THREADS for a given parallel section by using the **num_threads** clause available in several **#pragma omp** directives.

OMP_NESTED=TRUE|FALSE

This environment variable enables or disables nested parallelism. The setting of this environment variable can be overridden by calling the **omp_set_nested( )** runtime library function.

If nested parallelism is disabled, nested parallel regions are serialized and run in the current thread.

In the current implementation, nested parallel regions are always serialized. As a result, OMP_SET_NESTED does not have any effect, and **omp_get_nested()** always returns 0. If **-qsmp=nested_par** option is on (only in non-strict OMP mode), nested parallel regions may employ additional threads as available. However, no new team will be created to run nested parallel regions.

The default value for OMP_NESTED is FALSE.

Dynamic profiling environment variable:

OMP_DYNAMIC=TRUE|FALSE

This environment variable enables or disables dynamic adjustment of the number of threads available for running parallel regions.

If set to TRUE, the number of threads available for executing parallel regions may be adjusted at run time to make the best use of system resources. See the description for **profilefreq=***num* in "Dynamic profiling options" on page 5 for more information.

If set to FALSE, dynamic adjustment is disabled.

The default setting is TRUE.

- For information on the OpenMP specification, see: www.openmp.org/specs.

Customizing the configuration file

XL C/C++ generates a default configuration file `/etc/opt/ibmcmp/vac/8.0/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 modify existing stanzas or add new named stanzas to the configuration file. For example, to make **-qnoro** the default for the **xlc** compiler invocation command, add **-qnoro** to the **xlc** stanza in your copied version of the configuration file.

You can create new commands that are links to the existing commands. For example, to create a link to the **xlc_r** command, you could specify something similar to the following:

```
ln -s /opt/ibmcmp/vacpp/8.0/bin/xlc_r /home/lisa/bin/my_xlc
```

You can link the compiler invocation command to several different names. The name you specify when you invoke the compiler determines which stanza of the configuration file the compiler uses. You can add other stanzas to your copy of the configuration file to customize your own compilation environment. You can use the **-F** option with the compiler invocation command to make links to select additional stanzas or to specify a specific stanza in another configuration file. For example:

```
xlc myfile.c -Fmyconfig.cfg:SPECIAL
```

would compile `myfile.c` using the SPECIAL stanza in a `myconfig.cfg` configuration file that you had created.

When you run the compiler under another name, it uses the options, libraries, and so on, that are listed in the corresponding stanza.

Notes:

1. If you make any changes to the default configuration file and then move or copy your make files to another system, you will also need to copy the changed configuration file.
2. Installing a compiler program temporary fix (PTF) or an upgrade may overwrite the `vac.cfg` file. Therefore, be sure to save a copy of any modifications you have made before doing such an installation.
3. You cannot use tabs as separator characters in the configuration file. If you modify the configuration file, make sure that you use spaces for any indentation.
4. If you are mixing Message-Passing Interface (MPI) and threaded programming, use the appropriate stanza in the `vac.cfg` file to link in the proper libraries and to set the correct default behavior.
5. The compiler return code of 41 indicates that a configuration file error has been detected.

Configuration file attributes

A configuration file includes several stanzas. The items defined by stanzas in the configuration file include the following:

as Path name to be used for the assembler. The default is `/usr/bin/as`.

ccomp C front end. The default is `/opt/ibmcmp/vac/8.0/exe/xlcentry`.

cppcomp C++ front end. The default is `/opt/ibmcmp/vacpp/8.0/exe/xlCentry`.

code Path name to be used for the code generation phase of the compiler. The default is `/opt/ibmcmp/vac/8.0/exe/xlCcode` .

codeopt List of options for the code-generation phase of the compiler.

crt Path name of the object file passed as the first parameter to the linkage editor. If you do not specify either the **-p** or the **-pg** option, the **crt** value is used. The default is `/usr/lib/crt1.o`.

csuffix Suffix for source programs. The default is c (lowercase c).

dis Path name of the disassembler. The default is `/opt/ibmcmp/vac/8.0/exe/dis`.

gcrt Path name of the object file passed as the first parameter to the linkage editor. If you specify the **-pg** option, the gcrt value is used. The default is `/usr/lib/gcrt1.o`.

ld Path name to be used to link C or C++ programs. The default is `/usr/bin/ld`.

ldopt List of options, directed to the linkage editor to override all normal processing by the compiler. If the corresponding flag takes a parameter, the string is formatted for the `getopt` subroutine as a concatenation of flag letters, with a letter followed by a colon (`:`).

libraries2 Comma-separated list of library options that the compiler passes as the last parameters to the linkage editor. **libraries2** specifies the libraries that the linkage editor is to use at link-edit time for both profiling and nonprofiling. The default is empty.

mcrt Path name of the object file passed as the first parameter to the linkage editor if you have specified the **-p** option. The default is `/usr/lib/gcrt1.o`.

options A string of option flags, separated by commas, to be processed by the compiler as if they had been entered on the command line.

osuffix The suffix for object files. The default is .o.

use Values for attributes are taken from either the named stanza or the local stanza. For single-valued attributes, values in the **use** stanza apply if no value is provided in the local, or default, stanza. For comma-separated lists, the values from the use stanza are added to the values from the local stanza.

xlc The path name of the **xlc** compiler component. The default is `/opt/ibmcmp/vac/8.0/bin/xlc`.

xlC The path name of the **xlC** compiler component. The default is `/opt/ibmcmp/vacpp/8.0/bin/xlC`.

Related information

- “Specifying compiler options in a configuration file” on page 18

Chapter 2. Compiling and linking applications

By default, an invocation of the XL C/C++ compiler performs preprocessing of program source, compiling into object files, and linking into an executable. These translation phases are actually performed by separate executables, which are referred to as *compiler components*. In the absence of command-line options, an XL C/C++ compiler invocation command automatically invokes the preprocessor and linkage editor, as well as the component that performs translation of a source program into object code, also referred to as *the compiler*. However, the preprocessor and linkage editor can be invoked individually.

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

- "Invoking the compiler"
- "Types of input files" on page 13
- "Types of output files" on page 15
- "Specifying compiler options" on page 16
- "Preprocessing" on page 21
- "Linking" on page 23
- "Compiler messages and listings" on page 25

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.

You can use other forms of the command if your particular environment requires it. The various compiler invocation commands are:

Basic	Special
xlC	xlC_r
xlc++	xlc++_r
xlc	xlc_r
cc	cc_r
c99	c99_r
c89	c89_r

XL C/C++ provides **_r** variations on the basic compiler invocations, as described below:

Table 3. Suffixes for special invocations

_r-suffixed invocations	All **_r**-suffixed invocations allow for thread-safe compilation and you can use them to link the programs that use mullti-threading. They additionally define the macro names __VACPP_MULTI__ and REENTRANT, and add the library **-lpthread**. The compiler option **-qthreaded** is also added. Use these commands if you want to create threaded applications.

Selecting an invocation command

The basic compiler invocation commands appear as the first entry of each line in Table 4. Select a basic invocation using the following criteria:

Table 4. Compiler invocations

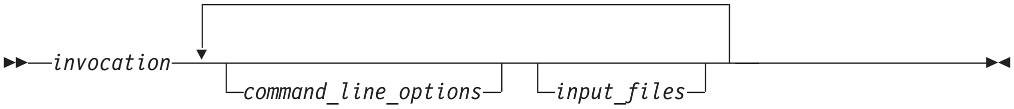
Invocation	**Criteria**
xlC xlc++	Both invoke the compiler so that source files are compiled as C++ language source code. If any of your source files are C++, you must use this invocation to link with the correct runtime libraries. Source files are compiled with **-qalias=ansi** set. Files with **.c** suffixes, assuming you have not used the **-+** compiler option, are compiled as C language source code when **-qlanglvl=extc89** is in effect.
xlc	Invokes the compiler for C source files. The following compiler options are implied with this invocation: • -qlanglvl=extc89 • -qalias=ansi • -qcpluscmt • -qkeyword=inline
cc	Invokes the compiler for C source files. The following compiler options are implied with this invocation: • -qlanglvl=extended • -qnoro • -qnoroconst
c99	Invokes the compiler for C source files, with support for ISO C99 language features. Full ISO C99 (ISO/IEC 9899:1999) conformance requires the presence of C99-compliant header files and runtime libraries. The following options are implied with this invocation: • -qlanglvl=stdc99 • -qalias=ansi • -qstrict_induction • -D_ANSI_C_SOURCE • -D_ISOC99_SOURCE • -D__STRICT_ANSI__ Use this invocation for strict conformance to the ANSI standard (ISO/IEC 9899:1999).
c89	Invokes the compiler for C source files, with support for ISO C89 language features. The following options are implied with this invocation: • -qlanglvl=stdc89 • -qalias=ansi • -qstrict_induction • -qnolonglong • -D_ANSI_C_SOURCE • -D__STRICT_ANSI__ Use this invocation for strict conformance to the ANSI standard (ISO/IEC 9899:1990).

Table 4. Compiler invocations (continued)

Invocation	Criteria
gxlc++	You can use this utility to compile C++ files. It accepts many common GNU C/C++ options, maps them to their XL C/C++ option equivalents, and then invokes **xlc**. For more information, refer to Chapter 4, “Reusing GNU C/C++ compiler options with glxc and glxc++,” on page 211.
gxlc	You can use this utility to compile C files. It accepts many common **gcc** options, maps them to their **xlc** option equivalents, and then invokes **xlc**. For more information, refer to Chapter 4, “Reusing GNU C/C++ compiler options with glxc and glxc++,” on page 211.

Invocation syntax

XL C/C++ is invoked using the following syntax, where *invocation* can be replaced with any valid XL C/C++ invocation command:



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

By default, the invocation command calls *both* the compiler and the linkage editor. It passes linkage editor options to the linkage editor. Consequently, the invocation commands also accept all linkage editor options. To compile without link-editing, 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*.c input source file, unless the **-o** option was used to specify a different object file name. The linkage editor is not invoked. You can link-edit the object files later using the same invocation command, specifying the object files without the **-c** option.

Related information
- “Types of input files”
- “Compiler messages and listings” on page 25

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 link editor will not be run and temporary object files will be removed.

Your program can consist of several source 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.

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 by specifying either the **-E** or the **-P** option. If you specify the **-P** option, a preprocessed source file, *file_name*.i, is created and processing ends.

The **-E** option preprocesses the source file, writes to standard output, and halts processing without generating an output file.

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

Table 5. Accepted input file types

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, for example, `mysource.c`. To use the C++ compiler, the source file must have a .C (uppercase C), .cc, .cp, .cpp, .cxx, or .c++ suffix. To compile other files as C++ source files, use the **-+** compiler option. All files specified with this option with a suffix other than .a, .o, .so, or .s, are compiled as C++ source files.
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 nonstripped executable files serve as input to the linkage editor. After compilation, the linkage editor 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**. Assembler files are assembled to create an object file.
Assembler-with-cpp	Assembler files must have a .S suffix, for example, *file_name*.S. The compiler compiles all source files with .S extension as if they are assembler language source files that needs preprocessing.
Shared library files	Shared library files must have a .so suffix, for example *file_name*.so.
Nonstripped executable files	Executable and linking format (ELF) files that have not been stripped with the Linux **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

The compiler gives object files a .o suffix, for example, *file_name*.o, unless the **-o** *file_name* option is specified giving a different suffix or no suffix at all.

If you specify the **-c** option, an output object file, *file_name*.o, is produced for each input source file *file_name*.*x*, where *x* is a recognized C or C++ file name extension. The linkage editor is not invoked, and the object files are placed in your current directory. All processing stops at the completion of the compilation.

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

Assembler files

Assembler files must have a .s suffix, for example, *file_name*.s.

They are created by specifying the **-S** option. Assembler files are assembled to create an object file.

Preprocessed source files

Preprocessed source files have a .i suffix, for example, *file_name*.i.

To make a preprocessed source file, specify the **-P** option. The source files are preprocessed but not compiled. You can also redirect the output from the **-E** option to generate a preprocessed file that contains `#line` directives.

A preprocessed source file, *file_name*.i, is produced for each source file and has the same file name (with a .i extension) as the source file from which it was produced.

Listing files

Listing files have a .lst suffix, for example, *file_name*.lst.

Specifying any one of the listing-related options to the invocation command produces a compiler listing (unless you have specified the **-qnoprint** option). The file containing this listing is placed in your current directory and has the same file name (with a .lst extension) as the source file from which it was produced.

Shared library files

Shared library files have a .so suffix, for example, `my_shrlib.so`.

Target files

Output files associated with the **-M** or **-qmakedep** options have a .d suffix, for example, conversion.d.

The file contains targets suitable for inclusion in a description file for the **make** command. A .d file is created for every input C or C++ file, and is used by the **make** command to determine if a given input file needs to be recompiled as a result of changes made to another input file. .d files are not created for any other files (unless you use the **-+** option so other file suffixes are treated as .C files).

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 configuration file which is a file with a .cfg extension.
- In your source program
- 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 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 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 19.

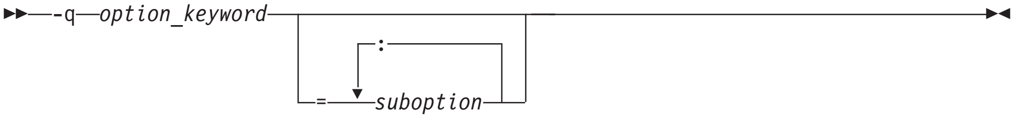
Specifying compiler options on the command line

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 19.

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 **-qflag** option **-qattr** with suboption **full** will produce an attribute listing of all identifiers in the program.

Flag options

The compilers available on Linux systems use a number of common conventional flag options. IBM XL C/C++ supports these flags. 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 linkage editor, while **-C** can be used with **-P** or **-E** to specify that user comments should be preserved.

IBM XL C/C++ also supports flags directed to other Linux programming tools and utilities (for example, the Linux **ld** command). The compiler passes on those flags directed to **ld** at link-edit 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 linkage editor (**-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 (`/etc/opt/ibmcmp/vacpp/8.0/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, and you can make entries to this file to support specific compilation requirements or to support other C or C++ compilation environments.

For information on how the compiler resolves the conflicting or incompatible options, see “Resolving conflicting compiler options” on page 19.

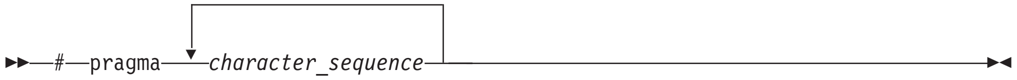
Related information

- “Customizing the configuration file” on page 8

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. It has one of the general forms given below:



Where *character_sequence* is a series of characters that give specific compiler instruction and arguments, if any. More than one pragma construct can be specified on a single pragma directive.

The unary operator `_Pragma` allows a preprocessor macro to be contained in a pragma directive:

```
►►—_Pragma—(string_literal)——————————————————————————————►◄
```

The *string_literal* may be prefixed with **L**, making it a wide-string literal. The string literal is destringized and tokenized. The resulting sequence of tokens is processed as if it appeared in a pragma directive. For example:

```
_Pragma ( "pack(full)" )
```

would be equivalent to

```
#pragma pack(full)
```

The *character_sequence* on a pragma is subject to macro substitutions, unless otherwise stated. The compiler ignores unrecognized pragmas, issuing an informational message indicating this.

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 pragma directives are listed in the detailed descriptions of the options to which they apply.

For complete details on the various pragma preprocessor directives supported by XL C/C++, see Chapter 5, “Compiler pragmas reference,” on page 215.

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 will override compiler options specified on the command line.
2. Compiler options specified on the command line will override compiler options specified 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 in a configuration file will 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
-qhalt	Multiple severities specified by **-qhalt**	Lowest severity specified
-qnoprint	**-qxref** | **-qattr** | **-qsource** | **-qlistopt** | **-qlist**	**-qnoprint**
-qfloat=rsqrt	**-qnoignerrno**	Last option specified
-qxref	**-qxref**=FULL	**-qxref**=FULL
-qattr	**-qattr**=FULL	**-qattr**=FULL
-p | **-pg** | **-qprofile**	**-p** | **-pg** | **-qprofile**	Last option specified
-E	**-P** | **-o** | **-S**	**-E**
-P	**-c** | **-o** | **-S**	**-P**
-#	**-v**	**-#**
-F	**-B** | **-t** | **-W** | **-qpath** | configuration file settings	**-B** | **-t** | **-W** | **-qpath**
-qpath	**-B** | **-t**	**-qpath** overrides **-B** and **-t**
-S	**-c**	**-S**

Related information
- "Acceptable compiler mode and processor architecture combinations" on page 208
- "Summary of compiler options by functional category" on page 31

Specifying compiler options for architecture-specific, 32-bit or 64-bit compilation

You can use XL C/C++ compiler options to optimize compiler output for use on specific processor architectures. You can also instruct the compiler to compile in either 32-bit or 64-bit mode.

The compiler evaluates compiler options in the following order, with the last allowable one found determining the compiler mode:

1. Internal default (32-bit mode)
2. Configuration file settings
3. Command line compiler options (**-q32**, **-q64**, **-qarch**, **-qtune**)
4. Source file statements (**#pragma options tune=***suboption*)

The compilation mode actually used by the compiler depends on a combination of the settings of the **-q32**, **-q64**, **-qarch** and **-qtune** compiler options, subject to the following conditions:

- *Compiler mode* is set according to the last-found instance of the **-q32** or **-q64** compiler options.
- *Architecture target* is set according to the last-found instance of the **-qarch** compiler option, provided that the specified **-qarch** setting is compatible with the *compiler mode* setting. If the **-qarch** option is not set, the compiler sets **-qarch** to the appropriate default based on the effective compiler mode setting.
- Tuning of the architecture target is set according to the last-found instance of the **-qtune** compiler option, provided that the **-qtune** setting is compatible with the

architecture target and *compiler mode* settings. If the **-qtune** option is not set, the compiler assumes a default **-qtune** setting according to the **-qarch** setting in use. If **-qarch** is not specified, the compiler sets **-qtune** to the appropriate default based on the effective **-qarch** as selected by default based on the effective compiler mode setting.

Possible option conflicts and compiler resolution of these conflicts are described below:

- **-q32** or **-q64** setting is incompatible with user-selected **-qarch** option.

  Resolution: -q32 or **-q64** setting overrides **-qarch** option; compiler issues a warning message, sets **-qarch** to its default setting, and sets the **-qtune** option accordingly to its default value.
- **-qarch** option is incompatible with user-selected **-qtune** option.

  Resolution: Compiler issues a warning message, and sets **-qtune** to the **-qarch** setting's default **-qtune** value.
- Selected **-qarch** or **-qtune** options are not known to the compiler.

  Resolution: Compiler issues a warning message, sets **-qarch** and **-qtune** to their default settings. The compiler mode (32-bit or 64-bit) is determined by the **-q32**/**-q64** compiler settings.

Related information
- "Summary of compiler options by functional category" on page 31

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. XL C/C++ is an integrated, single-pass compiler, which retains the ability to function as a multiple-pass compiler through the use of compiler options. The XL C/C++ preprocessor is provided as an independent compiler component.

The preprocessor can be invoked 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	Instructs the compiler to preprocess the source files. `#line` directives are generated.
P	Preprocesses the C or C++ source files specified in the compiler invocation and create an intermediary file with .i file name extension for each source file.
C	Preserves comments in preprocessed output.
D	Defines a macro name from the command line, as if in a `#define` directive.
U	Undefine a macro name defined by the compiler or by the **-D** option.

Specifying path names for include files

When you imbed one source file in another using the `#include` preprocessor directive, you must supply the name of the file to be included. You can specify a file name either by using a full path name or by using a relative path name.

- **Use a full path name to imbed files**

  The *full path name*, also called the *absolute path name*, is the file's complete name starting from the root directory. These path names start with the **/** (slash) character. The full path name locates the specified file regardless of the directory you are presently in (called your *working* or *current* directory).

  The following example specifies the full path to file `mine.h` in John Doe's subdirectory `example_prog`:

  ```
  /u/johndoe/example_prog/mine.h
  ```
- **Use a relative path name to imbed files**

  The *relative path name* locates a file relative to the directory that holds the current source file or relative to directories defined using the **-I***directory* option.

Directory search sequence for include files using relative path names

C and C++ define two versions of the `#include` preprocessor directive. IBM XL C/C++ supports both. With the `#include` directive, the include file name is enclosed between either the `< >` or `" "` delimiter characters.

Your choice of delimiter characters will determine the search path used to locate a given include file name. The compiler will search for that include file in all directories in the search path until the include file is found, as follows:

#include type	**Directory search order**
#include <*file_name*>	1. The compiler first searches for *file_name* in each user directory specified by the **-I***directory* compiler option, in the order that they appear on the command line. 2. For C++ compilations, the compiler then searches the directories specified by the **-qcpp_stdinc** and **-qgcc_cpp_stdinc** compiler options. 3. Finally, the compiler then searches the directories specified by the **-qc_stdinc** and **-qgcc_c_stdinc** compiler options.
#include "*file_name*"	1. The compiler first searches for the include file in the directory where your current source file resides. The current source file is the file that contains the directive `#include "`*file_name*`"`. 2. The compiler then searches for the include file according to the search order described above for `#include` <*file_name*>.

Notes:

1. *file_name* specifies the name of the file to be included, and can include a full or partial directory path to that file if you desire.
   - If you specify a file name by itself, the compiler searches for the file in the directory search list.
   - If you specify a file name together with a partial directory path, the compiler appends the partial path to each directory in the search path, and tries to find the file in the completed directory path.

- If you specify a full path name, the two versions of the `#include` directive have the same effect because the location of the file to be included is completely specified.

2. The only difference between the two versions of the `#include` directive is that the `" "` (user include) version first begins a search from the directory where your current source file resides. Typically, standard header files are included using the `< >` (system include) version, and header files that you create are included using the `" "` (user include) version.
3. You can change the search order by specifying the **-qstdinc** and **-qidirfirst** options along with the **-I***directory* option.

   Use the **-qnostdinc** option to search only the directories specified with the **-I***directory* option and the current source file directory, if applicable.

   Use the **-qidirfirst** option with the `#include "`*file_name*`"` directive to search the directories specified with the **-I***directory* option before searching other directories.

   Use the **-I** option to specify the directory search paths.

Linking

The linkage editor link-edits specified object files to create one executable file. Invoking the compiler with one of the invocation commands automatically calls the linkage editor 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 linkage editor. Object files must have a suffix, for example, `year.o`. Static library file names have an .a suffix, for example, `libold.a`. Dynamic library file names have a .so suffix, for example, `libold.so.`

Output files
The linkage editor 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:

```
xlc myfile.c -o myfile
```

If you use the **-qmkshrobj** option to create a shared library, the shared object created will have a .so file name extension.

You can invoke the linkage editor explicitly with the **ld** command. However, the compiler invocation commands set several linkage-editor 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-edit your object files.

Note: When link-editing object files, *do not* use the **-e** option of the **ld** command. The default entry point of the executable output is `__start`. Changing this label with the **-e** flag can cause erratic results.

Related information
- "Options that control linking" on page 40
- Appendix A, "Redistributable libraries," on page 301

Order of linking

XL C/C++ links libraries in the following order:

1. user .o files and libraries
2. XL C/C++ libraries
3. C++ standard libraries
4. C standard libraries

The table below shows the linking order in greater detail for a ″Hello World″ type of program.

Directory paths shown may vary depending on your particular compiler configuration. See the default configuration file installed on your system for information specific to your particular compiler configuration. See “Specifying compiler options in a configuration file” on page 18 for more information about compiler default configuration files in general.

ld command components	**Options**	**ld arguments**	**xldriver attributes**
ld	gcc, g++	ld	ld / ld_64
	xlc, xlC	ld	
enable exception handling personality handlers	all	--eh-frame-hdr	Option added to command line by xldriver
generate .ident directives	-Qn		
	otherwise	-Qy	Option added to command line by xldriver
output kind	-shared -static	-shared	Option added to command line by xldriver
	-shared	-shared	
	-static	-static	
	Otherwise		
arch	32-bit	-melf32ppclinux	Option added to command line by xldriver
	64-bit	-mel64ppc	
dynamic loader	32-bit !-shared !-static	-dynamic-linker /lib/ld.so.1	dynlib
	64-bit !-shared !-static	-dynamic-linker /lib64/ld64.so.1	dynlib64
call to main( )	32-bit !-shared	/usr/libcrt1.o	crt
	64-bit !-shared	/usr/lib64/crt1.o	crt_64
	32-bit !-shared -p	/usr/lib/gcrt1.o	mcrt
	32-bit !-shared -pg		gcrt
	64-bit !-shared -p	/usr/lib64/gcrt1.o	mcrt_64
	64-bit !-shared -pg		gcrt_64
init/fini functions prolog	32-bit all	/usr/lib/crti.o	crtp
	64-bit all	/usr/lib64/crti.o	crtp_64
init/fini register	-shared -static	crtbeginT.o	crtbegin_t / crtbegin_t_64
	-static		
	-shared	crtbeginS.o	crtbegin_s / crtbegin_s_64
	otherwise	crtbegin.o	crtbegin / crtbegin_64
library search paths	32-bit gcc	-L<*gcc*>/gcc-lib	gcc_libdirs
	64-bit gcc	-L<*gcc64*>/gcc-lib	gcc_libdirs_64
	32-bit g++	-L<*gcc*>/gcc-lib/powerpc-suse-linux-gnu/3.2 -L<*gcc*>/gcc-lib	gcc_libdirs
	64-bit g++	-L*gcc64*/gcc-lib/powerpc64-linux-gnu/3.2 -L*gcc64*/gcc-lib	gcc_libdirs_64

ld command components	Options	ld arguments	xldriver attributes
user .o files and libraries	all		
vacpp libraries	all		libraries2 / libraries2_64
C++ standard libraries	g++	-lstdc++ -lm	gcc_cpp_libs / gcc_cpp_libs_64
C standard libraries	gcc -static -static -shared-libgcc -shared -static-libgcc	-lgcc -lgcc_eh -lc -lgcc -lgcc_eh	gcc_static_libs / gcc_static_libs_64
	g++ -shared-libgcc	-lgcc_s -lgcc -lc -lgcc_s -lgcc	gcc_shared_libs / gcc_shared_libs_64
	all		gcc_libs / gcc_libs_64
save/restore routines	all	crtsavres.o	crtsavres / crtsavres_64
init/fini run		crtend.o	crtend / crtend_64
	-shared	crtendS.o	crtend_s / crtend_s_64
init/fini functions epilog	all	/usr/lib/crtn.o	crte
		/usr/lib64/crtn.o	crte_64

Compiler messages and listings

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

- "Compiler messages"
- "Compiler listings" on page 27
- "Compiler return codes" on page 28
- "Message catalog errors" on page 28
- "Paging space errors during compilation" on page 29

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 the appropriate options have been selected, to the listing file.

This section also outlines some of the basic reporting mechanisms the compiler uses to describe compilation errors.

The compiler issues messages specific to the C or C++ language.

C If you specify the compiler option "-qsrcmsg" on page 180 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 in the `stderr` file. A reconstructed source line is a preprocessed source line that has all the macros expanded.

If you specify the "-qsource" on page 177 compiler option, the compiler will place messages in the source listing. For example, if you compile your file using the command line invocation **xlc -qsource filename.c**, then you will find a file called `filename.lst` in your current directory.

You can control the diagnostic messages issued, according to their severity, using either the "-qflag" on page 82 option or the "-w" on page 205 option. To get additional informational messages about potential problems in your program, use the "-qinfo" on page 100 option.

Compiler message format

Diagnostic messages have the following format when the **-qnosrcmsg** option is active (which is the default):

```
"file", line line_number.column_number: 15dd-nnn (severity) text.
```

where:

file is the name of the C or C++ source file with the error

line_number is the line number of the error

column_number is the column number for the error

15 is the compiler product identifier

dd is a two-digit code indicating the XL C/C++ 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)

nnn is the message number

severity is a letter representing the severity of the error

text is a message describing the error

Diagnostic messages have the following format when the **-qsrcmsg** option is specified:

```
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 five-level classification scheme for diagnostic messages. Each level of severity is associated with a compiler response. Not every error halts compilation. The following table provides a key to the abbreviations for the severity levels and the associated compiler response.

Letter	Severity	Compiler response
I	Informational	Compilation continues. The message reports conditions found during compilation.
W	Warning	Compilation continues. The message reports valid but possibly unintended conditions.
E	Error	▶ C 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.

Letter	Severity	Compiler response
U	Unrecoverable error	The compiler halts. An internal compiler error has occurred. • 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 unrecoverable error. • If the message indicates an internal compiler error, the message should be reported to your IBM service representative.

Related information
- Options summary by functional category: Listings and messages
- Options summary by functional category: Error checking and debugging

Compiler listings

A listing is a type of compiler output 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.

Use the **-qsource** option to request a listing. 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
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 nondefault options that were in effect during the compilation. To list all options in effect, specify the **-qlistopt** option.

Attribute and cross-reference listing section
Provides information about the variables used in the compilation unit, such as type, storage duration, scope, and where they are defined and referenced. This section is only produced if the options **-qattr** and **-qxref** options in effect. Independently, 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 section Lists the object code generated by the compiler. This section is useful for diagnosing execution time problems, if you suspect the program is not performing as expected due to code generation error. This section is only produced if the **-qlist** option is in effect.

Related information

- Summary of command line options: 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.
- 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	No files specified.
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.

Message catalog errors

Before the compiler can compile your program, the message catalogs must be installed and the environment variables LANG and NLSPATH must be set to a language for which the message catalog has been installed.

If you see the following message during compilation, the appropriate message catalog cannot be opened:

```
Error occurred while initializing the message system in
file: message_file
```

where *message_file* is the name of the message catalog that the compiler cannot open. This message is issued in English only.

You should then verify that the message catalogs and the environment variables are in place and correct. If the message catalog or environment variables are not correct, compilation can continue, but diagnostic messages are suppressed and the following message is issued instead:

```
No message text for message_number
```

where *message_number* is the IBM XL C/C++ internal message number. This message is issued in English only.

To determine which message catalogs are installed on your system, assuming that you have installed the compiler to the default location, you can list all of the file names for the catalogs by the following command:

```
ls /opt/ibmcmp/vacpp/8.0/msg/$LANG/*.cat
```

where LANG is the environment variable on your system that specifies the system locale.

The compiler calls the message catalogs for **en_US** by default if LANG is not set correctly,

For more information about the NLSPATH and LANG environment variables, see your operating system documentation.

Paging space errors during compilation

If the operating system runs low on paging space during a compilation, the compiler issues the following message:

```
1501-229 Compilation ended due to lack of space.
```

To minimize paging-space problems, do any of the following and recompile your program:

- Reduce the size of your program by splitting it into two or more source files
- Compile your program without optimization
- Reduce the number of processes competing for system paging space
- Increase the system paging space

See your operating system documentation for more information about paging space and how to allocate it.

Chapter 3. Compiler options reference

This chapter contains detailed descriptions of the individual options available in XL C/C++. The chapter begins with a summary view of the options by functional category. Finally, a reference list of compatible hardware-related options is provided.

Summary of compiler options by functional category

The XL C/C++ options available on the Linux platform are grouped into the following categories, based on the essence or nature of the functionality the option provides:

- Input control. Accepted language features, search paths for input file.
- Output control. Characteristics of the object code, data size and alignment, file names of output files.
- Optimization. Predefined levels of optimization, specialized optimization techniques, code size.
- Error checking and debugging. Includes options for profiling and initializing automatic variables.
- Listings and messages. Includes options to produce output more specialized than that of **-qsource** or **-qinfo**.
- Compatibility. Reinstates specific functionality of an earlier compiler, hardware
- Integer and floating-point control. Options that direct rounding and the handling of `long long` and `floating-point` types.
- Linking. Search paths for input to and output from the linkage editor.
- Compiler customization. Control of internal compiler operation, such as how templates are handled.

To get detailed information on any option listed, see the full description page(s) for that option. Those pages describe each of the compiler options, including:

- The purpose of the option and additional information about its behavior. Unless specifically noted, all options apply to both C and C++ program compilations.
- The command-line syntax of the compiler option. The first line under the **Syntax** heading specifies the command-line or configuration-file method of specification. The second line, if one appears, is the **#pragma options** keyword for use in your source file.
- The default setting of the option if you do not specify the option on the command line, in the configuration file, or in a pragma directive within your program.

Options that control input

Table 6. Options for standards compliance

Option name	Type	Default	Description
-qlanglvl	**-q***opt*	See “-qlanglvl” on page 119.	Selects the C or C++ language level for compilation.

Table 7. Options for language extensions

Option name	Type	Default	Description
-qaltivec	**-q***opt*	**-qnoaltivec**	Enables compiler support for VMX vector data types.
-qasm	**-q***opt*	**-qasm=gcc**	Controls the interpretation of and subsequent code generation for `asm` statements.
-qdigraph	**-q***opt*	See "-qdigraph" on page 72.	Enables the use of digraph character sequences in your program source.
-qdollar	**-q***opt*	**-qnodollar**	Allows the $ symbol to be used in the names of identifiers.
-qkeyword	**-q***opt*	See "-qkeyword" on page 117.	Controls whether a specified string is treated as a keyword or an identifier.
-qtrigraph	**-q***opt*	**-qtrigraph**	Enables the use of trigraph character sequences in your program source.
-qutf	**-q***opt*	**-qnoutf**	Enables recognition of UTF literal syntax.

Table 8. Options for search paths

Option name	Type	Default	Description
▶ C -qc_stdinc	**-q***opt*	-	Changes the standard search location for the C headers.
▶ C++ -qcinc	**-q***opt*	**-qnocinc**	Instructs the compiler to place an `extern "C" { }` wrapper around the contents of an include file.
-qcomplexgccincl	**-q***opt*	**-qcomplexgccincl =/usr/include**	Instructs the compiler to internally wrap **#pragma complexgcc(on)** and **#pragma complexgcc(pop)** directives around include files found in specified directories.
▶ C++ -qcpp_stdinc	**-q***opt*	-	Changes the standard search location for the C++ headers.
▶ C -qgcc_c_stdinc	**-q***opt*	-	Changes the standard search location for the gcc headers.
▶ C++ -qgcc_cpp_stdinc	**-q***opt*	-	Changes the standard search location for the g++ headers.
-I	*-flag*	-	Specifies an additional search path for `#include` file names that do not specify an absolute path.
-qidirfirst	**-q***opt*	**-qnoidirfirst**	Specifies the search order for files included with the `#include "` *file_name*`"` directive.
-qstdinc	**-q***opt*	**-qstdinc**	Specifies which files are included with `#include <`*file_name*`>` and `#include "` *file_name*`"` directives.

Table 9. Other input options

Option name	Type	Default	Description
C++ -+ (plus sign)	*-flag*	-	Compiles any file, *filename.nnn*, as a C++ language file, where *nnn* is any suffix other than .o, .a, or .s.
-C	*-flag*	-	Preserves comments in preprocessed output.
C -qcpluscmt	**-q***opt*	See "-qcpluscmt" on page 64.	Enables the recognition of C++ comments in C source files.
-D	*-flag*	-	Defines the identifier *name* as in a `#define` preprocessor directive.
-qmbcs, -qdbcs	**-q***opt*	**-qnombcs**, **-qnodbcs**	Enables the recognition of multibyte characters in source code.
-qignprag	**-q***opt*	-	Instructs the compiler to ignore certain pragma statements.
C -qsyntaxonly	**-q***opt*	-	Causes the compiler to perform syntax checking without generating an object file.
-qsourcetype	**-q***opt*	**-qsourcetype=default**	Instructs the compiler to treat all source files as if they are the source type specified by this option, regardless of actual source file name suffix.
-U	*-flag*	-	Undefines a specified identifier defined by the compiler or by the **-D** option.

Options that control output

Table 10. Options for file output

Option name	Type	Default	Description
-E	*-flag*	-	Instructs the compiler to preprocess the source files.
-M	*-flag*	-	Creates an output file that contains targets suitable for inclusion in a description file for the **make** command.
-o	*-flag*	-	Specifies an output location for the object, assembler, or executable files created by the compiler.
-P	*-flag*	-	Preprocesses the C or C++ source files named in the compiler invocation and creates an output preprocessed source file for each input source file.
-S	*-flag*	-	Generates an assembly language file (**.s**) for each source file.
-s	*-flag*	-	Strips the symbol table.
-qfuncsect	**-q***opt*	**-qnofuncsect**	Places instructions for each function in a separate object file control section or csect.

Table 10. Options for file output (continued)

Option name	Type	Default	Description
-qmakedep	**-q***opt*	-	Creates an output file that contains targets suitable for inclusion in a description file for the **make** command.
-qppline	**-q***opt*	**-qppline**	Enables generation of `#line` directives in the preprocessed output.

Table 11. Options for signedness

Option name	Type	Default	Description
-qbitfields	**-q***opt*	**-qbitfields=signed**	Specifies if bit fields are signed.
-qchars	**-q***opt*	**-qchars=unsigned**	Instructs the compiler to treat all variables of type `char` as either `signed` or `unsigned`.
▶ C -qupconv	**-q***opt*	**-qnoupconv**	Preserves the `unsigned` specification when performing integral promotions.

Table 12. Options for data size and alignment

Option name	Type	Default	Description
-qalign	**-q***opt*	**-qalign=linuxppc**	Specifies the aggregate alignment rules the compiler uses for file compilation.
-qenum	**-q***opt*	See "-qenum" on page 78.	Specifies the amount of storage occupied by enumerations.

Table 13. Options that control the characteristics of the object code

Option name	Type	Default	Description
-qenablevmx	**-q***opt*	**-qenablevmx**	Enables generation of VMX (Vector Multimedia Extension) instructions on supporting architectures.
-qpic	**-q***opt*	**-qnopic**	Instructs the compiler to generate Position-Independent Code suitable for use in shared libraries.
▶ C -qreserved_reg	**-q***opt*	-	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.
▶ C++ -qstaticinline	**-q***opt*	**-qnostaticinline**	Treats inline functions as being static.
-qstatsym	**-q***opt*	**-qnostatsym**	Adds user-defined, non-external names that have a persistent storage class to the name list.
▶ C++ -qvftable	**-q***opt*	**-qvftable**	Controls the generation of virtual function tables.

Table 13. Options that control the characteristics of the object code (continued)

Option name	Type	Default	Description
-qvrsave	**-q**_opt_	**-qvrsave**	Controls function prolog and epilog code necessary to maintain the VRSAVE register.
-qxcall	**-q**_opt_	**-qnoxcall**	Generates code to treat static routines within a compilation unit as if they were external calls.

Table 14. Options that control the placement of strings and constant data

Option name	Type	Default	Description
-qro	**-q**_opt_	See “-qro” on page 169.	Specifies the storage type for string literals.
-qroconst	**-q**_opt_	See “-qroconst” on page 169.	Specifies the storage location for constant values.

Table 15. Other output options

Option name	Type	Default	Description
-# (pound sign)	-_flag_	-	Traces the compilation without doing anything.
-c	-_flag_	-	Instructs the compiler to pass source files to the compiler without sending them to the linkage editor.
-q32, -q64	**-q**_opt_	**-q32**	Selects 32-bit or 64-bit compiler mode.
▶ C -qalloca	**-q**_opt_	-	Substitutes inline code for calls to function **alloca** as if **#pragma alloca** directives are in the source code.
▶ C++ -qrtti	**-q**_opt_	**-qrtti**	Generates runtime type identification (RTTI) information for the typeid operator and the dynamic_cast operator.
-qsaveopt	**-q**_opt_	**-qnosaveopt**	Saves the compiler options into an object file.
-qthreaded	**-q**_opt_	See “-qthreaded” on page 192.	Indicates that the program will run in a multi-threaded environment.

Options for performance optimization

Table 16. Options for defined optimization levels

Option name	Type	Default	Description
-O, -qoptimize, -qoptimize	-_flag_, **-q**_opt_	**-qnooptimize**	Optimizes code at a choice of levels during compilation.

Table 17. Options for ABI performance tuning

Option name	Type	Default	Description
-qdataimported	**-q**_opt_	-	Marks data as imported.
-qdatalocal	**-q**_opt_	-	Marks data as local.

Table 17. Options for ABI performance tuning (continued)

Option name	Type	Default	Description
-qlibansi	**-q***opt*	**-qnolibansi**	Assumes that all functions with the name of an ANSI C library function are in fact the system functions.
-qminimaltoc	**-q***opt*	**-qnominimaltoc**	Avoids TOC overflow conditions in 64-bit compilations by placing TOC entries into a separate data section for each object file.
-qproclocal, -qprocimported, -qprocunknown	**-q***opt*	See "-qproclocal, -qprocimported, -qprocunknown" on page 161.	Marks functions as local, imported, or unknown.
-qtocdata	**-q***opt*	**-qnotocdata**.	Specifies the thread-local storage model to be used by the application.
-qunwind	**-q***opt*	**-qunwind**	Informs the compiler that the application does not rely on any program stack unwinding mechanism.

Table 18. Options that restrict optimization

Option name	Type	Default	Description
-qprefetch	**-q***opt*	**-qprefetch**	Enables generation of prefetching instructions in compiled code.
-qsmallstack	**-q***opt*	**-qnosmallstack**	Instructs the compiler to reduce the size of the stack frame.
-qspill	**-q***opt*	**-qspill=512**	Specifies the size of the register allocation spill area.
-qstrict	**-q***opt*	See "-qstrict" on page 183.	Turns off aggressive optimizations of the **-O3** option that have the potential to alter the semantics of your program.

Table 19. Options for processor and architectural optimization

Option name	Type	Default	Description
-qarch	**-q***opt*	**-qarch=ppc64grsq**	Specifies the architecture on which the executable program will be run.
-qcache	**-q***opt*	-	Specifies a cache configuration for a specific execution machine.
-qdirectstorage	**-q***opt*	**-qnodirectstorage**.	Informs the compiler that write-through enabled or cache-inhibited storage may be referenced.
-qtune	**-q***opt*	See "-qtune" on page 197.	Specifies the architecture for which the executable program is optimized.

Table 20. Options for loop optimization

Option name	Type	Default	Description
-qhot	**-q***opt*	**-qnohot**	Instructs the compiler to perform high-order loop analysis and transformations during optimization.
-qstrict_induction	**-q***opt*	See "-qstrict_induction" on page 184.	Disables loop induction variable optimizations that have the potential to alter the semantics of your program.
-qunroll	**-q***opt*	**-qunroll=auto**	Unrolls inner loops in the program.

Table 21. Options for code size reduction

Option name	Type	Default	Description
-qcompact	**-q***opt*	**-qnocompact**	When used with optimization, reduces code size where possible, at the expense of execution speed.
▶ C++ -qeh	**-q***opt*	**-qeh**	Controls exception handling.
▶ C++ -qkeepinlines	**-q***opt*	**-qnokeepinlines**	Instructs the compiler to keep or discard definitions for unreferenced external inline functions.

Table 22. Options for whole-program analysis

Option name	Type	Default	Description
-qipa	**-q***opt*	See "-qipa" on page 106.	Turns on or customizes a class of optimizations known as interprocedural analysis (IPA).

Table 23. Options for function inlining

Option name	Type	Default	Description
-qinline	**-q***opt*	See "-qinline" on page 104.	Attempts to inline functions instead of generating calls to a function.
-Q	**-***flag*	See "-Q" on page 164.	Attempts to inline functions.

Table 24. Options for performance data collection

Option name	Type	Default	Description
-qpdf1, -qpdf2	**-q***opt*	**-qnopdf1**, **-qnopdf2**	Tunes optimizations through profile-directed feedback.
-qshowpdf	**-q***opt*	**-qnoshowpdf**	Used together with **-qpdf1** and a minimum of **-O** to add additional call and block count profiling information to an executable.

Options for error checking and debugging

Table 25. Options for debugging

Option name	Type	Default	Description
-g	**-***flag*	-	Generates debugging information for use by a debugger.

Table 25. Options for debugging (continued)

Option name	Type	Default	Description
▶ C -qdbxextra	**-q***opt*	**-qnodbxextra**	Specifies that all `typedef` declarations, `struct`, `union`, and `enum` type definitions are included for debugger processing.
-qfullpath	**-q***opt*	**-qnofullpath**	Specifies the path information that is stored for files when you use the **-g** option.
-qlinedebug	**-q***opt*	**-qnolinedebug**	Generates abbreviated line number and source file name information for the debugger.
▶ C -qsymtab	**-q***opt*	-	Determines what information appears in the symbol table.

Table 26. Options for profiling

Option name	Type	Default	Description
-p	-*flag*	-	Sets up the object files produced by the compiler for profiling.
-pg	-*flag*	-	Sets up the object files for profiling.

Table 27. Other error checking and debugging options

Option name	Type	Default	Description
▶ C -qgenproto	**-q***opt*	**-qnogenproto**	Produces ANSI prototypes from K&R function definitions.
-qinitauto	**-q***opt*	**-qnoinitauto**	Initializes automatic storage to a specified two-digit hexadecimal byte value.
-qkeepparm	**-q***opt*	**-qnokeepparm**	Ensures that function parameters are stored on the stack even if the application is optimized.
▶ C -qproto	**-q***opt*	**-qnoproto**	Assumes all functions are prototyped.
-qtbtable	**-q***opt*	See "-qtbtable" on page 188.	Sets traceback table characteristics.

Options that control listings and messages

Table 28. Options for listings

Option name	Type	Default	Description
-qattr	**-q***opt*	**-qnoattr**	Produces a compiler listing that includes an attribute listing for all identifiers.
-qdump_class_hierarchy	**-q***opt*	-	Outputs the class layout and structure of the inheritance to standard error.
-qlist	**-q***opt*	**-qnolist**	Produces a compiler listing that includes an object listing.

Table 28. Options for listings (continued)

Option name	Type	Default	Description
-qlistopt	**-q***opt*	**-qnolistopt**	Produces a compiler listing that displays all options in effect.
-qprint	**-q***opt*	**-qprint**	**-qnoprint** suppresses listings.
-qshowinc	**-q***opt*	**-qnoshowinc**	Used together with **-qsource** to selectively show user header files (includes using ″ ″) or system header files (includes using < >) in the program source listing.
-qsource	**-q***opt*	**-qnosource**	Produces a compiler listing and includes source code.
-qtabsize	**-q***opt*	**-qtabsize=8**	Changes the length of tabs as perceived by the compiler.
-qxref	**-q***opt*	**-qnoxref**	Produces a compiler listing that includes a cross-reference listing of all identifiers.

Table 29. Options for messages

Option name	Type	Default	Description
-qflag	**-q***opt*	**-qflag=i:i**	Specifies the minimum severity level of diagnostic messages to be reported.
-qformat	**-q***opt*	See "-qformat" on page 88	Warns of possible problems with string input and output format specifications.
-qhalt	**-q***opt*	**-qhalt=s**	Instructs the compiler to stop after the compilation phase when it encounters errors of specified *severity* or greater.
▶ C++ -qhaltonmsg	**-q***opt*	-	Instructs the compiler to stop after the compilation phase when it encounters a specific error message.
-qinfo	**-q***opt*	▶ C **-qnoinfo** ▶ C++ **-qinfo=lan:trx**	Produces informational messages.
-qphsinfo	**-q***opt*	**-qnophsinfo**	Reports the time taken in each compilation phase.
-qreport	**-q***opt*	**-qnoreport**	Instructs the compiler to produce transformation reports that show how program loops are parallelized and optimized.
▶ C -qsrcmsg	**-q***opt*	**-qnosrcmsg**	Adds the corresponding source code lines to the diagnostic messages in the `stderr` file.

Table 29. Options for messages (continued)

Option name	Type	Default	Description
-qsuppress	**-q**_opt_	See “-qsuppress” on page 185.	Specifies compiler message numbers to be suppressed.
-qversion	**-q**_opt_	**-qnoversion**	Displays the version of the compiler being invoked.
-V	-_flag_	-	Instructs the compiler to report information on the progress of the compilation in a command-like format.
-v	-_flag_	-	Instructs the compiler to report information on the progress of the compilation.
-w	-_flag_	-	Requests that warning messages be suppressed.

Options for compatibility

Table 30. Options for compatibility

Option name	Type	Default	Description
▶ C++ -qabi_version	**-q**_opt_	See “-qabi_version” on page 44.	Specifies a C++ ABI version for binary compatibility with different levels of GNU C++.

Options that control integer and floating-point processing

Table 31. Options for integer and floating-point control

Option name	Type	Default	Description
-qfloat	**-q**_opt_	See “-qfloat” on page 83.	Specifies various floating point options to speed up or improve the accuracy of floating point operations.
-qflttrap	**-q**_opt_	**-qnoflttrap**	Generates extra instructions to detect and trap floating point exceptions.
-qlonglit	**-q**_opt_	**-qnolonglit**	Makes unsuffixed literals the long type for 64-bit mode.
-qlonglong	**-q**_opt_	See “-qlonglong” on page 139.	Allows `long long` types in your program.
-y	-_flag_	**-yn**	Specifies the compile-time rounding mode of constant floating-point expressions.

Options that control linking

Table 32. Options for linker input control

Option name	Type	Default	Description
-qbigdata	**-q**_opt_	**-qnobigdata**	In 32-bit mode, allows initialized data to be larger than 16 MB in size.

Table 32. Options for linker input control (continued)

Option name	Type	Default	Description
-e	-*flag*	-	Specifies the entry name for the shared object. Equivalent to using **ld -e** *name*.
-L	-*flag*	See "-L" on page 117.	Searches the specified directory at link time for library files specified by the **-l** option.
-l	-*flag*	See "-l" on page 118.	Searches a specified library for linking.
-qlib	**-q***opt*	**-qlib**	Instructs the compiler to use the standard system libraries at link time.
-R	-*flag*	See "-R" on page 166.	Searches the specified directory at run time for shared libraries.

Table 33. Options for linker output control

Option name	Type	Default	Description
-qmkshrobj	**-q***opt*	-	Creates a shared object from generated object files.
-qstaticlink	**-q***opt*	**-qnostaticlink**	Controls linking to shared libraries.
-r	-*flag*	-	Produces a relocatable object.

Table 34. Other linker options

Option name	Type	Default	Description
-qcrt	**-q***opt*	**-qcrt**	Instructs the linkage editor to use the standard system startup files at link time.
-qinlglue	**-q***opt*	**-qnoinlglue**	Generates fast external linkage by inlining the pointer glue code necessary to make a call to an external function or a call through a function pointer.
C++ -qpriority	**-q***opt*	**-qpriority=65535**	Specifies the priority level for the initialization of static objects.

Options for customizing the compiler

Table 35. Options for general customization

Option name	Type	Default	Description
-B	-*flag*	-	Determines substitute path names for the compiler, assembler, linkage editor, and preprocessor.
-F	-*flag*	-	Names an alternative configuration file for the compiler.
-qasm_as	**-q***opt*	-	Specifies the path and flags used to invoke the assembler.

Table 35. Options for general customization (continued)

Option name	Type	Default	Description
-qmaxmem	**-q***opt*	**-qmaxmem=8192**	Limits the amount of memory used for local tables of specific, memory-intensive optimizations.
-qpath	**-q***opt*	-	Constructs alternate program and path names.
-t	*-flag*	See "-t" on page 187.	Adds the prefix specified by the **-B** option to designated programs.
-W	*-flag*	-	Passes the listed options to a designated compiler program.
-qtls	**-q***opt*	See "-qtls" on page 192.	Marks data as local.

Table 36. Template-related options

Option name	Type	Default	Description
▶ C++ -qtempinc	**-q***opt*	**-qnotempinc**.	Generates separate include files for template functions and class declarations, and places these files in a directory which can be optionally specified.
▶ C++ -qtemplaterecompile	**-q***opt*	See "-qtemplaterecompile" on page 190.	Helps manage dependencies between compilation units that have been compiled using the **-qtemplateregistry** compiler option.
▶ C++ -qtemplateregistry	**-q***opt*	**-qnotemplateregistry**	Maintains records of all templates as they are encountered in the source and ensures that only one instantiation of each template is made.
▶ C++ -qtempmax	**-q***opt*	**-qtempmax=1**	Specifies the maximum number of template include files to be generated by the **tempinc** option for each header file.
▶ C++ -qtmplinst	**-q***opt*	**-qtmplinst=auto**	Manages the implicit instantiation of templates.
▶ C++ -qtmplparse	**-q***opt*	**-qtmplparse=no**	Controls whether parsing and semantic checking are applied to template definition implementations.

Individual option descriptions

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

-+ (plus sign)

▶ C++

Description

Compiles any file, *filename.nnn*, as a C++ language file, where *nnn* is any suffix other than .a, .o, .so, .S or .s.

Syntax

```
►►── -+ ──────────────────────────────────────────────────────►◄
```

Notes

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.

Example

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

```
 xlc++ -+ myprogram.cplspls
```

Related information
- "-qsourcetype" on page 178
- Options that control input: Other input options

## -# (pound sign)

Description

Traces the compilation without invoking anything. This option previews the compilation steps specified on the command line. When the **xlc++** command is issued with this option, it names the programs within the preprocessor, compiler, and linkage editor that would be invoked, and the options that would be specified to each program. The preprocessor, compiler, and linkage editor are not invoked.

Syntax

```
►►── -# ──────────────────────────────────────────────────────►◄
```

Notes

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. Information is displayed to standard output.

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

Example

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

```
xlc myprogram.c -#
```

Related information
- "-v" on page 202
- Options that control output: Other output options

-q32, -q64

Description

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

Syntax

```
        ┌─32─┐
►►── -q─┴─64─┴──────────────────────────────────────────────►◄
```

Notes

If this option is not explicitly specified on the command line, the compiler will default to 32-bit output mode.

If the compiler is invoked in 64-bit mode, the __64BIT__ preprocessor macro is defined.

Use **-q32** and **-q64** options, along with the **-qarch** and **-qtune** compiler options, to optimize the output of the compiler to the architecture on which that output will be used.

Example

To specify that the executable program testing compiled from `myprogram.c` is to run on a computer with a 32-bit PowerPC architecture, enter:

```
xlc -o testing myprogram.c -q32 -qarch=ppc
```

Important!

- If you mix 32-bit and 64-bit compilation modes for different source files, your objects will not bind. You must recompile completely to ensure that all objects are in the same mode.
- Your link options must reflect the type of objects you are linking. If you compiled 64-bit objects, you must link these objects using 64-bit mode.

Related information

- “-qarch” on page 49
- “-qtune” on page 197
- “Acceptable compiler mode and processor architecture combinations” on page 208
- Options that control output: Other output options

-qabi_version

▶ C++

Description

Specifies the C++ ABI version for binary compatibility with different levels of GNU C++.

Syntax

```
►►── -q──abi_version──=──┬─1─┬──────────────────────────────►◄
                         └─2─┘
```

where:

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, if this version is supported by the operating system.

Notes

The option **-qabi_version** is provided for compatibility with the GNU C++ option -fabi-version=*n*, which allows the user to specify the version of the C++ abstract binary interface used during compilation. The default setting of **-qabi_version** depends on the compiling machine itself and the level of GNU C++ configured during the installation of XL C++. The default is **-qabi_version=1** if GNU C++ 3.2 or 3.3 is installed on the compiling machine.

Informational messages

The value of **-qabi_version** can be ascertained by compiling with **-qlistopt** in effect.

Related information
- “-qlistopt” on page 137
- Options for compatibility

-qaggrcopy

Description

Enables destructive copy operations for structures and unions.

Syntax

```
►►── -q──aggrcopy──=──┬─nooverlap─┬────────────────────────────────────────►◄
                      └─overlap───┘
```

Default setting

The default setting of this option is **-qaggrcopy=overlap** when compiling with **-qlanglvl=extended** or **-qlanglvl=classic** in effect. Otherwise, the default is **-qaggrcopy=nooverlap**.

Programs that do not comply to the ANSI C standard as it pertains to non-overlap of source and destination assignment may need to be compiled with the **-qaggrcopy=overlap** compiler option.

Notes

If the **-qaggrcopy=nooverlap** compiler option is enabled, the compiler assumes that the source and destination for structure and union assignments do not overlap. This assumption lets the compiler generate faster code.

Example

```
xlc myprogram.c -qaggrcopy=nooverlap
```

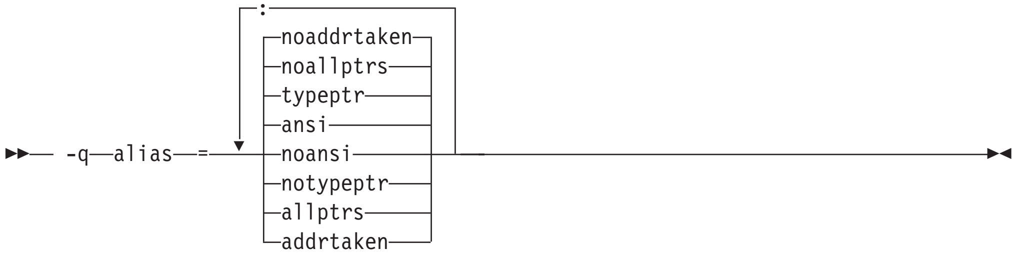
Related information
- “-qlanglvl” on page 119
- Summary of command line options: Optimization flags

-qalias

Description

Instructs the compiler to apply aliasing assertions to your compilation unit. The compiler will take advantage of the aliasing assertions to improve optimizations where possible, unless you specify otherwise.

Syntax



where available aliasing options are:

[no]typeptr
If **notypeptr** is specified, pointers to different types are never aliased. In other words, in the compilation unit, no two pointers of different types will point to the same storage location.

[no]allptrs
If **noallptrs** is specified, pointers are never aliased (this also implies **-qalias=typeptr**). Therefore, in the compilation unit, no two pointers will point to the same storage location.

[no]addrtaken
If **noaddrtaken** is specified, 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.

[no]ansi
If **ansi** is specified, 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 (**ansi**) is the default for the **xlc**, **xlc++**, **xlC**, **c89** and **c99** invocation commands. This option has no effect unless you also specify the **-O** option.

If you select **noansi**, 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. This is the default for the **cc** invocation command.

Notes

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`.

Example

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

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

Related information

- "#pragma disjoint" on page 225
- Options for performance optimization: Options for aliasing

-qalign

Description

Specifies what aggregate alignment rules the compiler uses for file compilation. Use this option to specify the maximum alignment to be used when mapping a class-type object, either for the whole source program or for specific parts.

Syntax

```
                        ┌─linuxppc───┐
►►── -q──align──=───────┴─bit_packed─┴─────────────────────────────────────►◄
```

where available alignment options are:

linuxppc The compiler uses default GNU C/C++ alignment rules to maintain compatibility with GNU C/C++ objects. This is the default.

bit_packed The compiler uses the **bit_packed** alignment rules. This suboption is similar to the GCC **-fpack-struct** option.

Notes

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

You can control the alignment of a subset of your code by using **#pragma align(***alignment_rule***)** to override the setting of the **-qalign** compiler option. Use **#pragma align(reset)** to revert to a previous alignment rule. The compiler stacks alignment directives, so you can go back to using the previous alignment directive, without knowing what it is, by specifying the **#pragma align(reset)** directive. For example, you can use this option if you have a class declaration within an include file and you do not want the alignment rule specified for the class to apply to the file in which the class is included.

Examples

Example 1 - Affecting only aggregate definition

Using the compiler invocation:

```
xlc++ file2.C /* <-- default alignment rule for file is                */
           /*     linuxppc because no alignment rule specified */
```

Where `file2.C` has:

```
extern struct A A1;
typedef struct A A2;

#pragma options align=bit_packed /* <-- use bit_packed alignment rules*/
struct A {
  int a;
  char c;
};
#pragma options align=reset /* <-- Go back to default alignment rules */

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

Example 2 - Imbedded pragmas

Using the compiler invocation:

```
xlc -qalign=linuxppc file.c  /* <-- default alignment rule for file */
                            /*    is linuxppc                      */
```

Where `file.c` has:

```
struct A {
  int a;
  struct B {
    char c;
    double d;
#pragma options align=bit_packed /* <-- B will be unaffected by this  */
                            /*     #pragma, unlike previous behavior; */
                            /*     linuxppc alignment rules still    */
                            /*     in effect                          */
  } BB;
#pragma options align=reset /* <-- A is unaffected by this #pragma;   */
} AA;                       /*     linuxppc alignment rules still    */
                            /*     in effect                          */
```

Related information

- “#pragma align” on page 217
- “#pragma options” on page 248
- “#pragma pack” on page 253
- Options that control output: Options for data size and alignment
- "The __align specifier" in the *XL C/C++ Language Reference*
- "Aligning data in aggregates"in the *XL C/C++ Programming Guide*
- ″The aligned variable attribute″ in the *XL C/C++ Language Reference*
- ″The packed variable attribute″ in the *XL C/C++ Language Reference*

-qalloca

C

Description

Substitutes inline code for calls to function `alloca`, as if **#pragma alloca** directives were in the source code.

Syntax

```
►►── -q──alloca──────────────────────────────────────────────────────►◄
```

Notes

C If **#pragma alloca** is unspecified, and if you do not use **-ma**, `alloca` is treated as a user-defined identifier rather than as a built-in function.

C++ In C++ programs, you should use the `__alloca` built-in function. If your source code already references `alloca` as a function name, use the following option on the command line when invoking the compiler:

```
-Dalloca=__alloca
```

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

Example

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

```
xlc myprogram.c -qalloca
```

Related information

- "#pragma alloca" on page 218
- "-D" on page 69
- "-ma" on page 141
- Options that control output: Other output options

-qaltivec

Description

Enables compiler support for vector data types.

Syntax

```
                 ┌─noaltivec─┐
►►── -q──────────┴─altivec───┴──────────────────────────────────────────────►◄
```

Notes

This option instructs the compiler to support vector data types and operators and has effect only when **-qarch** is set or implied to be a target architecture that supports VMX instructions and the **-qenablevmx** compiler option is in effect (it is in effect by default on currently supported Linux distributions). Otherwise, the compiler will ignore **-qaltivec** and issue a warning message.

When **-qaltivec** is in effect, the following macros are defined:

- __ALTIVEC__ is defined to 1.
- __VEC__ is defined to 10205.

Example

To enable compiler support for vector programming, enter:

```
xlc myprogram.c  -qarch=ppc64v -qaltivec
```

Related information

- "#pragma altivec_vrsave" on page 219
- "-qarch"
- "-qenablevmx" on page 77
- ″Appendix C. Vector data types and literals″in the*XL C/C++ Language Reference*
- *AltiVec Technology Programming Interface Manual*, available at http://www.freescale.com
- Options that control input: Options for language extensions

-qarch

Description

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

In general, the **-qarch** option allows you to target a specific architecture for the compilation. For any given **-qarch** setting, the compiler defaults to a specific, matching **-qtune** setting, which can provide additional performance improvements. The resulting code may not run on other architectures, but it will provide the best performance for the selected architecture. To generate code that can run on more than one architecture, specify a **-qarch** suboption that supports a group of architectures, such as **ppc**, or **ppc64**; doing this will generate code that runs on all supported architectures, all PowerPC architectures, or all 64-bit PowerPC architectures, respectively. When a **-qarch** suboption is specified with a group argument, you can specify **-qtune** as either **auto**, or provide a specific architecture in the group. In the case of **-qtune=auto**, the compiler will generate code that runs on all architectures in the group specified by the **-qarch** suboption, but select instruction sequences that have best performance on the architecture of the machine used to compile. Alternatively you can target a specific architecture for tuning performance.

Syntax

```
                  ┌─ppc64grsq─┐
►►── -q──arch──=──┼─auto──────┼───────────────────────────────────────►◄
                  ├─pwr3──────┤
                  ├─pwr4──────┤
                  ├─pwr5──────┤
                  ├─pwr5x─────┤
                  ├─ppc───────┤
                  ├─ppc64v────┤
                  ├─ppc64─────┤
                  ├─ppcgr─────┤
                  ├─ppc64gr───┤
                  ├─ppc970────┤
                  ├─rs64b─────┤
                  └─rs64c─────┘
```

where available options specify broad families of processor architectures or subgroups of those architecture families, described below.

auto
- This option is implied if **-O4** or **-O5** is set or implied.
- Produces object code containing instructions that will run on the hardware platform on which it is compiled.

pwr3
- Produces object code containing instructions that will run on any POWER3™, POWER4™, POWER5™, POWER5+™ or PowerPC 970 hardware platform.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, and _ARCH_PWR3 macros.

pwr4
- Produces object code containing instructions that will run on the POWER4, POWER5, POWER5+ or PowerPC 970 hardware platform.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, _ARCH_PWR3, and _ARCH_PWR4 macros.

pwr5
- Produces object code containing instructions that will run on the POWER5 or POWER5+ hardware platforms.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, _ARCH_PWR3, _ARCH_PWR4, and _ARCH_PWR5 macros.

pwr5x
- Produces object code containing instructions that will run on the POWER5+ hardware platforms.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, _ARCH_PWR3, _ARCH_PWR4, _ARCH_PWR5 and _ARCH_PWR5X macros.

ppc

- In 32-bit mode, produces object code containing instructions that will run on any of the 32-bit PowerPC hardware platforms. This suboption will cause the compiler to produce single-precision instructions to be used with single-precision data.
- Defines the _ARCH_PPC macro.
- Specifying **-qarch=ppc** together with **-q64** implies **-qarch=ppc64grsq**.

ppc64

- Produces object code that will run on any of the 64-bit PowerPC hardware platforms.
- This suboption can be selected when compiling in 32-bit mode, but the resulting object code may include instructions that are not recognized or behave differently when run on 32-bit PowerPC platforms.
- Defines the _ARCH_PPC and _ARCH_PPC64 macros.

ppcgr

- In 32-bit mode, produces object code for PowerPC processors that support optional graphics instructions.
- Specifying **-qarch=ppcgr** together with **-q64** silently upgrades the architecture setting to **-qarch=ppc64grsq**.
- Defines the _ARCH_PPC and _ARCH_PPCGR macros.

ppc64gr

- Produces code for any 64-bit PowerPC hardware platform that supports optional graphics instructions.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, and _ARCH_PPC64GR macros.

ppc64grsq

- Produces code for any 64-bit PowerPC hardware platform that supports optional graphics and square root instructions.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, and _ARCH_PPC64GRSQ macros.

ppc64v

- Generates instructions for generic PowerPC chips with VMX processors, such as the PowerPC 970. Valid in 32-bit or 64-bit mode.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, _ARCH_PPC64V macros.

ppc970

- Generates instructions specific to the PowerPC 970 architecture.
- Defines the _ARCH_PPC, _ARCH_PPC64V, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC970, _ARCH_PWR3, _ARCH_PWR4, _ARCH_PPC64GR, and_ARCH_PPC64GRSQ macros.

rs64b

- Produces object code that will run on RS64II platforms.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, and _ARCH_RS64B macros.

rs64c

- Produces object code that will run on RS64III platforms.
- Defines the _ARCH_PPC, _ARCH_PPCGR, _ARCH_PPC64, _ARCH_PPC64GR, _ARCH_PPC64GRSQ, and _ARCH_RS64C macros.

Notes

If you want maximum performance on a specific architecture and will not be using the program on other architectures, use the appropriate architecture option.

You can use **-qarch=***suboption* with **-qtune=***suboption*. **-qarch=***suboption* specifies the architecture for which the instructions are to be generated, and **-qtune=***suboption* specifies the target platform for which the code is optimized. If **-qarch** is specified without **-qtune**, the compiler uses the default tuning option for the specified architecture, and the listing shows the effective **-qtune** setting.

Example

To specify that the executable program testing compiled from `myprogram.c` is to run on a computer with a 32-bit PowerPC architecture, enter:

```
xlc -o testing myprogram.c -q32 -qarch=ppc
```

Related information

- “-qtune” on page 197
- “Specifying compiler options for architecture-specific, 32-bit or 64-bit compilation” on page 20
- “Acceptable compiler mode and processor architecture combinations” on page 208
- Options for performance optimization: Options for processor and architectural optimization
- "Optimizing your applications"in the *XL C/C++ Programming Guide*

-qasm

Description

Controls the interpretation of and subsequent generation of code for an `asm` assembly statement.

Syntax

▶ C The default is **-qasm=gcc**, independent of the language level. Specifying **-qasm** without a suboption is equivalent to specifying the default.

```
         ┌asm=gcc┐
▶▶─ -q───┴noasm──┴──────────────────────────────────────────────▶◀
```

▶ C++ The default is also**-qasm=gcc**, independent of the language level.

```
         ┌asm=gcc─────┐
▶▶─ -q───┼asm=stdcpp──┼─────────────────────────────────────────▶◀
         └noasm───────┘
```

Notes

The **-qasm** option and its negative form control whether or not code is emitted for an assembly statement. The positive form of the option directs the compiler to generate code for assembly statements in the source code. The suboptions specify the syntax used to interpret the content of the assembly statement. For example, specifying **-qasm=gcc** instructs the compiler to recognize the extended GCC syntax and semantics for assembly statements.

▶ 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.

Predefined macros

Whenever asm is treated as a keyword, the compiler predefines one of the following mutually exclusive macros, depending on the assembly language syntax specified. If assembler code is generated, the macro has the value 1; otherwise, 0.

__IBM_GCC_ASM
C++ __IBM_STDCPP_ASM

Informational messages

When the option **-qinfo=eff** is also in effect, the compiler emits an informational message if no code is generated for an assembly statement.

Whenever an assembly statement is recognized as a valid language feature, the option **-qinfo=por** instructs the compiler to report it in an informational message.

The system assembler program must be available for this command to have effect. See the “-qasm_as” compiler option for more information.

Example

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

- “-qlanglvl” on page 119
- “-qinfo” on page 100
- “-qkeyword” on page 117
- Options that control input: Options for language extensions
- "Inline assembly statements"in the*XL C/C++ Language Reference*
- "Keywords for language extensions"in the*XL C/C++ Language Reference*

-qasm_as

Description

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

Syntax

```
►►— -q—┬─asm_as—=—asm_path—flags─┬——————————————————————————————►◄
       └─noasm_as────────────────┘
```

where

asm_path A space-separated list of flags required to invoke the assembler for assembly statements

flags The full path name of the assembler to be used

By default, the compiler reads the *asm_path* from the compiler configuration file.

Notes

Use this option to specify an alternate assembler program and the flags required to invoke that assembler.

This option overrides the default setting of the **as** command defined in the compiler configuration file.

Example

To instruct the compiler to use the assembler program at `/bin/as` when it encounters inline assembler code in `myprog.c`, specify the following on the command line:

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

Related information

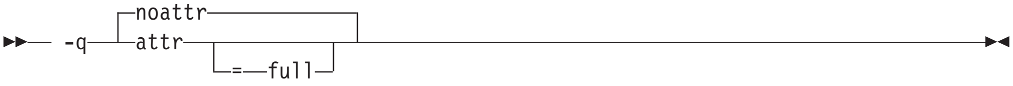
- "-qasm" on page 52
- Compiler customization
- Options for customizing the compiler: Options for general customization

-qattr

Description

Produces a compiler listing that includes an attribute listing for all identifiers.

Syntax



where:

-qnoattr	Does not produce an attribute listing for identifiers in the program.
-qattr=full	Reports all identifiers in the program.
-qattr	Reports only those identifiers that are used.

See also "#pragma options" on page 248.

Notes

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

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

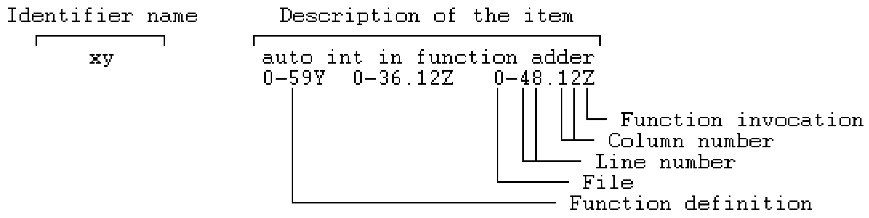
If **-qattr** is specified after **-qattr=full**, it has no effect. The full listing is produced.

Example

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

```
xlc++ myprogram.C -qxref -qattr=full
```

A typical cross-reference listing has the form:



Related information

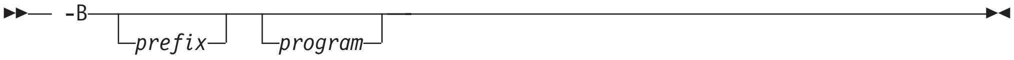
- “-qprint” on page 160
- “-qxref” on page 206
- Options that control listings and messages: Options for listing

-B

Description

Determines substitute path names for programs such as the compiler, assembler, linkage editor, and preprocessor.

Syntax



where *program* can be a compiler component or a program name recognized by the **-t** compiler option.

Default

If **-B** is specified but *prefix* is not, the default prefix is `/lib/o`. If **-B***prefix* is not specified at all, the prefix of the standard program names is `/lib/n`.

If **-B** is specified but **-t***programs* is not, the default is to construct path names for all the standard program names.

Notes

The optional *prefix* defines part of a path name to the new programs. The compiler does not add a / between the prefix and the program name.

To form the complete path name for each program, IBM XL C/C++ adds prefix to the standard program names for the compiler, assembler, editor and preprocessor.

Use this option if you want to keep multiple levels of some or all of IBM XL C/C++ executables and have the option of specifying which one you want to use.

If **-B***prefix* is not specified, the default path is used.

-B -t*programs* specifies the programs to which the **-B** prefix name is to be appended.

The **-B***prefix* **-t***programs* options override the **-F***config_file* option.

Example

To compile `myprogram.C` using a substitute **xlc++** compiler in `/lib/tmp/mine/` enter:

```
xlc++ myprogram.C -B/lib/tmp/mine/ -tc
```

To compile `myprogram.C` using a substitute editor in `/lib/tmp/mine/`, enter:

```
xlc++ myprogram.C -B/lib/tmp/mine/ -tl
```

Related information
- "-qpath" on page 153
- "-t" on page 187
- "Invoking the compiler" on page 11
- Options for customizing the compiler: Options for general customization

-qbigdata

Description

In 32-bit mode, allows initialized data to be larger than 16 MB in size.

Syntax

```
          ┌─nobigdata─┐
►►── -q───┴─bigdata───┴──────────────────────────────────────────────►◄
```

Notes

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.

Related information
- Options that control linking: Options for linker input control

-qbitfields

Description

Specifies if bit fields are `signed`. By default, bit fields are `signed`.

Syntax

```
                          ┌─signed───┐
►►── -q──bitfields──=─────┴─unsigned─┴───────────────────────────────►◄
```

where options are:

signed	Bit fields are signed.
unsigned	Bit fields are unsigned.

Related information
- Summary of command line options: Options for signedness

-C

Description

Preserves comments in preprocessed output.

Syntax

```
►►── -C──────────────────────────────────────────────────────────►◄
```

Notes

The **-C** option has no effect without either the **-E** or the **-P** option. With the **-E** option, comments are written to standard output. With the **-P** option, comments are written to an output file.

Example

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

```
xlc myprogram.c -P -C
```

Related information

- "-E" on page 75
- "-P" on page 152
- Summary of command line options: Other input options

-c

Description

Instructs the compiler to pass source files to the compiler component only. The compiled source files are not sent to the linkage editor. 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.

Syntax

```
►►── -c──────────────────────────────────────────────────────────►◄
```

Notes

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

The **-c** option can be used in combination with the **-o** option to provide an explicit name of the object file that is created by the compiler.

Example

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

```
xlc++ myprogram.C -c
```

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

```
xlc++ myprogram.C -c -o new.o
```

Related information

- "-E" on page 75
- "-o" on page 151
- "-P" on page 152
- "-qsyntaxonly" on page 186
- Options that control output: Other output options

-qc_stdinc

▶ C

Description

Changes the standard search location for the C headers.

Syntax

```
                          ┌─:────┐
                          ▼      │
▶▶── -q──c_stdinc──=──────path───┴──────────────────────────────────────▶◀
```

Notes

The standard search path for C headers is determined by combining the search paths specified by both this (**-qc_stdinc**) and the **-qgcc_c_stdinc** compiler option, in that order. You can find the default search path for this option in the compiler default configuration file.

If one of these compiler options is not specified or specifies an empty string, the standard search location will be the path specified by the other option. If a search path is not specified by either of the **-qc_stdinc** or **-qgcc_c_stdinc** compiler options, the default header file search path is used.

If this option is specified more than once, only the last instance of the option is used by the compiler. To specify multiple directories for a search path, specify this option once, using a **:** (colon) to separate multiple search directories.

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

Example

To specify `mypath/headers1` and `mypath/headers2` as being part of the standard search path, enter:

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

Related information

- "-qcpp_stdinc" on page 68
- "-qgcc_c_stdinc" on page 90
- "-qstdinc" on page 182
- "Directory search sequence for include files using relative path names" on page 22
- "Specifying compiler options in a configuration file" on page 18
- Options that control input: Options for search paths

-qcache

Description

The **-qcache** option specifies the cache configuration for a specific execution machine. If you know the type of execution system for a program, and that system has its instruction or data cache configured differently from the default case, use this option to specify the exact cache characteristics. The compiler uses this information to calculate the benefits of cache-related optimizations.

Syntax

```
                  ┌─:───────────────────────┐
                  ▼                         │
►►─ -q─cache─=──┬─assoc─=─┬─0───┬─┬──────┴──────────────────────►◄
                │         ├─1───┤ │
                │         └─n>1─┘ │
                ├─auto────────────┤
                ├─cost─=─cycles───┤
                ├─level─=─┬─1─┬───┤
                │         ├─2─┤   │
                │         └─3─┘   │
                ├─line─=─bytes────┤
                ├─size─=─Kbytes───┤
                └─type─=─┬─C─┬────┘
                         ├─c─┤
                         ├─D─┤
                         ├─d─┤
                         ├─I─┤
                         └─i─┘
```

where available cache options are:

assoc=*number* Specifies the set associativity of the cache, where *number* is one of:

0 Direct-mapped cache

1 Fully associative cache

N>1 n-way set associative cache

auto Automatically detects the specific cache configuration of the compiling machine. This assumes that the execution environment will be the same as the compilation environment.

cost=*cycles* Specifies the performance penalty resulting from a cache miss.

level=*level* Specifies the level of cache affected, where *level* is one of:

1 Basic cache

2 Level-2 cache or, if there is no level-2 cache, the table lookaside buffer (TLB)

3 TLB

If a machine has more than one level of cache, use a separate -qcache option.

line=*bytes* Specifies the line size of the cache.

size=*Kbytes* Specifies the total size of the cache.

type=*cache_type* The settings apply to the specified type of cache, where *cache_type* is one of:

C or c Combined data and instruction cache

D or d Data cache

I or i Instruction cache

Notes

The **-qtune** setting determines the optimal default **-qcache** settings for most typical compilations. You can use the **-qcache** to override these default settings. However, if you specify the wrong values for the cache configuration, or run the program on a machine with a different configuration, the program will work correctly but may be slightly slower.

You must specify **-O4**, **-O5**, or **-qipa** with the **-qcache** option.

Use the following guidelines when specifying **-qcache** suboptions:

- Specify information for as many configuration parameters as possible.
- If the target execution system has more than one level of cache, use a separate **-qcache** option to describe each cache level.
- If you are unsure of the exact size of the cache(s) on the target execution machine, specify an estimated cache size on the small side. It is better to leave some cache memory unused than it is to experience cache misses or page faults from specifying a cache size larger than actually present.
- The data cache has a greater effect on program performance than the instruction cache. If you have limited time available to experiment with different cache configurations, determine the optimal configuration specifications for the data cache first.
- If you specify the wrong values for the cache configuration, or run the program on a machine with a different configuration, program performance may degrade but program output will still be as expected.
- The **-O4** and **-O5** optimization options automatically select the cache characteristics of the compiling machine. If you specify the **-qcache** option together with the **-O4** or **-O5** options, the option specified last takes precedence.

Example

To tune performance for a system with a combined instruction and data level-1 cache, where cache is 2-way associative, 8 KB in size and has 64-byte cache lines, enter:

```
xlc++ -O4 -qcache=type=c:level=1:size=8:line=64:assoc=2 file.C
```

Related information

- “-O, -qoptimize” on page 148
- “-qipa” on page 106
- Options for performance optimization: Options for processor and architectural optimization
- "Optimizing your applications"in the *XL C/C++ Programming Guide*

-qchars

Description

Instructs the compiler to treat all variables of type `char` as either `signed` or `unsigned`.

Syntax

```
                   ┌─unsigned─┐
►►── -q──chars──=──┴─signed───┴──────────────────────────────────────────►◄
```

See also “#pragma chars” on page 222 and “#pragma options” on page 248.

Notes

You can also specify sign type in your source program using either of the following preprocessor directives:

```
#pragma options chars=sign_type

#pragma chars (sign_type)
```

where *sign_type* is either `signed` or `unsigned`.

Regardless of the setting of this option, 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.

Example

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

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

Related information

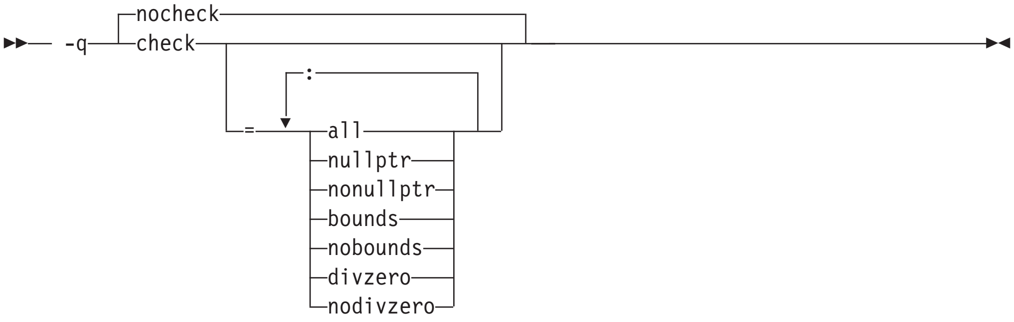
- Summary of command line options: Options for signedness

-qcheck

Description

Generates code that performs certain types of runtime checking. If a violation is encountered, a runtime exception is raised by sending a SIGTRAP signal to the process.

Syntax



where:

all
Switches on all the following suboptions. You can use the **all** option 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 options, **all** should be the first suboption.

[no]nullptr
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.

[no]bounds
: Performs runtime checking of addresses when 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.

[no]divzero
: Performs runtime checking of integer division. A trap will occur if an attempt is made to divide by zero.

See also "#pragma options" on page 248.

Notes

The **-qcheck** option has several suboptions, as described above. If you use more than one *suboption*, separate each one with a colon (:).

Specifying the **-qcheck** option without any suboptions, and without any other variations of **-qcheck** on the command line, turns all of the suboptions on.

Using the **-qcheck** option with suboptions turns the specified suboptions on if they do not have the no prefix, and off if they have the no prefix.

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

The **-qcheck** option affects the runtime performance of the application. When checking is enabled, runtime checks are inserted into the application, which may result in slower execution.

Examples

1. For **-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 */
}
```

2. For **-qcheck=divzero**:

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

Related information

- Options for error checking and debugging: Options for error checking

-qcinc

C++

Description

Instructs the compiler to place an `extern "C" { }` wrapper around the contents of an include file.

Syntax

```
          ┌nocinc────────────────────┐
►►── -q───┴cinc──=──directory_prefix─┴───────────────────────────────►◄
```

where:

directory_prefix Specifies the directory where files affected by this option are found.

Notes

Include files from specified directories have the tokens **extern ″C″ {** inserted before the first statement in the include file, and **}** appended after the last statement in the include file.

Example

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:

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

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

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

Related information

- Options that control input: Options for search paths

-qcompact

Description

When used with optimization, reduces code size where possible, at the expense of execution speed.

Syntax

```
          ┌nocompact┐
►►── -q───┴compact──┴────────────────────────────────────────────────►◄
```

See also “#pragma options” on page 248.

Notes

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

Example

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

```
xlc++ myprogram.C -O -qcompact
```

Related information

- Options for performance optimization: Options for code size reduction

-qcomplexgccincl

Description

The **-qcomplexgccincl** compiler option instructs the compiler to internally wrap **#pragma complexgcc(on)** and **#pragma complexgcc(pop)** directives around include files found in specified directories.

Syntax

```
            ┌─complexgccincl───┐   ┌─=──/usr/include─┐
►►── -q─────┴─nocomplexgccincl─┴───┼─────────────────┼─────────────────────────►◄
                                   └─=──pathname─────┘
```

where:

pathname Specifies a search path for include files. If *pathname* is not specified, the compiler assumes a *pathname* of `/usr/include`.

Notes

Include files found in directories specified by the **-qcomplexgccincl** compiler option are internally wrapped by the **#pragma complexgcc(on)** and **#pragma complexgcc(pop)** directives.

Include files found in directories specified by **-qnocomplexgccincl** are not wrapped by these directives.

The default setting is **-qcomplexgccincl=/usr/include**.

Related information

- "#pragma complexgcc" on page 224
- Options that control input: Options for search paths

-qcpluscmt

▶ C

Description

Use this option if you want C++ comments to be recognized in C source files.

Syntax

```
►►── -q──┬─nocpluscmt─┬──────────────────────────────────────────────────────►◄
         └─cpluscmt───┘
```

Default

The default setting varies:

- **-qcpluscmt** is implicitly selected when you invoke the compiler with **xlc** or **c99** and related **_r** invocations.
- **-qcpluscmt** is also implicitly selected when **-qlanglvl** is set to **stdc99** or **extc99**. You can override these implicit selections by specifying **-qnocpluscmt** after the

-qlanglvl option on the command line; for example: **-qlanglvl=stdc99 -qnocpluscmt** or **-qlanglvl=extc99 -qnocpluscmt**.

- Otherwise, the default setting is **-qnocpluscmt**.

Notes

The __C99_CPLUSCMT compiler macro is defined when **cpluscmt** is selected.

The character sequence // begins a C++ comment, except within a header name, a character constant, a string literal, or a comment. Comments do not nest, and macro replacement is not performed within comments. The following character sequences are ignored within a C++ comment:

- `//`
- `/*`
- `*/`

C++ comments have the form **//text**. The two slashes (**//**) in the character sequence must be adjacent with nothing between them. Everything to the right of them until the end of the logical source line, as indicated by a new-line character, is treated as a comment. The **//** delimiter can be located at any position within a line.

// comments are *not* part of C89. The result of the following valid C89 program will be incorrect if **-qcpluscmt** is specified:

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

The correct answer is 2 (2 divided by 1). When **-qcpluscmt** is specified, the result is 3 (2 plus 1).

The preprocessor handles all comments in the following ways:

- If the **-C** option is *not* specified, all comments are removed and replaced by a single blank.
- If the **-C** option *is* specified, comments are output unless they appear on a preprocessor directive or in a macro argument.
- If **-E** is specified, continuation sequences are recognized in all comments and are output
- If **-P** is specified, comments are recognized and stripped from the output, forming concatenated output lines.

A comment can span multiple physical source lines if they are joined into one logical source line through use of the backslash (\) character. You can represent the backslash character by a trigraph (??/).

Examples

1. **Example of C++ Comments**

   The following examples show the use of C++ comments:

   ```
   // A comment that spans two \
      physical source lines

   // A comment that spans two ??/
      physical source lines
   ```

2. **Preprocessor Output Example 1**

For the following source code fragment:

```
int a;
int b;  // A comment that spans two \
           physical source lines
int c;
        // This is a C++ comment
int d;
```

The output for the **-P** option is:

```
int a;
int b;
int c;

int d;
```

The C89 mode output for the **-P -C** options is:

```
int a;
int b;  // A comment that spans two    physical source lines
int c;
        // This is a C++ comment
int d;
```

The output for the **-E** option is:

```
int a;
int b;

int c;

int d;
```

The C89 mode output for the **-E -C** options is:

```
#line 1 "fred.c"
int a;
int b;  // a comment that spans two \
           physical source lines
int c;
        // This is a C++ comment
int d;
```

Extended mode output for the **-P -C** options or **-E -C** options is:

```
int a;
int b;  // A comment that spans two \
           physical source lines
int c;
        // This is a C++ comment
int d;
```

3. **Preprocessor Output Example 2 - Directive Line**

   For the following source code fragment:

```
int a;
#define mm 1   // This is a C++ comment on which spans two \
                  physical source lines
int b;
               // This is a C++ comment
int c;
```

The output for the **-P** option is:

```
int a;
int b;

int c;
```

The output for the **-P -C** options:

```
int a;
int b;
               // This is a C++ comment
int c;
```

The output for the **-E** option is:

```
#line 1 "fred.c"
int a;
#line 4
int b;

int c;
```

The output for the **-E -C** options:

```
#line 1 "fred.c"
int a;
#line 4
int b;
               // This is a C++ comment
int c;
```

4. **Preprocessor Output Example 3 - Macro Function Argument**

   For the following source code fragment:

```
#define mm(aa) aa
int a;
int b;  mm(// This is a C++ comment
              int blah);
int c;
        // This is a C++ comment
int d;
```

The output for the **-P** option:

```
int a;
int b;  int blah;
int c;

int d;
```

The output for the **-P -C** options:

```
int a;
int b;  int blah;
int c;
        // This is a C++ comment
int d;
```

The output for the **-E** option is:

```
#line 1 "fred.c"
int a;
int b;
int blah;
int c;

int d;
```

The output for the **-E -C** option is:

```
#line 1 "fred.c"
int a;
int b;
int blah;
int c;
        // This is a C++ comment
int d;
```

5. **Compile example**

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

```
xlc myprogram.c -qcpluscmt
```

Related information

- "-C" on page 56

- “-E” on page 75
- “-qlanglvl” on page 119
- “-P” on page 152
- Options that control input: Other input options

-qcpp_stdinc

C++

Description

Changes the standard search location for the C++ headers.

Syntax

```
                          ┌─:───┐
                          ▼     │
►►── -q──cpp_stdinc──=────path──┴────────────────────────────────────►◄
```

Notes

The standard search path for C++ headers is determined by combining the search paths specified by both this (**-qcpp_stdinc**) and the **-qgcc_cpp_stdinc** compiler option, in that order. You can find the default search path for this option in the compiler default configuration file.

If one of these compiler options is not specified or specifies an empty string, the standard search location will be the path specified by the other option. If a search path is not specified by either of the **-qcpp_stdinc** or **-qgcc_cpp_stdinc** compiler options, the default header file search path is used.

If this option is specified more than once, only the last instance of the option is used by the compiler. To specify multiple directories for a search path, specify this option once, using a **:** (colon) to separate multiple search directories.

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

Example

To make `mypath/headers1` and `mypath/headers2` the standard search path, enter:

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

Related information

- “-qc_stdinc” on page 58
- “-qgcc_cpp_stdinc” on page 91
- “-qstdinc” on page 182
- “Directory search sequence for include files using relative path names” on page 22
- “Specifying compiler options in a configuration file” on page 18
- Options that control input: Options for search paths

-qcrt

Description

Instructs the linkage editor to use the standard system startup files at link time.

Syntax

```
         ┌─crt───┐
►►── -q──┴─nocrt─┴─────────────────────────────────────────────────►◄
```

Notes

If the **-qnocrt** compiler option is specified, the compiler will not use the standard system startup files at link time.

Related information

- "-qlib" on page 135
- Options that control linking: Other linker options

-D

Description

Defines the macro *name* as in a `#define` preprocessor directive.

Syntax

```
►►── -D──name──┬─────────────────────┬─────────────────────────────►◄
               └─=──┬─────────────┬──┘
                    └─definition──┘
```

definition is an optional definition or value assigned to *name*.

Notes

You can also define a macro name in your source program using the `#define` preprocessor directive, provided that the macro name has not already been defined by the **-D** compiler option.

-D*name*= is equivalent to `#define` *`name`*.

-D*name* is equivalent to `#define` *`name`* `1`. (This is the default.)

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

To aid in program portability and standards compliance, the operating system provides several header files that refer to macro names you can set with the **-D** option. You can find most of these header files either in the `/usr/include` directory or in the `/usr/include/sys` directory.

To ensure that the correct macros for your source file are defined, use the **-D** option with the appropriate macro name.

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

Example

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

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

This is equivalent to having `#define COUNT 100` at the beginning of the source file.

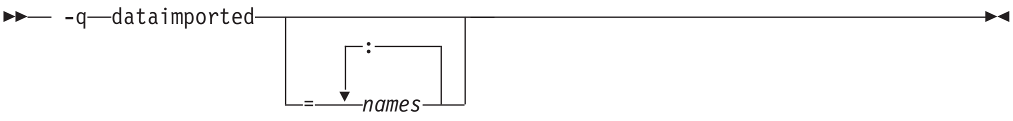
Related information
- "-U" on page 198
- Chapter 6, "Predefined macros," on page 279
- Summary of command line options: Other input options

-qdataimported

Description

Marks data as imported.

Syntax



Notes

This option applies only to 64-bit compilations.

When this option is in effect, imported variables are dynamically bound with a shared portion of a library.

- Specifying **-qdataimported** instructs the compiler to assume that all variables are imported.
- Specifying **-qdataimported=***names* marks the named variables as being imported, where *names* is a list of variable names separated by colons (**:**). Variables not explicitly named are not affected.

Note: C++ In C++ programs, variable *names* must be specified using their mangled names. For example, assuming the following code segment:

```
struct C{
        static int i;
}
```

you would specify the variable **C::i** as being imported by specifying the compiler option in the following manner:

```
-qdataimported=i__1C
```

You can use the operating system **dump -tv** or **nm** utilities to get the mangled names from an object file. To verify a mangled name, use the **c++filt** utility.

Conflicts among the **-qdataimported** and **-qdatalocal** data-marking options are resolved in the following manner:

Options that list variable names: The last explicit specification for a particular variable name is used.

Options that change the default: This form does not specify a name list. The last option specified is the default for variables not explicitly listed in the name-list form.

Related information

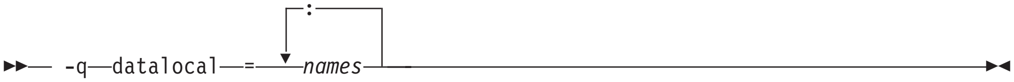
- "-qdatalocal"
- Options for performance optimization: Options for ABI performance tuning

-qdatalocal

Description

Marks data as local.

Syntax



Notes

This option applies only to 64-bit compilation.

When this option is in effect, local variables are statically bound with the functions that use them.

- You must specify which variables are local. If no names are specified, the linkage editor will fail to link at link-time.
- Specifying **-qdatalocal=***names* marks the named variables as local, where *names* is a list of identifiers separated by colons (**:**). Variables not explicitly named are not affected.

Note: C++ In C++ programs, variable *names* must be specified using their mangled names. For example, assuming the following code segment:

```
struct C{
        static int i;
}
```

you would specify the variable **C::i** as being local data by specifying the compiler option in the following manner:

```
-qdatalocal=i__1C
```

You can use the operating system **dump -tv** or **nm** utilities to get the mangled names from an object file. To verify a mangled name, use the **c++filt** utility.

Performance may decrease if an imported variable is assumed to be local.

Conflicts among the **-qdataimported** and **-qdatalocal** data-marking options are resolved in the following manner:

Options that list variable names:	The last explicit specification for a particular variable name is used.
Options that change the default:	This form does not specify a name list. The last option specified is the default for variables not explicitly listed in the name-list form.

Related information

- "-qdataimported" on page 70
- Options for performance optimization: Options for ABI performance tuning

-qdbxextra

C

Description

Specifies that all `typedef` declarations, `struct`, `union`, and `enum` type definitions are included for debugging.

Syntax

```
         ┌nodbxextra┐
►►─ -q───┴dbxextra──┴──────────────────────────────────────────────►◄
```

Notes

Use this option with the **-g** option to produce additional debugging information for use with a debugger.

When you specify the **-g** option, debugging information is included in the object file. To minimize the size of object and executable files, the compiler only includes information for symbols that are referenced. Debugging information is not produced for unreferenced arrays, pointers, or file-scope variables unless **-qdbxextra** is specified.

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

Example

To include all symbols in `myprogram.c` for debugging, enter:

```
xlc myprogram.c -g -qdbxextra
```

Related information

- "-qfullpath" on page 89
- "-qlinedebug" on page 136
- "-g" on page 90
- "#pragma options" on page 248.
- Options for error checking and debugging: Options for debugging

-qdigraph

Description

Lets you use digraph key combinations or keywords to represent characters not found on some keyboards.

Syntax

```
►►─ -q──┬nodigraph┬──────────────────────────────────────────────►◄
        └digraph──┘
```

See also "#pragma options" on page 248.

Defaults

- C **-qdigraph** when **-qlanglvl** is set to **extc89**, **extended**, **extc99** or **stdc99**.
- C **-qnodigraph** when **-qlanglvl** is set to all other language levels.
- C++ **-qdigraph**

Notes

A digraph is a keyword or combination of keys that lets you produce a character that is not available on all keyboards.

The digraph key combinations are:

Key combination	Character produced
<%	{
%>	}
<:	[
:>	]
%%	#

Additional keywords, valid in C++ programs only, are:

Keyword	Character produced
bitand	&
and	&&
bitor	|
or	||
xor	^
compl	~
and_eq	&=
or_eq	|=
xor_eq	^=
not	!
not_eq	!=

Example

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

```
xlc++ myprogram.C -qnodigraph
```

Related information

- "-qlanglvl" on page 119
- "-qtrigraph" on page 196
- Options that control input: Options for language extensions

-qdirectstorage

Description

Informs the compiler that write-through enabled or cache-inhibited storage may be referenced.

Syntax

```
          ┌─nodirectstorage─┐
►►── -q───┴─directstorage───┴──────────────────────────────────────────►◄
```

Notes

The **-qdirectstorage** compiler option informs the compiler that write-through enabled or cache-inhibited storage may be referenced, and that appropriate compiler output should be generated.

The PowerPC architecture allows many different implementations of cache organization. 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.

Depending on the storage control attributes specified by the program and the function being performed, your program may use cache instructions to guarantee that the function is performed correctly.

For example, the **dcbz** instruction allocates a block of data in the cache and then initializes it to a series of zeroes. Though it can be used to boost performance when zeroing a large block of data, the **dcbz** instruction should be used with caution because it will cause an alignment error to occur under any of the following conditions:

- The cache block specified by the instruction is in a memory region marked cache-inhibited.
- The cache is in write-though mode.
- The L1 Dcache or L2 cache is disabled.

Specifying **-qdirectstorage** will suppress generation of the **dcbz** instruction, and avoid the alignment errors mentioned above.

Related information

- Options for performance optimization: Options for processor and architectural optimization

-qdollar

Description

Allows the **$** symbol to be used in the names of identifiers.

Syntax

```
          ┌─nodollar─┐
▶▶── -q───┴─dollar───┴─────────────────────────────────────────────▶◀
```

When **-qdollar** is in effect, the dollar symbol $ in an identifier is treated as a base character. If the options **-qnodollar** and **-qlanglvl=ucs** are both in effect, the dollar symbol is treated as an extended character and translated into `\u0024`.

Example

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

```
xlc myprogram.c -qdollar
```

Related information

- “#pragma options” on page 248
- “-qlanglvl” on page 119
- Options that control input: Options for language extensions

-qdump_class_hierarchy

▶ C++

Description

For each class object, this option dumps a representation of its hierarchy and virtual function table layout to a file. The file name is made by appending `.class` to the source file name. For example, if you compile `myprogram.C` using **-qdump_class_hierarchy**, a file named `myprogram.C.class` is created.

Syntax

```
►►── -qdump_class_hierarchy──────────────────────────────────────────────►◄
```

Related information

- Options that control listings and messages: Options for listing

-E

Description

Instructs the compiler to preprocess the source files named in the compiler invocation and creates an output preprocessed source file.

Syntax

```
►►── -E──────────────────────────────────────────────────────────────────►◄
```

Notes

The **-E** and **-P** options have different results. When the **-E** option is specified, the compiler assumes that the input is a C or C++ file and that the output will be recompiled or reprocessed in some way. These assumptions are:

- Original source coordinates are preserved. This is why **#line** directives are produced.
- All tokens are output in their original spelling, which, in this case, includes continuation sequences. This means that any subsequent compilation or reprocessing with another tool will give the same coordinates (for example, the coordinates of error messages).

The **-P** option is used for general-purpose preprocessing. No assumptions are made concerning the input or the intended use of the output. This mode is intended for use with input files that are not written in C or C++. As such, all preprocessor-specific constructs are processed as described in the ANSI C standard. In this case, the continuation sequence is removed as described in the "Phases of Translation" of that standard. All non-preprocessor-specific text should be output as it appears.

Using **-E** causes `#line` directives to be generated to preserve the source coordinates of the tokens. Blank lines are stripped and replaced by compensating `#line` directives.

The line continuation sequence is removed and the source lines are concatenated with the **-P** option. With the **-E** option, the tokens are output on separate lines in order to preserve the source coordinates. The continuation sequence may be removed in this case.

The **-E** option overrides the **-P**, **-o**, and **-qsyntaxonly** options, and accepts any file name.

If used with the **-M** option, **-E** will work only for files with a .C, .cpp, .cc (all C++ source files), .c (C source files), or a .i (preprocessed source files) file name suffix. Source files with unrecognized file name suffixes are treated and preprocessed as C files, and no error message is generated.

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, and when **-C** is not specified. Comments within a macro function argument are deleted.

Example

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

```
xlc++ 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

- "-M" on page 140
- "-o" on page 151
- "-P" on page 152
- "-qsyntaxonly" on page 186
- Options that control output: Options for file output

-e

Description

This option is used only together with the **-qmkshrobj** compiler option. See the description for the "-qmkshrobj" on page 147 compiler option for more information.

Syntax

```
▶▶── -e──name──────────────────────────────────────────────────▶◀
```

Related information

- “-qmkshrobj” on page 147
- Options that control linking: Options for linker input control

-qeh

▶ C++

Description

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

Syntax

```
           ┌─eh───┐
►►── -q────┴─noeh─┴──────────────────────────────────────────────────────►◄
```

where:

-qeh Exception handling is enabled.

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

Notes

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

Related information

- “-qrtti” on page 170
- Options for performance optimization: Options for code size reduction

-qenablevmx

Description

Enables generation of Vector Multimedia Extension (VMX) instructions.

Syntax

```
           ┌─enablevmx───┐
►►── -q────┴─noenablevmx─┴───────────────────────────────────────────────►◄
```

Defaults

On all supported Linux distributions, **-qenablevmx** is set by default.

Notes

- Some processors are able to support Vector Multimedia Extension (VMX) instructions. These instructions can offer higher performance when used with algorithmic-intensive tasks such as multimedia applications.
- If **-qnoenablevmx** is in effect, **-qaltivec** and **-qhot=simd** cannot be used.

Related information

- “-qaltivec” on page 49
- “-qarch” on page 49
- “-qhot” on page 94
- Options that control output: Options that control the characteristics of the object code

-qenum

Description

Specifies the amount of storage occupied by enumerations.

Syntax

```
                             (2)
                        ┌─────────intlong─┐
                        │    (1)          │
                        ├─────────int─────┤
►►── -q──enum──=────────┼─small───────────┼───────────────────────────────────►◄
                        ├─1───────────────┤
                        ├─2───────────────┤
                        ├─4───────────────┤
                        └─8───────────────┘
```

Notes:

1 C compilation default

2 C++ compilation default

where valid **enum** settings are:

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.

4 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, the enumeration is of type `long` if the range of enumeration values falls within the limits of `signed  long`, and `unsigned  long` otherwise.

int Specifies that enumerations occupy 4 bytes of storage and are represented by `int`. Values cannot exceed the range of `signed int` in C compilations.

intlong Specifies that enumerations will occupy 8 bytes of storage if the range of values in the enumeration exceeds the limit for `int`. See the description for "-qenum."
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. See the description for "-qenum"

Notes

The **-qenum=small** option allocates to an `enum` variable the amount of storage that is required by the smallest predefined type that can represent that range of `enum` constants. By default, an unsigned predefined type is used. If any `enum` constant is negative, a signed predefined type is used.

The **-qenum=1|2|4|8** options allocate a specific amount of storage to an enum variable . If the specified storage size is smaller than that required by the range of enum variables, a severe error message is issued and compilation stops.

The ISO C 1989 and ISO C1999 Standards require that enumeration values not exceed the range of int. When compiling with **-qlanglvl=stdc89** or **-qlanglvl=stdc99** in effect, the compiler will behave as follows if the value of an enumeration exceeds the range of int:

- If **-qenum=int** is in effect, a Severe error message is issued and compilation stops.
- For all other settings of **-qenum**, an Informational message is issued and compilation continues.

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.

Related information

"Summary of compiler options by functional category" on page 31
"#pragma enum" on page 227
"#pragma options" on page 248

Enumeration sizes and types – All types are `signed` unless otherwise noted.

	enum=1		enum=2		enum=4		enum=8			
							32-bit compilation mode		64-bit compilation mode	
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[2b]	ERROR[1]	long[2b]	ERROR[1]	long[2b]	long long[2b]	long long[2b]	long[2b]	long[2b]
$-2^{63}..(2^{63}-1)$	ERROR[1]	long[2b]	ERROR[1]	long[2b]	ERROR[1]	long[2b]	long long[2b]	long long[2b]	long[2b]	long[2b]
$0..2^{64}$	ERROR[1]	unsigned long[2b]	ERROR[1]	unsigned long[2b]	ERROR[1]	unsigned long[2b]	unsigned long long[2b]	unsigned long long[2b]	unsigned long[2b]	unsigned long[2b]

Notes:

1. These enumerations are too large for the **-qenum=1|2|4** 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 compiling with **-qlanglvl=stdc89** or **-qlanglvl=stdc99** 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.

Enumeration sizes and types – All types are`signed` unless otherwise noted.

	enum=int		enum=intlong				enum=small			
			32-bit compilation mode		64-bit compilation mode		32-bit compilation mode		64-bit compilation mode	
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^{2a}	ERR^{2a}	long long^{2b}	long long^{2b}	long^{2b}	long^{2b}	unsigned long long^{2b}	unsigned long long^{2b}	unsigned long^{2b}	unsigned long^{2b}
$-2^{63}..(2^{63}-1)$	ERR^{2a}	ERR^{2a}	long long^{2b}	long long^{2b}	long^{2b}	long^{2b}	long long^{2b}	long long^{2b}	long^{2b}	long^{2b}
$0..2^{64}$	ERR^{2a}	ERR^{2a}	unsigned long long^{2b}	unsigned long long^{2b}	unsigned long^{2b}	unsigned long^{2b}	unsigned long long^{2b}	unsigned long long^{2b}	unsigned long^{2b}	unsigned long^{2b}

Notes:

1. These enumerations are too large for the **-qenum=1|2|4** settings. A Severe error is issued and compilation stops. To correct this condition, you should reduce the range of the enumerations, choose a larger `enum` setting, or choose a dynamic `enum` 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 compiling with **-qlanglvl=stdc89** or **-qlanglvl=stdc99** 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.

Related information

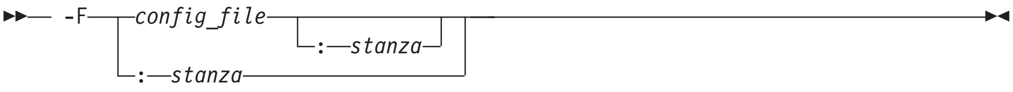
- Options that control output: Options for data size and alignment

-F

Description

Names an alternative configuration file (.cfg) for the compiler.

Syntax



where suboptions are:

config_file Specifies the name of a compiler configuration file.

stanza Specifies the name of the command used to invoke the compiler. This directs the compiler to use the entries under *stanza* in the *config_file* to set up the compiler environment.

Notes

The default is a configuration file configured at installation time. Any file names or stanzas that you specify on the command line or within your source file override the defaults specified in the configuration file.

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

Example

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

```
xlc myprogram.c -F/usr/tmp/myvac.cfg:xlc
```

Related information

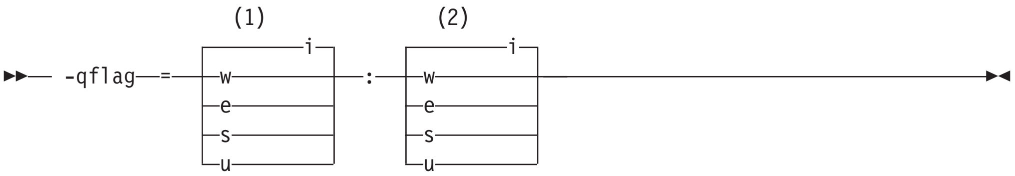
- "-B" on page 55
- "-t" on page 187
- "-W" on page 204
- "Specifying compiler options in a configuration file" on page 18
- Options for customizing the compiler: Options for general customization

-qflag

Description

Specifies the minimum severity level of diagnostic messages to be reported in a listing and displayed on a terminal. The diagnostic messages display with their associated sub-messages.

Syntax



Notes:

1 Minimum severity level messages reported in listing

2 Minimum severity level messages reported on terminal

where message severity levels are:

severity	**Description**
i	Information
w	Warning
e	Error
s	Severe error
u	Unrecoverable error

See also “#pragma options” on page 248.

Notes

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

Specifying informational message levels does not turn on the **-qinfo** option.

Example

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:

```
xlc++ myprogram.C -qflag=i:e
```

Related information

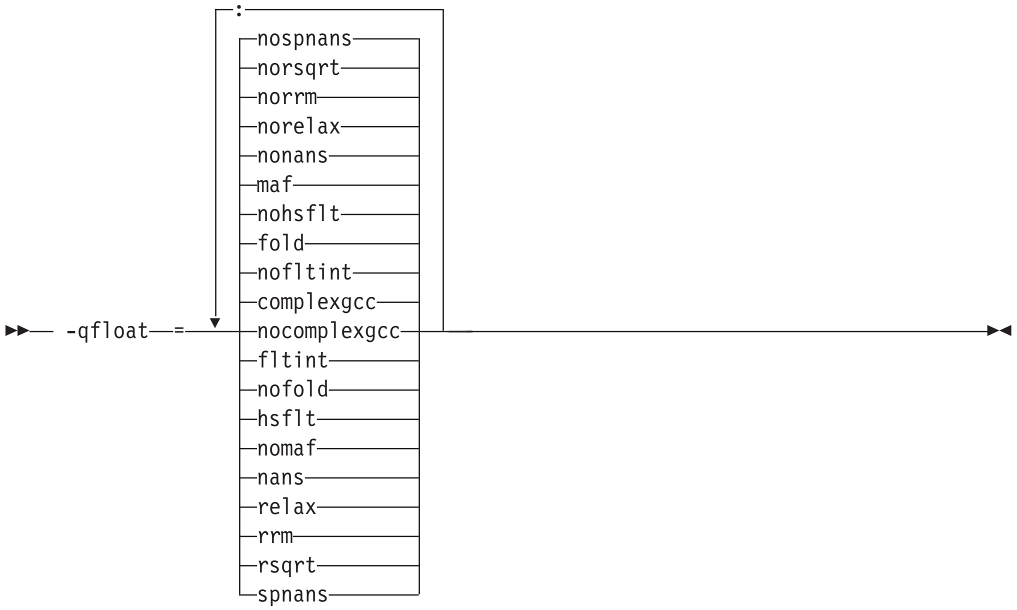
- “-qinfo” on page 100
- “-w” on page 205
- “Compiler messages” on page 25
- Options that control listings and messages: Options for messages

-qfloat

Description

Specifies various floating-point options. These options provide different strategies for speeding up or improving the accuracy of floating-point calculations.

Syntax



Option selections are described in the **Notes** section below. See also “#pragma options” on page 248.

Notes

Using **float** suboptions other than the default settings may produce varying results in floating point computations. Incorrect computational results may be produced if not all required conditions for a given suboption are met. For these reasons, 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.

You can specify one or more of the following **float** suboptions.

complexgcc
nocomplexgcc

Enables compatibility with GCC passing parameters and returning values of complex type. The default is **float=complexgcc** when compiling in 32-bit mode, and **float=nocomplexgcc** when compiling in 64-bit mode.

fltint
nofltint

Speeds up floating-point-to-integer conversions by using faster inline code that does not check for overflows. The default is **float=nofltint**, which checks floating-point-to-integer conversions for out-of-range values.

This suboption must only be used with an optimization option.

- With **-O2** in effect, **-qfloat=nofltint** is the implied setting.
- With **-O3** and greater in effect, **-qfloat=fltint** is implied.

  To include range checking in floating-point-to-integer conversions with the **-O3** option, specify **-qfloat=nofltint**.
- **-qnostrict** sets **-qfloat=fltint**

Changing the optimization level will not change the setting of the **fltint** suboption if **fltint** has already been specified.

If the **-qstrict | -qnostrict** and **-qfloat=** options conflict, the last setting is used.

fold
nofold

Specifies that constant floating-point expressions are to be evaluated at compile time rather than at run time.

hsflt
nohsflt

Note: The **hsflt** suboption is for specific applications in which floating-point computations have known characteristics. Using this option when you are compiling other application programs can produce incorrect results without warning. Also, using this option with **-qfloat=rndsngl**, **-q64**, or **-qarch=ppc** or any other PPC family architecture setting may produce incorrect results on rs64b or future systems.

The **hsflt** option speeds up calculations by truncating instead of rounding computed values to single precision before storing and on conversions from floating point to integer. The **nohsflt** suboption specifies that single-precision expressions are rounded after expression evaluation and that floating-point-to-integer conversions are to be checked for out-of-range values.

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

The **-qfloat=hsflt** option replaces the obsolete **-qhsflt** option. Use **-qfloat=hsflt** in your new applications.

This option has little effect unless the **-qarch** option is set to **pwr, pwr2, pwrx, pwr2s** or, in 32-bit mode, **com**. For PPC family architectures, all single-precision (float) operations are rounded. This option only affects double-precision (double) expressions cast to single-precision (float).

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 option may affect the precision of floating-point intermediate results.

nans
nonans

Generates extra instructions to detect signalling NaN (Not-a-Number) when converting from single-precision to double-precision at run time. The option **nonans** specifies that this conversion need not be detected. **-qfloat=nans** is required for full compliance to the IEEE 754 standard.

When used with the **-qflttrap** or **-qflttrap=invalid** option, the compiler detects invalid operation exceptions in comparison operations that occur when one of the operands is a signalling NaN.

relax
norelax

Relaxes the 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.

rrm
norrm

Prevents floating-point optimizations that are incompatible with runtime rounding to plus and minus infinity modes. Informs the compiler that the floating-point rounding mode may change at run time or that the floating-point rounding mode is not *round to nearest* at run time.

-qfloat=rrm must be specified if the Floating Point Status and Control register is changed at run time (as well as for initializing exception trapping).

rsqrt
norsqrt

Specifies whether a sequence of code that involves division by the result of a square root can be replaced by calculating the reciprocal of the square root and multiplying. Allowing this replacement produces code that runs faster.

- For **-O2**, the default is **-qfloat=norsqrt**.
- For **-O3**, the default is **-qfloat=rsqrt**. Use **-qfloat=norsqrt** to override this default.
- **-qnostrict** sets **-qfloat=rsqrt**. (Note that **-qfloat=rsqrt** means that `errno` will *not* be set for any `sqrt` function calls.)
- **-qfloat=rsqrt** has no effect unless **-qignerrno** is also specified.

Changing the optimization level will not change the setting of the **rsqrt** option if **rsqrt** has already been specified. If the **-qstrict | -qnostrict** and **-qfloat=** *options* conflict, the last setting is used.

spnans
nospnans

Generates extra instructions to detect signalling NaN on conversion from single-precision to double-precision. The option **nospnans** specifies that this conversion need not be detected.

Example

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

```
xlc++ myprogram.C -qfloat=fold:nomaf
```

Related information

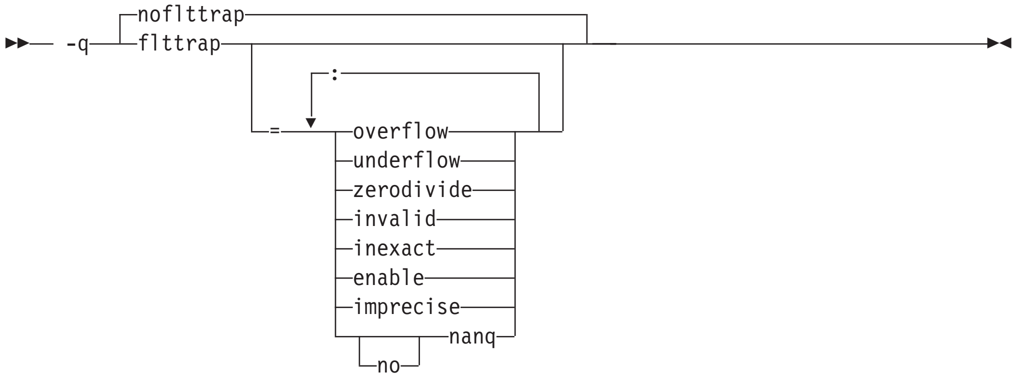
- "-qarch" on page 49
- "-qcomplexgccincl" on page 64
- "-qflttrap"
- "-qstrict" on page 183
- "#pragma complexgcc" on page 224
- Options that control integer and floating-point processing

-qflttrap

Description

Generates extra instructions to detect and trap runtime floating-point exceptions.

Syntax



where suboptions do the following:

enable
Enables the specified exceptions in the prologue of the main program. With the exception of **nanq** (described below), this suboption is required if you want to turn on exception trapping options listed below without modifying the source code.

overflow
Generates code to detect and trap floating-point overflow.

underflow
Generates code to detect and trap floating-point underflow.

zerodivide
Generates code to detect and trap floating-point division by zero.

invalid
Generates code to detect and trap floating-point invalid operation exceptions.

inexact
Generates code to detect and trap floating-point inexact exceptions.

imprecise
Generates code for imprecise detection of the specified exceptions. If an exception occurs, it is detected, but the exact location of the exception is not determined.

nanq
Generates code to detect and trap NaNQ (Not a Number Quiet) exceptions handled by or generated by floating point operations. The **nanq** and **nonanq** settings are not affected by **-qnoflttrap**, **-qflttrap**, or **-qflttrap=enable**.

Notes

This option is recognized during linking. **-qnoflttrap** specifies that these extra instructions need not be generated.

Specifying the **-qflttrap** option with no suboptions is equivalent to setting **-qflttrap=overflow:underflow:zerodivide:invalid:inexact**. The exceptions are not automatically enabled, and all floating-point operations are checked to provide precise exception-location information.

If specified with **#pragma options**, the **-qnoflttrap** option *must* be the first option specified.

If your program contains signalling NaNs, you should use the **-qfloat=nans** 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 **-qoptimize** options:

- 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.

Example

To compile `myprogram.c` so that floating-point overflow and underflow and divide by zero are detected, enter:

```
xlc myprogram.c -qflttrap=overflow:underflow:zerodivide:enable
```

Related information

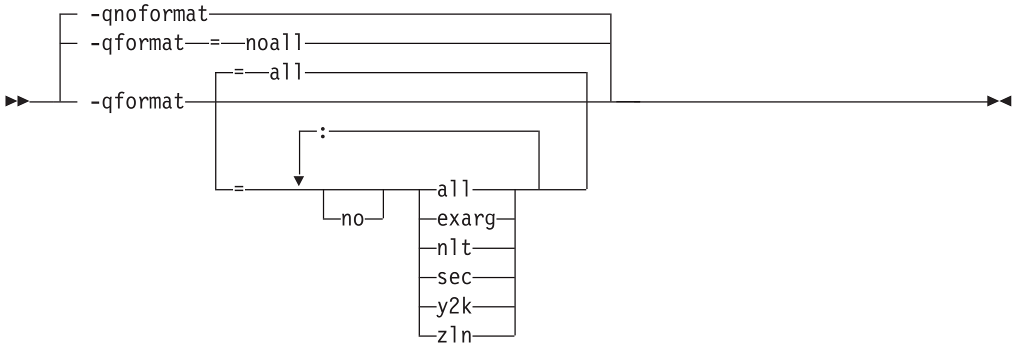
- "-qfloat" on page 83
- "#pragma options" on page 248
- Options that control integer and floating-point processing

-qformat

Description

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



where suboptions are:

all Turns on all format diagnostic messages.

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

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

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

y2k Warns of *strftime* formats that produce a 2-digit year.

zln Warns of zero-length formats.

Note: Specifying **no** in front of any of the above suboptions disables that group of diagnostic messages. For example, to turn off diagnostic messages for y2k warnings, specify **-qformat=noy2k** on the command line.

Notes

If **-qformat** is *not* specified on the command line, the compiler assumes a default setting of **-qnoformat**, which is equivalent to **-qformat=noall**.

If **-qformat** is specified on the command line without any suboptions, the compiler assumes a default setting of **-qformat=all**.

Examples

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

```
xlc++ myprogram.C -qformat=all
```

```
xlc++ myprogram.C -qformat
```

2. To enable all format diagnostic checking except that for y2k date diagnostics, enter:

```
xlc++ myprogram.C -qformat=all:noy2k
```

Related information

- Options that control listings and messages: Options for messages

-qfullpath

Description

Specifies what path information is stored for files when you use the **-g** compiler option.

Syntax

```
          ┌─nofullpath─┐
►►── -q───┴─fullpath───┴──────────────────────────────────────────►◄
```

Notes

Using **-qfullpath** causes the compiler to preserve the absolute (full) path name of source files specified with the **-g** option.

The relative path name of files is preserved when you use **-qnofullpath**.

-qfullpath is useful if the executable file was moved to another directory. If you specified **-qnofullpath**, the debugger would be unable to find the file unless you provide a search path in the debugger. Using **-qfullpath** would locate the file successfully.

Related information
- "-qlinedebug" on page 136
- "-g" on page 90
- Options for error checking and debugging: Options for debugging

-qfuncsect

Description

Places instructions for each function in a separate object file control section or csect. By default, each object file will consist of a single control section combining all functions defined in the corresponding source file.

Syntax

```
          ┌─nofuncsect─┐
►►── -q───┴─funcsect───┴──────────────────────────────────────────►◄
```

Notes

Using multiple csects can reduce the size of the final executable by allowing the editor to remove functions that are not called or that have been inlined by the optimizer at all places they are called.

If this option is specified in **#pragma options**, the pragma directive must be specified before the first statement in the compilation unit.

Related information
- "#pragma options" on page 248
- Options that control output: Options for file output

-g

Description

Generates information used for debugging tools such as the GNU GDB Debugger.

Syntax

```
►►── -g──────────────────────────────────────────────────────────────►◄
```

Notes

Specifying **-g** will turn off all inlining unless you explicitly request it. For example:

Options	Effect on inlining
-g	No inlining.
-O	Inline declared functions.
-O -Q	Inline declared functions and auto inline others.
-g -O	Inline declared functions.
-g -O -Q	Inline declared functions and auto inline others.

The default with **-g** is not to include information about unreferenced symbols in the debugging information.

To include information about both referenced and unreferenced symbols, use the **-qdbxextra** option with **-g**.

To specify that source files used with **-g** are referred to by either their absolute or their relative path name, use **-qfullpath**.

You can also use the **-qlinedebug** option to produce abbreviated debugging information in a smaller object size.

Example

To compile `myprogram.c` to produce an executable program `testing` so you can debug it, enter:

```
xlc myprogram.c -o testing -g
```

To compile `myprogram.c` to produce an executable program named `testing_all`, and containing additional information about unreferenced symbols so you can debug it, enter:

```
xlc myprogram.c -o testing_all -g -qdbxextra
```

Related information

- "-qdbxextra" on page 72
- "-qfullpath" on page 89
- "-qlinedebug" on page 136
- "-O, -qoptimize" on page 148
- "-Q" on page 164
- Options for error checking and debugging: Options for debugging

-qgcc_c_stdinc

▶ C

Description

Changes the standard search location for the GCC headers.

Syntax

```
                          ┌─:───┐
                          ▼     │
►►── -qgcc_c_stdinc──=────path──┴─────────────────────────────────────────────►◄
```

Notes

The standard search path for GCC headers is determined by combining the search paths specified by both the **-qc_stdinc** and this (**-qgcc_c_stdinc**) compiler option, in that order. You can find the default search path for this option in the compiler default configuration file.

If one of these compiler options is not specified or specifies an empty string, the standard search location will be the path specified by the other option. If a search path is not specified by either of the **-qc_stdinc** or **-qgcc_c_stdinc** compiler options, the default header file search path is used.

If this option is specified more than once, only the last instance of the option is used by the compiler. To specify multiple directories for a search path, specify this option once, using a **:** (colon) to separate multiple search directories.

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

Example

To specify `mypath/headers1` and `mypath/headers2` as being part of the standard search path, enter:

```
xlc myprogram.c -qgcc_c_stdinc=mypath/headers1:mypath/headers2
```

Related information

- "-qc_stdinc" on page 58
- "-qcpp_stdinc" on page 68
- "-qgcc_cpp_stdinc"
- "-qstdinc" on page 182
- "Directory search sequence for include files using relative path names" on page 22
- "Specifying compiler options in a configuration file" on page 18
- Options that control input: Options for search paths

-qgcc_cpp_stdinc

▶ C++

Description

Changes the standard search location for the g++ headers.

Syntax

```
                            ┌─:───┐
                            ▼     │
►►── -qgcc_cpp_stdinc──=────path──┴───────────────────────────────────────────►◄
```

Notes

The standard search path for g++ headers is determined by combining the search paths specified by both the **-qcpp_stdinc** and this (**-qgcc_cpp_stdinc**) compiler option, in that order. You can find the default search path for this option in the compiler default configuration file.

If one of these compiler options is not specified or specifies an empty string, the standard search location will be the path specified by the other option. If a search path is not specified by either of the **-qcpp_stdinc** or **-qgcc_cpp_stdinc** compiler options, the default header file search path is used.

If this option is specified more than once, only the last instance of the option is used by the compiler. To specify multiple directories for a search path, specify this option once, using a **:** (colon) to separate multiple search directories.

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

Example

To specify mypath/headers1 and mypath/headers2 as being part of the standard search path, enter:

```
xlc++ myprogram.C -qgcc_cpp_stdinc=mypath/headers1:mypath/headers2
```

Related information

- "-qc_stdinc" on page 58
- "-qcpp_stdinc" on page 68
- "-qgcc_c_stdinc" on page 90
- "-qstdinc" on page 182
- "Directory search sequence for include files using relative path names" on page 22
- "Specifying compiler options in a configuration file" on page 18
- Options that control input: Options for search paths

-qgenproto

▶ C

Description

Produces ANSI prototypes from K&R function definitions. This should help to ease the transition from K&R to ANSI.

Syntax

```
              ┌─nogenproto────────────────┐
►►── -q──┴─genproto──┬──────────────┬─┴──────────────────────────────────►◄
                     └─=──parmnames─┘
```

Notes

Using **-qgenproto** without **parmnames** will cause prototypes to be generated without parameter names. Parameter names are included in the prototype when **parmnames** is specified.

Example

For the following function, foo.c:

```
foo(a,b,c)
  float a;
  int *b;
  int c;
```

specifying

```
xlc -c -qgenproto foo.c
```

produces

```
int foo(double, int*, int);
```

The parameter names are dropped. On the other hand, specifying

```
xlc -c -qgenproto=parmnames foo.c
```

produces

```
int foo(double a, int* b, int c);
```

In this case the parameter names are kept.

Note that **float a** is represented as `double` or **double a** in the prototype, since ANSI states that all narrow-type arguments (such as `chars`, `shorts`, and `floats`) are widened before they are passed to K&R functions.

Related information

- Options for error checking and debugging: Other error checking and debugging options

-qhalt

Description

Instructs the compiler to stop after the compilation phase when it encounters errors of specified *severity* or greater.

Syntax

```
                  ┌─s─┐
►►── -qhalt──=────┼─e─┼──────────────────────────────────────────────────►◄
                  ├─i─┤
                  ├─w─┤
                  └─u─┘
```

where severity levels in order of increasing severity are:

severity	**Description**
i	Information
w	Warning
e	Error (C only)
s	Severe error
u	Unrecoverable error

See also “#pragma options” on page 248.

Notes

When the compiler stops as a result of the **-qhalt** option, the compiler return code is nonzero.

When **-qhalt** is specified more than once, the lowest severity level is used.

The **-qhalt** option can be overridden by the **-qmaxerr** option.

Diagnostic messages may be controlled by the **-qflag** option.

Example

To compile `myprogram.c` so that compilation stops if a warning or higher level message occurs, enter:

```
xlc myprogram.c -qhalt=w
```

Related information

- "-qflag" on page 82
- "-qmaxerr" on page 144
- Options that control listings and messages: Options for messages

-qhaltonmsg

C++

Description

Instructs the compiler to stop after the compilation phase when it encounters the specified *msg_number*.

Syntax

```
                      ┌─,──────────┐
                      ▼            │
►►── -qhaltonmsg──=───msg_number─┴──────────────────────────────►◄
```

Notes

When the compiler stops as a result of the **-qhaltonmsg** option, the compiler return code is nonzero.

You can specify more than one message number with the **-qhaltonmsg** option. Additional message numbers must be separated by a comma.

Related information

- "Compiler messages" on page 25
- Options that control listings and messages: Options for messages

-qhot

Description

Instructs the compiler to perform **h**igh-**o**rder loop analysis and **t**ransformations during optimization.

Syntax

```
          ┌─nohot──────────────────────────────┐
►►── -q ──┴─hot──┬──────────────────────────┬──┴──────────────────────────►◄
                 │      ┌─vector──────────┐ │
                 │      ├─simd────────────┤ │
                 └─=────┼─arraypad────────┼─┘
                        │        └─=──n─┘ │
                        ├─level──=──┬─0─┬─┤
                        │           └─1─┘ │
                        ├─nosimd──────────┤
                        └─novector────────┘
```

where:

arraypad
: Because of the implementation of the cache architecture, array dimensions that are powers of two can lead to decreased cache utilization. The **arraypad** suboption permits the compiler to increase the dimensions of arrays where doing so might improve the efficiency of array-processing loops. If you use the **arraypad** suboption with no numeric value, 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.

arraypad=*n*
: The compiler will pad every array in the code. The pad amount must be a positive integer value, and each array will be padded by an integral number of elements. Because *n* is an integral value, we recommend that pad values be multiples of the largest array element size, typically 4, 8, or 16.

level=0
: The compiler performs a subset of the high-order transformations.

When you specify **-qhot=level=0**, the default is set to **novector**, **nosimd** and **noarraypad**.

If you specify **-qhot=level=0** before **-O4** , **level** is set to 1. If you specify **-qhot=level=0** after **-O4**, **level** is set to 0.

level=1
: **-qhot=level=1** is equivalent to **-qhot** and the compiler options that imply **-qhot** also imply **-qhot=level=1** unless **-qhot=level=0** is explicitly specified.

The default hot level for all **-qhot** suboptions other than **level** is 1. For example, specifying **-O3 -qhot=novector** sets the hot level to 1.

Specifying **-O4** or **-qsmp** implies **-qhot=level=1**, unless you explicitly specify **-qhot=level=0** option.

simd | nosimd

The compiler converts certain operations that are performed in a loop on successive elements of an array into a call to a Vector Multimedia Extension (VMX) instruction. This call calculates several results at one time, which is faster than calculating each result sequentially.

Parallel operations occur in 16-byte vector registers. The compiler divides vectors that exceed the register length into 16-byte units to facilitate optimization. A 16-byte unit can contain one of the following types of data:

- 4 Integers.
- 8 2–byte units
- 16 1–byte units

Applying **-qhot=simd** optimization is useful for applications with significant image processing demands.

This suboption has effect only if you specify an architecture that supports VMX instructions; in these conditions, **-qhot=simd** is set as the default.

If you specify **-qhot=nosimd**, the compiler performs optimizations on loops and arrays, but avoids replacing certain code with calls to VMX instructions.

vector | novector

When specified with **-qnostrict** and **-qignerrno**, or an optimization level of **-O3** or higher, the vector suboption 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 MASS library routine. This call will calculate several results at one time, which is faster than calculating each result sequentially. The compiler uses standard registers with no vector size restrictions. The **vector** suboption supports single and double-precision floating-point mathematics, and is useful for applications with significant mathematical processing demands.

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.

Default

The default is **-qnohot**.

Specifying **-qhot** without suboptions implies **-qhot=nosimd**, **-qhot=noarraypad**, **-qhot=vector**, and **-qhot=level=1**. The **-qhot** option is also implied by **-qsmp**, **-O4**, and**-O5**.

Notes

If you do not also specify optimization of at least level 2 when specifying **-qhot** on the command line, the compiler assumes **-O2**.

Both **-qhot=arraypad** and **-qhot=arraypad=***n* are unsafe options. They do not perform any checking for reshaping or equivalences that may cause the code to break if padding takes place.

Example

The following example turns on the **-qhot=arraypad** option:

```
xlc -qhot=arraypad myprogram.c
```

Related information

- "-qarch" on page 49
- "-C" on page 56
- "-O, -qoptimize" on page 148
- "-qstrict" on page 183

- "-qsmp" on page 175
- Options for performance optimization: Options for loop optimization
- "Using the Mathematical Acceleration Subsystem (MASS)"in the*XL C/C++ Programming Guide*

-I

Description

Specifies an additional search path for include file names that do not specify an absolute path.

Syntax

```
►►── -I──directory──────────────────────────────────────────────────►◄
```

Notes

The value for *directory* must be a valid path name (for example, `/u/golnaz`, or `/tmp`, or `./subdir`). The compiler appends a slash (/) to the directory and then concatenates it with the file name before doing the search. The path directory is the one that the compiler searches first for include files whose names do not start with a slash (/). If directory is not specified, the default is to search the standard 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.

If you specify a full (absolute) path name on the `#include` directive, this option has no effect.

Example

To compile `myprogram.C` and search `/usr/tmp` and then `/oldstuff/history` for included files, enter:

```
xlc++ myprogram.C -I/usr/tmp -I/oldstuff/history
```

Related information

- "Directory search sequence for include files using relative path names" on page 22
- Options that control input: Options for search paths

-qidirfirst

Description

Specifies the search order for files included with the **#include "***file_name***"** directive.

Syntax

```
              ┌─noidirfirst─┐
►►── -q───────┴─idirfirst───┴──────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

Use **-qidirfirst** with the **-I** option.

The normal search order (for files included with the `#include` "*file_name*" directive) *without* the **idirfirst** option is:

1. Search the directory where the current source file resides.
2. Search the directory or directories specified with the **-I** option.
3. Search the standard include directories.

With **-qidirfirst**, the directories specified with the **-I** option are searched before the directory where the current file resides.

-qidirfirst has no effect on the search order for the `#include` <*file_name*> directive.

-qidirfirst is independent of the **-qnostdinc** option, which changes the search order for both `#include` "*file_name*" and `#include` <*file_name*>.

The search order of files is described in "Directory search sequence for include files using relative path names" on page 22..

The last valid **#pragma options** [**no**]**idirfirst** remains in effect until replaced by a subsequent **#pragma options** [**no**]**idirfirst**.

Example

To compile `myprogram.c` and search `/usr/tmp/myinclude` for included files before searching the current directory (where the source file resides), enter:

```
xlc myprogram.c -I/usr/tmp/myinclude -qidirfirst
```

Related information

- "-I" on page 97
- "-qstdinc" on page 182
- "Directory search sequence for include files using relative path names" on page 22
- Options that control input: Options for search paths

-qignerrno

Description

Allows the compiler to perform optimizations that assume `errno` is not modified by system calls.

Syntax

```
          ┌─noignerrno─┐
►►── -q───┴─ignerrno───┴──────────────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

Some system library routines set `errno` when an exception occurs. This setting and subsequent side effects of `errno` may be ignored by specifying **-qignerrno**.

Specifying a **-O3** or greater optimization option will also set **-qignerrno**. If you require both optimization and the ability to set `errno`, you should specify **-qnoignerrno** after the optimization option on the command line.

Related information

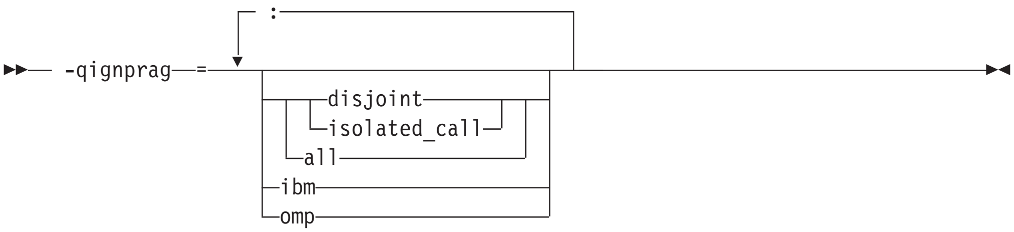
- "-O, -qoptimize" on page 148
- Options for performance optimization: Options for side effects

-qignprag

Description

Instructs the compiler to ignore certain pragma statements.

Syntax



where pragma statements affected by this option are:

disjoint Ignores all **#pragma disjoint** directives in the source file.

isolated_call Ignores all **#pragma isolated_call** directives in the source file.

all Ignores all **#pragma isolated_call** and **#pragma disjoint** directives in the source file.

ibm ▶ C Ignores all **#pragma ibm snapshot** directives in the source file.

omp Ignores all OpenMP parallel processing directives in the source file, such as **#pragma omp parallel**, **#pragma omp critical**.

See also "#pragma options" on page 248.

Notes

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 **-qignprag** with the **-O** option, the information specified in the aliasing pragmas is likely incorrect.

Example

To compile `myprogram.c` and ignore any **#pragma isolated_call** directives, enter:

```
xlc myprogram.c -qignprag=isolated
```

Related information

- "#pragma disjoint" on page 225
- "#pragma isolated_call" on page 238
- "#pragma ibm snapshot" on page 233
- "Summary of OpenMP pragma directives" on page 216
- Options that control input: Other input options

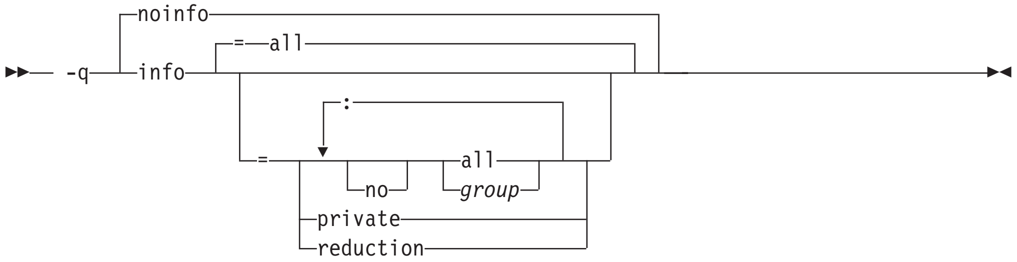
-qinfo

Description

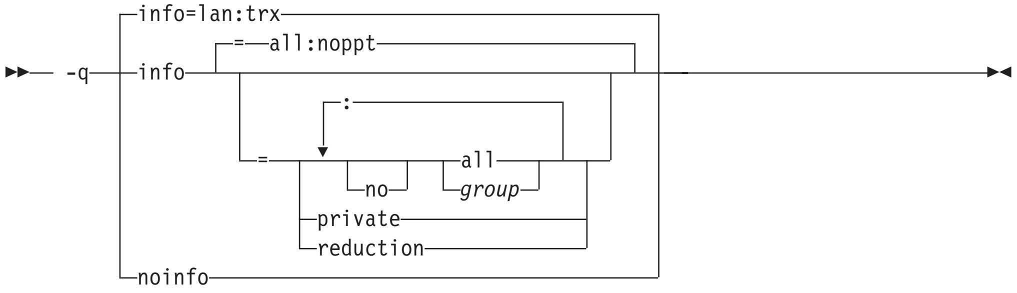
Produces informational messages.

Syntax

C



C++



where **-qinfo** options and diagnostic message groups are described in the **Notes** section below.

See also "#pragma info" on page 234 and "#pragma options" on page 248.

Defaults

If you do not specify **-qinfo** on the command line, the compiler assumes:

1. C **-qnoinfo**
2. C++ **-qinfo=lan:trx**

If you specify **-qinfo** on the command line without any suboptions, the compiler assumes:

1. C **-qinfo=all**
2. C++ **-qinfo=all:noppt**

Notes

Specifying **-qinfo=all** or **-qinfo** with no suboptions turns on all diagnostic messages for all groups except for the **ppt** (preprocessor trace) group in C++ code.

Specifying **-qnoinfo** or **-qinfo=noall** turns off all diagnostic messages for all groups.

You can use the **#pragma options info=***suboption*[**:***suboption* ...] or **#pragma options noinfo** forms of this compiler option to temporarily enable or disable messages in one or more specific sections of program code.

Available forms of the **-qinfo** option are:

all
Turns on all diagnostic messages for all groups.

C The **-qinfo** and **-qinfo=all** forms of the option have the same effect.

C++ The **-qinfo** and **-qinfo=all** forms of the option both have the same effect, but do not include the **ppt** group (preprocessor trace).

lan
Enables diagnostic messages informing of language level effects. This is the default for C++ compilations.

noall
Turns off all diagnostic messages for specific portions of your program.

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
Turns on or off specific groups of messages, where *group* can be one or more of:

group	Type of messages returned or suppressed
c99|noc99	C code that may behave differently between C89 and C99 language levels.
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.
inl|noinl	Functions not inlined.
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.
vft|novft	Generation of virtual function tables in C++ programs.
zea|nozea	Zero-extent arrays.

Example

To compile `myprogram.C` to produce informational message about all items except conversions and unreached statements, enter:

```
xlc++ myprogram.C -qinfo=all -qinfo=nocnv:norea
```

Related information

- "-qhaltonmsg" on page 94
- "-qsuppress" on page 185
- Options that control listings and messages: Options for messages

-qinitauto

Description

Initializes automatic variables to the two-digit hexadecimal byte value *hex_value*.

Syntax

```
         ┌─noinitauto─────────────┐
►►── -q──┴─initauto──=──hex_value─┴──────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

The 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.

There is no default setting for the initial value of **-qinitauto**. You must set an explicit value (for example, **-qinitauto=FA**).

Example

To compile `myprogram.c` so that automatic variables are initialized to hex value FF (decimal 255), enter:

```
xlc myprogram.c -qinitauto=FF
```

Related information

- Options for error checking and debugging: Other error checking and debugging options

-qinlglue

Description

Generates fast external linkage by inlining the pointer glue code necessary to make a call to an external function or a call through a function pointer.

Syntax

```
         ┌─noinlglue─┐
►►── -q──┴─inlglue───┴───────────────────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

This option applies only to 64-bit compilation.

Glue code, generated by the linkage editor, is used for passing control between two external functions, or when you call functions through a pointer. Therefore 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.

For performance enhancement on selected architectures, inlining of glue code is now automated through the selection of hardware tuning options. Specifying **-qtune=pwr4**, **-qtune=pwr5**, **-qtune=ppc970**, or **-qtune=auto** on a system that uses one of these architectures, will automatically enable the **-qinlglue** option. If you use the **-qtune** option with any of these suboptions and want to disable inlining of glue code, make sure to specify **-qnoinlglue** as well. Note, however, that **-qcompact** overrides the **-qinlglue** setting regardless of other options specified, so if you want **-qinlglue** to be enabled, you should not specify **-qcompact**.

Inlining glue code can cause the code size to grow. The option **-qcompact** reduces code size, but it should be noted that **-qcompact** overrides **-qinlglue**, regardless of other options specified.

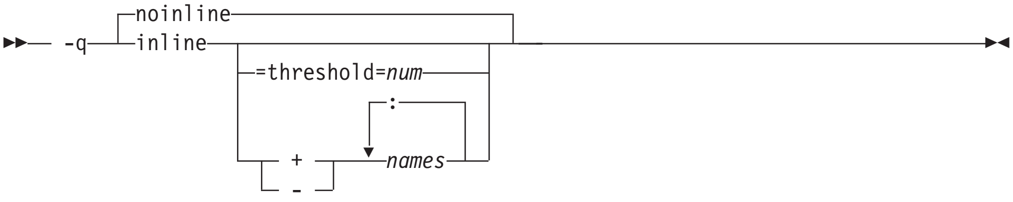
Related information
- "-q32, -q64" on page 44
- "-qcompact" on page 63
- "-qproclocal, -qprocimported, -qprocunknown" on page 161
- "-qtune" on page 197
- Options that control linking: Other linker options

-qinline

Description

Attempts to inline functions instead of generating calls to those functions. Inlining is performed if possible but, depending on which optimizations are performed, some functions might not be inlined.

Syntax



▶ C The following **-qinline** options apply in the C language:

-qinline

The compiler attempts to inline all appropriate functions with 20 executable source statements or fewer, subject to any other settings of the suboptions to the **-qinline** option. If **-qinline** is specified last, all functions are inlined.

-qinline=threshold=*num*

Sets a size limit on the functions to be inlined. The number of executable statements must be less than or equal to *num* for the function to be inlined. *num* must be a positive integer. The default value is 20. Specifying a threshold value of **0** causes no functions to be inlined except those functions marked with supported forms of the `inline` function specifier.

The *num* value applies to logical C statements. 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 */
   }
}
```

-qinline-*names*

The compiler does not inline functions listed by *names*. Separate each *name* with a colon (**:**). All other appropriate functions are inlined. The option implies **-qinline**.

For example:

```
-qinline-salary:taxes:expenses:benefits
```

causes all functions except those named `salary`, `taxes`, `expenses`, or `benefits` to be inlined if possible.

A warning message is issued for functions that are not defined in the source file.

-qinline+*names*

Attempts to inline the functions listed by *names* and any other appropriate functions. Each *name* must be separated by a colon (**:**). The option implies **-qinline**.

For example,

```
-qinline+food:clothes:vacation
```

causes all functions named `food`, `clothes`, or `vacation` to be inlined if possible, along with any other functions eligible for inlining.

A warning message is issued for functions that are not defined in the source file or that are defined but cannot be inlined.

This suboption overrides any setting of the *threshold* value. You can use a threshold value of zero along with **-qinline+***names* to inline specific functions. For example:

```
-qinline=threshold=0
```

followed by:

```
-qinline+salary:taxes:benefits
```

causes *only* the functions named `salary`, `taxes`, or `benefits` to be inlined, if possible, and no others.

-qnoinline

Does not inline any functions. If **-qnoinline** is specified last, no functions are inlined.

▶ C++ The following **-qinline** options apply to the C++ language:

-qinline

Compiler inlines all functions that it can.

-qnoinline	Compiler does not inline any functions.

Default

The default is to treat inline specifications as a hint to the compiler, and the result depends on other options that you select:

- If you optimize your program using one of the **-O** compiler options, the compiler attempts to inline all functions declared as inline. Otherwise, the compiler attempts to inline only some of the simpler functions declared as inline.

Notes

The **-qinline** option is functionally equivalent to the **-Q** option.

If you specify the **-g** option (to generate debug information), inlining may be affected. See the information for the “-g” on page 90 compiler option.

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.

Normally, application performance is optimized if you request optimization (**-O** option), and compiler performance is optimized if you do not request optimization.

To maximize inlining, specify optimization (**-O**) and also specify the appropriate **-qinline** options.

The XL C/C++ keywords `inline`, `__inline__`, `_inline`, `_Inline`, and `__inline` override all **-qinline** options except **-qnoinline**. The compiler tries to inline functions marked with these keywords regardless of other **-qinline** option settings.

See ″The inline function specifier″ in *XL C/C++ Language Reference* for more information.

Example

To compile `myprogram.C` so that no functions are inlined, enter:

```
xlc++ myprogram.C -O -qnoinline
```

To compile `myprogram.c` so that the compiler attempts to inline functions of fewer than 12 lines, enter:

```
xlc myprogram.c -O -qinline=12
```

Related information

- “-O, -qoptimize” on page 148
- “-Q” on page 164
- “-g” on page 90
- Options for performance optimization: Options for function inlining

-qipa

Description

Turns on or customizes a class of optimizations known as interprocedural analysis (IPA).

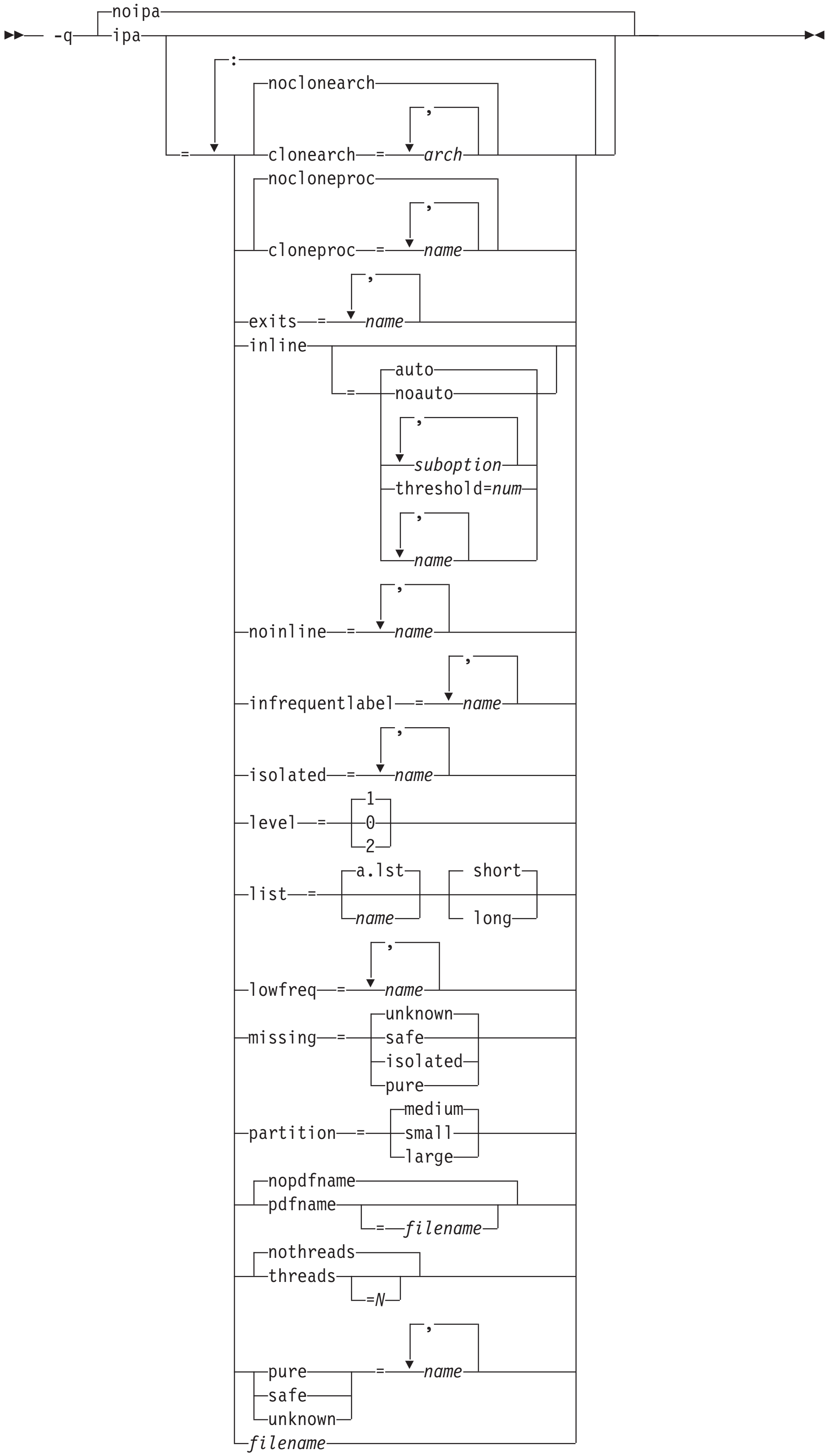
Compile-time syntax

```
►►── -qipa──┬─────────────────────┬──────────────────────────────────►◄
            │      ┌─object───┐   │
            └─=────┴─noobject─┴───┘
```

where:

-qipa compile-time options	**Description**
-qipa	Activates interprocedural analysis with the following **-qipa** *suboption* defaults: • **inline=auto** • **level=1** • **missing=unknown** • **partition=medium**
-qipa=object -qipa=noobject	Specifies whether to include standard object code in the object files. Specifying the **noobject** suboption can substantially reduce overall compile time by not generating object code during the first IPA phase. If the **-S** compiler option is specified with **noobject**, **noobject** is ignored. If compilation and linking are performed in the same step, and neither the **-S** nor any listing option is specified, **-qipa=noobject** is implied by default. 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**.

Link-time syntax


-q
noipa
ipa
=
:
noclonearch
clonearch
=
,
arch
nocloneproc
cloneproc
=
,
name
exits
=
,
name
inline
=
auto
noauto
,
suboption
threshold=num
,
name
noinline
=
,
name
infrequentlabel
=
,
name
isolated
=
,
name
level
=
1
0
2
list
=
a.lst
name
short
long
lowfreq
=
,
name
missing
=
unknown
safe
isolated
pure
partition
=
medium
small
large
nopdfname
pdfname
=
filename
nothreads
threads
=N
pure
safe
unknown
=
,
name
filename

where:

Link-time suboptions	Description
-qnoipa	Deactivates interprocedural analysis.
-qipa	Activates interprocedural analysis with the following **-qipa** *suboption* defaults: • **inline=auto** • **level=1** • **missing=unknown** • **partition=medium**

Suboptions can also include one or more of the forms shown below.

Link-time suboptions	Description
clonearch=*arch*{,*arch*} noclonearch	Specifies the architectures for which multiple versions of the same instruction set are produced. During the IPA link phase, the compiler generates a generic version of a procedure targeted for the default architecture setting and then if appropriate, produces another version that is optimized for the specified architectures. At run time, the compiler dynamically determines which architecture the program is running on, and chooses the particular version of the function that will be executed accordingly. Using this option, your program can achieve compatibility for different PowerPC architectures. *arch* is a comma-separated list of architectures. The supported clonearch values are **pwr4**, **pwr5** and **ppc970**. If you specify no value, an invalid value or a value equal to the **-qarch** setting, no function versioning will be performed for this option. **Notes:** 1. To ensure compatibility across multiple platforms, the **-qarch** value must be the subset of the architecture specified by **-qarch=clonearch**. 2. When **-qcompact** is in effect, **-qarch=clonearch** is disabled. 3. For information on allowed **clonearch** values on different architectures, see Table 37 on page 112. 4. In the case that suboptions are specified for **-qipa=clonearch** and **-qarch** that do not match the target architecture, the compiler will generate instructions based on the suboption that most closely matches the system on which the application is currently running.

cloneproc=*name*{,*name*}
nocloneproc=*name*{,*name*}
	Specifies the name of the functions to clone for the architectures specified by **clonearch** suboption. Where *name* is a comma-separated list of function names.
	Note: If you do not specify **-qipa=clonearch** or specify **-qipa=noclonearch**, **-qipa=cloneproc=***name*,{*name*} and **-qipa=nocloneproc=***name*,{*name*} have no effect.

Link-time suboptions	Description
exits=*name*{,*name*}	Specifies names of functions which represent program exits. Program exits are calls which can never return and can never call any procedure which has been compiled with IPA pass 1.
infrequentlabel=*name*{,*name*}	Specifies a list of user-defined labels that are likely to be called infrequently during a program run.

inline=auto
inline=noauto
	Enables or disables automatic inlining only. The compiler still accepts user-specified functions as candidates for inlining.

inline[=*suboption*]	Same as specifying the **-qinline** compiler option, with *suboption* being any valid **-qinline** suboption.
inline=threshold=*num*	Specifies an upper limit for the number of functions to be inlined, where *num* is a non-negative integer. This argument is implemented only when **inline=auto** is on.
inline=*name*{,*name*}	Specifies a comma-separated list of functions to try to inline, where functions are identified by *name*.
noinline=*name*{,*name*}	Specifies a comma-separated list of functions that must not be inlined, where functions are identified by *name*.
isolated=*name*,{*name*}	Specifies a list of *isolated* functions that are not compiled with IPA. Neither isolated functions nor functions within their call chain can refer to global variables.

level=0
level=1
level=2
	Specifies the optimization level for interprocedural analysis. The default level is 1. Valid levels are as follows:
	• Level 0 - Does only minimal interprocedural analysis and optimization.
	• Level 1 - Turns on inlining, limited alias analysis, and limited call-site tailoring.
	• Level 2 - Performs full interprocedural data flow and alias analysis.

list list=[*name*] [short|long]	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 generated by the back end for each partition. This option can also be used to specify the name of the listing file. If listings have been requested (using either the **-qlist** or **-qipa=list** options), and *name* is not specified, the listing file name defaults to **a.lst**. The **long** and **short** suboptions can be used to request more or less information in the listing file. The **short** suboption, which is the default, generates the Object File Map, Source File Map and Global Symbols Map sections of the listing. The **long** suboption causes the generation of all of the sections generated through the short suboption, as well as the Object Resolution Warnings, Object Reference Map, Inliner Report and Partition Map sections.
lowfreq=*name*{,*name*}	Specifies names of functions which are likely to be called infrequently. These will typically be 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.

Link-time suboptions	Description
missing=*attribute*	Specifies the interprocedural behavior of procedures that are not compiled with **-qipa** and are not explicitly named in an **unknown**, **safe**, **isolated**, or **pure** suboption. The following attributes may be used to refine this information: • safe - Functions which do not indirectly call a visible (not missing) function either through direct call or through a function pointer. • isolated - Functions which do not directly reference global variables accessible to visible functions. Functions bound from shared libraries are assumed to be *isolated*. • pure - Functions which are *safe* and *isolated* and which do not indirectly alter storage accessible to visible functions. *pure* functions also have no observable internal state. • unknown - The default setting. This option greatly restricts the amount of interprocedural optimization for calls to *unknown* functions. Specifies that the missing functions are not known to be *safe*, *isolated*, or *pure*.

partition=small
partition=medium
partition=large
	Specifies the size of each program partition created by IPA during pass 2.

nopdfname pdfname pdfname=*filename*	Specifies the name of the profile data file containing the PDF profiling information. If you do not specify *filename*, the default file name is **._pdf**. The profile is placed in the current working directory or in the directory named by the PDFDIR environment variable. This lets you do simultaneous runs of multiple executables using the same PDFDIR, which can be useful when tuning with PDF on dynamic libraries.
nothreads threads threads=*N*	Specifies the number of threads the compiler assigns to code generation. Specifying **nothreads** is equivalent to running one serial process. This is the default. Specifying **threads** allows the compiler to determine how many threads to use, depending on the number of processors available. Specifying **threads**=*N* instructs the program to use *N* threads. Though *N* can be any integer value in the range of 1 to MAXINT, *N* is effectively limited to the number of processors available on your system.
pure=*name*{,*name*}	Specifies a list of *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=*name*{,*name*}	Specifies a list of *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**.

<table>
<tr><th>Link-time suboptions</th><th>Description</th></tr>
<tr><td>unknown=<i>name</i>{,<i>name</i>}</td><td>Specifies a list of <i>unknown</i> functions that are not compiled with <b>-qipa</b>. Any function specified as <i>unknown</i> can make calls to other parts of the program compiled with <b>-qipa</b>, and modify global variables and dummy arguments.</td></tr>
<tr><td><i>filename</i></td><td>Gives the name of a file which contains suboption information in a special format.

The file format is the following:

... comment
<i>attribute</i>{, <i>attribute</i>} = <i>name</i>{, <i>name</i>}
clonearch=<i>arch</i>,{<i>arch</i>}
cloneproc=<i>name</i>,{<i>name</i>}
missing = <i>attribute</i>{, <i>attribute</i>}
exits = <i>name</i>{, <i>name</i>}
lowfreq = <i>name</i>{, <i>name</i>}
inline [= auto | = noauto]
inline = <i>name</i>{, <i>name</i>} [from <i>name</i>{, <i>name</i>}]
inline-threshold = <i>unsigned_int</i>
inline-limit = <i>unsigned_int</i>
list [= file-name | short | long]
noinline
noinline = <i>name</i>{, <i>name</i>} [from <i>name</i>{, <i>name</i>}]
level = 0 | 1 | 2
prof [= <i>file-name</i>]
noprof
partition = small | medium | large | <i>unsigned_int</i>

where <i>attribute</i> is one of:
• clonearch
• cloneproc
• exits
• lowfreq
• unknown
• safe
• isolated
• pure</td></tr>
</table>

The following table shows the allowed **clonearch** values for different **-qarch** settings.

Table 37. Allowable clonearch values

-qarch setting	Allowed clonearch value
ppc, pwr3, ppc64, ppcgr, ppc64gr, ppc64grsq	pwr4, pwr5, ppc970
pwr4	pwr5, ppc970
ppc64v	ppc970
pwr5, ppc970	N/A

Notes

The necessary steps to use IPA are:

1. Do preliminary performance analysis and tuning before compiling with the **-qipa** option, because the IPA analysis uses a two-pass mechanism that increases compile and link time. You can reduce some compile and link overhead by using the **-qipa=noobject** option.
2. Specify the **-qipa** option on both the compile and the link steps of the entire application, or as much of it as possible. Use suboptions to indicate

assumptions to be made about parts of the program *not* compiled with **-qipa**. During compilation, the compiler stores interprocedural analysis information in the .o file. During linking, the **-qipa** option causes a complete recompilation of the entire application.

Note: If a severe error occurs during compilation, **-qipa** returns RC=1 and terminates. Performance analysis also terminates.

- IPA can significantly increase compilation time, even with the **-qipa=noobject** option, so using IPA should be limited to the final performance tuning stage of development.
- Specify the **-qipa** option on both the compile and link steps of the entire application, or as much of it as possible. You should at least compile the file containing `main`, or at least one of the entry points if compiling a library.
- While IPA's interprocedural optimizations can significantly improve performance of a program, they can also cause previously incorrect but functioning programs to fail. Listed below are some programming practices that can work by accident without aggressive optimization, but are exposed with IPA:
  1. Relying on the allocation order or location of automatic variables. For example, taking the address of an automatic variable and then later comparing it with the address of another local to determine the growth direction of a stack. The C language does not guarantee where an automatic variable is allocated, or it's position relative to other automatics. Do not compile such a function with IPA(and expect it to work).
  2. Accessing an either invalid pointer or beyond an array's bounds. IPA can reorganize global data structures. A wayward pointer which may have previously modified unused memory may now trample upon user allocated storage.
- Ensure you have sufficient resources to compile with IPA. IPA can generate significantly larger object files than traditional compilations. As a result, the temporary storage location used to hold these intermediate files (by convention `/tmp`) is sometimes too small. If a large application is being compiled, consider redirecting temporary storage with the TMPDIR environment variable.
- Ensure there is enough swap space to run IPA (at least 200Mb for large programs). Otherwise the operating system might kill IPA with a signal 9 , which cannot be trapped, and IPA will be unable to clean up its temporary files.
- You can link objects created with different releases of the compiler, but you must ensure that you use a linker that is at least at the same release level as the newer of the compilers used to create the objects being linked.
- Some symbols which are clearly referenced or set in the source code may be optimized away by IPA, and may be lost to debug, nm, or dump outputs. Using IPA together with the **-g** compiler will usually result in non-steppable output.

Regular expression syntax can be used when specifying a *name* for the following suboptions.

- cloneproc, nocloneproc
- exits
- inline, noinline
- isolated
- lowfreq
- pure
- safe
- unknown

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.
[*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`.

Example

To compile a set of files with interprocedural analysis, enter:

```
xlc++ -c -O3 *.C -qipa
xlc++ -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 exits two functions, `trace_error` and `debug_dump`, which are rarely executed.

```
xlc++ -c -O3 *.C -qipa=noobject
xlc++ -c *.o -qipa=lowfreq=trace_error,debug_dump
```

Related information

- "-qlibansi" on page 135
- "-qlist" on page 136
- "-S" on page 171
- Options for performance optimization: Options for whole-program analysis
- "Optimizing your applications"in the *XL C/C++ Programming Guide*

-qisolated_call

Description

Specifies functions in the source file that have no side effects.

Syntax

```
                               ┌─:─────────────┐
                               ▼               │
▶▶── -q──isolated_call──=────function_name─────┴─────────────────────────────────▶◀
```

where:

function_name Is the name of a function that does not have side effects, except changing the value of a variable pointed to by a pointer or reference parameter, or does not rely on functions or processes that have side effects.

Side effects are any changes in the state of the runtime environment. Examples of such changes are accessing a volatile object, modifying an external object, modifying a file, or calling another function that does any of these things. Functions with no side effects cause no changes to external and static variables.

function_name can be a list of functions separated by colons (:).

See also “#pragma isolated_call” on page 238 and “#pragma options” on page 248.

Notes

Marking a function as isolated can improve the runtime performance of optimized code by indicating the following to the optimizer:

- external and static variables are not changed by the called function
- calls to the function with loop-invariant parameters may be moved out of loops
- multiple calls to the function with the same parameter may be merged into one call
- calls to the function may be discarded if the result value is not needed

The **#pragma options isolated_call** directive must be specified at the top of the file, before the first C or C++ statement. You can use the **#pragma isolated_call** directive at any point in your source file.

If a function is incorrectly identified as having no side effects, the resultant program behavior might be unexpected or produce incorrect results.

Example

To compile `myprogram.c`, specifying that the functions `myfunction(int)` and `classfunction(double)` do not have side effects, enter:

```
xlc myprogram.c -qisolated_call=myfunction:classfunction
```

Related information

- Options for performance optimization: Options for side effects

-qkeepinlines

▶ C++

Description

Instructs the compiler to keep or discard definitions for unreferenced extern inline functions.

Syntax

```
             ┌─nokeepinlines─┐
▶▶── -q──────┴─keepinlines───┴──────────────────────────────────────────────▶◀
```

Notes

The default **-qnokeepinlines** setting instructs the compiler to discard the definitions of unreferenced external inline functions. This can reduce the size of the object files.

The **-qkeepinlines** setting keeps the definitions of unreferenced external inline functions. This setting provides the same behavior as VisualAge C++ compilers previous to the v5.0.2.1 update level, allowing compatibility with shared libraries and object files built with the earlier releases of the compiler.

Related information
- "-qinline" on page 104
- Options for performance optimization: Options for code size reduction

-qkeepparm

Description

Ensures that function parameters are stored on the stack even if the application is optimized.

Syntax

```
             ┌─nokeepparm─┐
▶▶── -q──────┴─keepparm───┴─────────────────────────────────────────────────▶◀
```

Notes

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.

Specifying **-qkeepparm** ensures that the parameters are stored on the stack even when optimizing. This compiler option ensures that the values of incoming parameters are available to tools, such as debuggers, by preserving those values on the stack. However, doing so may negatively affect application performance.

Related information
- "-O, -qoptimize" on page 148
- Options for error checking and debugging: Other error checking and debugging options

-qkeyword

Description

This option controls whether the specified name is treated as a keyword or as an identifier whenever it appears in your program source.

Syntax

```
►►── -q──┬─keyword───┬──=──keyword_name──────────────────────────────────────►◄
         └─nokeyword─┘
```

Notes

By default all the built-in keywords defined in the C and C++ language standards are reserved as keywords. 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.

This option can be used with all C++ built-in keywords.

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 **ansi**, **stdc89** or **stdc99**.

Example

► C++

You can reinstate `bool` with the following invocation:

```
xlc++ -qkeyword=bool
```

► C

You can reinstate `typeof` with the following invocation:

```
xlc -qkeyword=typeof
```

Related information
- "-qasm" on page 52
- Options that control input: Options for language extensions

-L

Description

At link time, searches the path directory for library files specified by the **-l***key* option.

Syntax

```
►►── -L──directory───────────────────────────────────────────────────────────►◄
```

Default

The default is to search only the standard directories.

Notes

If the LIBPATH environment variable is set, the compiler will search for libraries first in directory paths specified by LIBPATH, and then in directory paths specified by the **-L** compiler option.

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.

Paths specified with the **-L** compiler option are *not* searched at run time.

Example

To compile `myprogram.c` so that the directory `/usr/tmp/old` and all other directories specified by the **-l** option are searched for the library `libspfiles.a`, enter:

```
xlc myprogram.c -lspfiles -L/usr/tmp/old
```

Related information

- "-l"
- Appendix A, "Redistributable libraries," on page 301
- Options that control linking: Options for linker input control

-l

Description

Searches the specified library file, lib*key*.so, and then lib*key*.a for dynamic linking, or just lib*key*.a for static linking.

Syntax

```
►►— -l—key——————————————————————————————————————————————►◄
```

Default

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.

Notes

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***directory* option.

The C and C++ runtime libraries are automatically added.

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.

Example

To compile `myprogram.C` and link it with library `mylibrary` (`libmylibrary.a`) found in the `/usr/mylibdir` directory, enter:

```
xlc++ myprogram.C -lmylibrary -L/usr/mylibdir
```

Related information

- "-B" on page 55
- "-L" on page 117
- "Order of linking" on page 24
- "Specifying compiler options in a configuration file" on page 18
- Options that control linking: Options for linker input control

-qlanglvl

Description

Selects the language level and language options for the compilation.

Syntax

```
                      ┌─:─────────┐
                      ▼           │
►►── -q──langlvl──=───suboption───┴──────────────────────────────►◄
```

where values for *suboption* are described below in the **Notes** section.

See also "#pragma langlvl" on page 239 and "#pragma options" on page 248.

Default

The default language level varies according to the command you use to invoke the compiler:

Invocation	Default language level
xlC/xlc++	extended
xlc	extc89
cc	extended
c89	stdc89
c99	stdc99

Notes

▶ C You can also use either of the following pragma directives to specify the language level in your C language source program:

```
#pragma options langlvl=suboption
#pragma langlvl(suboption)
```

The pragma directive must appear before any noncommentary lines in the source code.

▶ C For C programs, you can use the following **-qlanglvl** suboptions for *suboption*:

classic
Allows the compilation of non-stdc89 programs, and conforms closely to the K&R level preprocessor.

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 to the ANSI C89 standard, also known as ISO C90.

stdc99 — Compilation conforms to the ISO C99 standard.

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.

[no]ucs — Under language levels **stdc99** and **extc99**, the default is **-qlanglvl=ucs**

This option controls whether Unicode characters are allowed in identifiers, string literals and character literals in program source code.

The Unicode character set is supported by the C standard. This character set contains the full set of letters, digits and other characters used by a wide range of languages, including all North American and Western European languages. Unicode characters can be 16 or 32 bits. The ASCII one-byte characters are a subset of the Unicode character set.

When this option is set to yes, you can insert Unicode characters in your source files either directly or using a notation that is similar to escape sequences. Because many Unicode characters cannot be displayed on the screen or entered from the keyboard, the latter approach is usually preferred. Notation forms for Unicode characters are \u*hhhh* for 16-bit characters, or \U*hhhhhhhh* for 32-bit characters, where *h* represents a hexadecimal digit. Short identifiers of characters are specified by ISO/IEC 10646.

The following **-qlanglvl** suboptions are accepted but ignored by the C compiler. Use **-qlanglvl=extended**, **-qlanglvl=extc99**, or **-qlanglvl=extc89** to enable the functions that these suboptions imply. For other values of **-qlanglvl**, 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.

C++ For C++ programs, you can specify one or more of the following **-qlanglvl** suboptions for *suboption*:

extended — Compilation is based on the ISO C++ Standard, with some differences to accommodate extended language features.

[no]anonstruct

This suboption controls whether anonymous structs and anonymous classes are allowed in your C++ source.

By default, the compiler allows anonymous structs. This is an extension to the C++ standard and gives behavior that is compatible with the C++ compilers provided by Microsoft® Visual C++.

Anonymous structs typically are 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 this suboption is set, you receive a warning if your code declares an anonymous struct and **-qinfo=por** is specified. When you build with **-qlanglvl=noanonstruct**, an anonymous struct is flagged as an error. Specify **noanonstruct** for compliance with standard C++.

[no]anonunion

This suboption controls what members are allowed in anonymous unions.

When this suboption is set to **anonunion**, 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.

By default, the compiler allows non-data members in anonymous unions. This is an extension to standard C++ and gives behavior that is compatible with the C++ compilers provided by previous versions of VisualAge C++ and predecessor products, and Microsoft Visual C++.

When this option is set to **anonunion**, you receive a warning if your code uses the extension, unless you suppress the arning message with the **-qsuppress** option.

Set **noanonunion** for compliance with standard C++.

[no]ansifor

This suboption controls whether scope rules defined in the C++ standard apply to names declared in for-init statements.

By default, standard C++ rules are used. For example 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-init-statement, is visible only within the for statement. To correct the error, either declare `i` outside the loop or set ansiForStatementScopes to no.

Set **noansifor** to allow old language behavior. You may need to do this for code that was developed with other products, such as the compilers provided by earlier versions of VisualAge C++ and predecessor products, and Microsoft Visual C++.

[no]ansisinit

This option works in the same way as **g++ -fuse-cxa-atexit** and is required for fully standards-compliant handling of static destructors.

[no]c99__func__

This suboption instructs the compiler to recognize the C99 `__func__` identifier. The `__func__` identifier behaves as if there is an implicit declaration like:

```
static const char __func__[] = function_name;
```

where *function_name* is the name of the function in which the `__func__` identifier appears.

The effect of the `__func__` identifier can be seen in the following code segment:

```
void this_function()
{
 printf("__func__ appears in %s", __func__);
}
```

which outputs the following when run:

```
__func__ appears in this_function
```

The **c99__func__** suboption is enabled by default when **-qlanglvl=extended** is in effect. It can be enabled for any language level by specifying **-qlanglvl=c99__func__**, or disabled by specifying **-qlanglvl=noc99__func__**.

The __C99__FUNC__ macro is defined to be 1 when **c99__func__** is in effect, and is undefined otherwise.

[no]c99complex

This suboption instructs the compiler to recognize C99 complex data types and related keywords.
Note: Support for complex data types may vary among different C++ compilers, creating potential portability issues. The compiler will issue a portability warning message if you specify this compiler option together with **-qinfo=por**.

[no]c99compoundliteral

This suboption instructs the compiler to support the C99 compound literal feature.

[no]c99hexfloat
This option enables support for C99-style hexadecimal floating constants in C++ applications. This suboption is on by default for **-qlanglvl=extended**. When it is in effect, the compiler defines the macro __C99_HEX_FLOAT_CONST.

[no]c99vla
When **c99vla** is in effect, the compiler will support the use of C99-type variable length arrays in your C++ applications. The macro __C99_VARIABLE_LENGTH_ARRAY is defined with a value of 1.
Note: In C++ applications, storage allocated for use by variable length arrays is not released until the function they reside in completes execution.

[no]dependentbaselookup
The default is **-qlanglvl=dependentbaselookup**.

This suboption provides the ability to specify compilation in conformance with Issue 213 of TC1 of the C++ Standard.

The default setting retains the behavior of previous XL C/C++ compilers with regard to the name lookup for a template base class of dependent type: 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.

For compliance with TC1, specify **-qlanglvl=nodependentbaselookup**.

[no]gnu_assert
GNU C portability option to enable or disable support for the following GNU C system identification assertions:
- #assert
- #unassert
- #cpu
- #machine
- #system

[no]gnu_complex
This suboption instructs the compiler to recognize GNU complex data types and related keywords.
Note: Support for complex data types may vary among different C++ compilers, creating potential portability issues. The compiler will issue a portability warning message if you specify this compiler option together with **-qinfo=por**.

[no]gnu_computedgoto
GNU C portability option to enable support for computed gotos. This suboption is enabled for **-qlanglvl=extended**, and defines the macro __IBM_COMPUTED_GOTO.

[no]gnu_externtemplate

This suboption enables or disables extern template instantiations.

The default setting is **gnu_externtemplate** when compiling to the **extended** language level.

If **gnu_externtemplate** is in effect, you can declare a template instantiation to be extern by adding the keyword `extern` in front of an explicit C++ template instantiation. The `extern` keyword must be the first keyword in the declaration, and there can be only one `extern` keyword.

This does not instantiate the class or function. For both classes and functions, the extern template instantiation will prevent instantiation of parts of the template, provided that instantiation has not already been triggered by code prior to the extern template instantiation, and it is not explicitly instantiated nor explicitly specialized.

For classes, static data members and member functions will not be instantiated, but a class itself will be instantiated if required to map the class. Any required compiler generated functions (for example, default copy constructor) will be instantiated. For functions, the prototype will be instantiated but the body of the template function will not.

See the following examples:

```
template < class T > class C {
  static int i;
  void f(T) { }
};

template < class U > int C<U>::i = 0;
extern template class C<int>; // extern explicit
                              // template
                              // instantiation
C<int> c;  // does not cause instantiation of
           // C<int>::i  or C<int>::f(int) in
           // this file but class is
           // instantiated for mapping
C<char> d; // normal instantiations

==========================

template < class C > C foo(C c) { return c; }

extern template int foo<int>(int); // extern explicit
                                   // template
                                   // instantiation
int i = foo(1);    // does not cause instantiation
                   // of body of foo<int>
```

[no]gnu_include_next

GNU C portability option to enable or disable support for the GNU C `#include_next` preprocessor directive.

[no]gnu_labelvalue

GNU C portability option to enable or disable support for labels as values. This suboption is on by default for **-qlanglvl=extended**, and defines the macro __IBM_LABEL_VALUE.

[no]gnu_locallabel

GNU C portability option to enable or disable support for locally-declared labels.

gnu_membernamereuse

GNU C++ portability option to enable reusing a template name in a member list as a typedef.

[no]gnu_suffixij

GNU C portability option to enable or disable support for GNU-style complex numbers. If **gnu_suffixij** is specified, a complex number can be ended with suffix i/I or j/J.

[no]gnu_varargmacros

This option is similar to **-qlanglvl=varargmacros**. The main differences are:

- An optional variable argument identifier may precede the ellipsis, allowing that identifier to be used in place of the macro __VA_ARGS__ . Whitespace may appear between the identifier and the ellipsis.
- The variable argument can be omitted.
- If the token paste operator (**##**) appears between the comma and the variable argument, the preprocessor removes the dangling comma (**,**) if the variable argument is not provided.
- The macro __IBM_MACRO_WITH_VA_ARGS is defined to 1.

Example 1 - Simple substitution:

```
#define debug(format, args...) printf(format, args)

debug("Hello %s\n", "Chris");
```

preprocesses to:

```
printf("Hello %s\n", "Chris");
```

Example 2 - Omitting the variable argument:

```
#define debug(format, args...) printf(format, args)

debug("Hello\n");
```

preprocesses to the following, leaving a dangling comma:

```
printf("Hello\n",);
```

Example 3 - Using the token paste operator to remove a dangling comma when the variable argument is omitted:

```
#define debug(format, args...) printf(format, ## args)

debug("Hello\n");
```

preprocesses to:

```
printf("Hello\n");
```

[no]gnu_warning

GNU C portability option to enable or disable support for the GNU C `#warning` preprocessor directive.

[no]illptom

This suboption controls what expressions can be used to form pointers to members. The XL C++ compiler can accept some forms that are in common use but do not conform to the C++ Standard.

By default, the compiler allows these forms. This is an extension to standard C++ and gives behavior that is compatible with the C++ compilers provided by earlier versions of VisualAge C++, its predecessor products, and Microsoft Visual C++.

When this suboption is set to **illptom**, you receive warnings if your code uses the extension, unless you suppress the warning messages with the **-qsuppress** option.

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;
```

Set **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;
```

[no]implicitint

This suboption controls whether the compiler will accept missing or partially specified types as implicitly specifying int. This is no longer accepted in the standard but may exist in legacy code.

With the suboption set to **noimplicitint**, all types must be fully specified.

With the suboption set to **implicitint**, 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. Note that the effect is as if the `int` specifier were present. This means that the specifier `const`, by itself, would specify a constant integer.

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, _cdecl)

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.

By default, the compiler sets **-qlanglvl=implicitint**. This is an extension to the C++ standard and gives behavior that is compatible with the C++ compilers provided by earlier versions of VisualAge C++ and predecessor products, and Microsoft Visual C++.

For example, the return type of function `MyFunction` is `int` because it was omitted in the following code:

```
MyFunction()
{
   return 0;
}
```

Set **-qlanglvl=noimplicitint** for compliance with standard C++. For example, the function declaration above must be modified to:

```
int MyFunction()
{
   return 0;
}
```

[no]offsetnonpod

This suboption 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.

By default, the compiler allows `offsetof` to be used with non-POD classes. This is an extension to the C++ standard, and gives behavior that is compatible with the C++ compilers provided by VisualAge C++ for OS/2® 3.0, VisualAge for C++ for Windows®, Version 3.5, and Microsoft Visual C++

When this option is set, you receive a warning if your code uses the extension, unless you suppress the warning message with the **-qsuppress** option.

Set **-qlanglvl=nooffsetnonpod** for compliance with standard C++.

Set **-qlanglvl=offsetnonpod** if your code applies `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

[no]olddigraph

This option controls whether old-style digraphs are allowed in your C++ source. It applies only when **-qdigraph** is also set.

By default, the compiler supports only the digraphs specified in the C++ standard.

Set **-qlanglvl=olddigraph** if your code contains at least one of following digraphs:

Digraph	**Resulting character**
%%	# (pound sign)
%%%%	## (double pound sign, used as the preprocessor macro concatenation operator)

Set **-qlanglvl=noolddigraph** for compatibility with standard C++ and the extended C++ language level supported by previous versions of VisualAge C++ and predecessor products.

[no]oldfriend

This option controls whether friend declarations that name classes without elaborated class names are treated as C++ errors.

By default, the compiler lets you declare a friend class without elaborating the name of the class with the keyword class. This is an extension to the C++ standard and gives behavior that is compatible with the C++ compilers provided by earlier versions of VisualAge C++ and predecessor products, and Microsoft Visual C++.

For example, the statement below declares the class IFont to be a friend class and is valid when the **oldfriend** suboption is set specified.

```
friend IFont;
```

Set the **nooldfriend** suboption for compliance with standard C++. The example declaration above causes a warning unless you modify it to the statement as below, or suppress the warning message with **-qsuppress** option.

```
friend class IFont;
```

[no]oldtempacc

This suboption controls whether access to a copy constructor to create a temporary object is always checked, even if creation of the temporary object is avoided.

By default, the compiler suppresses the access checking. This is an extension to the C++ standard and gives behavior that is compatible with the C++ compilers provided by VisualAge C++ for OS/2 3.0, VisualAge for C++ for Windows, Version 3.5, and Microsoft Visual C++.

When this suboption is set to yes, you receive a warning if your code uses the extension, unless you disable the warning message with the **-qsuppress** option.

Set **-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 thrown 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&).

[no]oldtmplalign

This suboption specifies the alignment rules implemented in versions of the compiler (**xlC**) prior to Version 5.0. These earlier versions of the xlC compiler ignore alignment rules specified for nested templates. By default, these alignment rules are not ignored in VisualAge C++ 4.0 or later. 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
};
```

[no]oldtmplspec

This suboption controls whether template specializations that do not conform to the C++ standard are allowed.

By default, the compiler allows these old specializations (**-qlanglvl=nooldtmplspec**). This is an extension to standard C++ and gives behavior that is compatible with the C++ compilers provided by VisualAge C++ for OS/2 3.0, VisualAge for C++ for Windows, Version 3.5, and Microsoft Visual C++.

When **-qlanglvl=oldtmplspec** is set, you receive a warning if your code uses the extension, unless you suppress the warning message with the **-qsuppress** option.

For example, you can explicitly specialize the template class ribbon for type char with the following lines:

```
template<class T> class ribbon { /*...*/};
class ribbon<char> { /*...*/};
```

Set **-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> { /*...*/};
```

[no]redefmac

Specifies whether a macro can be redefined without a prior #undef or undefine() statement.

[no]trailenum

This suboption controls whether trailing commas are allowed in enum declarations.

By default, the compiler allows one or more trailing commas at the end of the enumerator list. This is an extension to the C++ standard, and provides compatibility with Microsoft Visual C++. The following enum declaration uses this extension:

```
enum grain { wheat, barley, rye,, };
```

Set **-qlanglvl=notrailenum** for compliance with standard C++ or with the **stdc89** language level supported by previous versions of VisualAge C++ and predecessor products.

[no]typedefclass

This suboption provides backwards compatibility with previous versions of VisualAge C++ and predecessor products.

The current C++ standard does not allow a typedef name to be specified where a class name is expected. This option relaxes that restriction. Set **-qlanglvl=typedefclass** to allow the use of typedef names in base specifiers and constructor initializer lists.

By default, a typedef name cannot be specified where a class name is expected.

[no]ucs

This suboption controls whether Unicode characters are allowed in identifiers, string literals and character literals in C++ sources. The default setting is **-qlanglvl=noucs**.

The Unicode character set is supported by the C++ standard. This character set contains the full set of letters, digits and other characters used by a wide range of languages, including all North American and Western European languages. Unicode characters can be 16 or 32 bits. The ASCII one-byte characters are a subset of the Unicode character set.

When **-qlanglvl=ucs** is enabled, you can insert Unicode characters in your source files either directly or using a notation that is similar to escape sequences. Because many Unicode characters cannot be displayed on the screen or entered from the keyboard, the latter approach is usually preferred. Notation forms for Unicode characters are \u*hhhh* for 16-bit characters, or \U*hhhhhhhh* for 32-bit characters, where *h* represents a hexadecimal digit. Short identifiers of characters are specified by ISO/IEC 10646.

[no]varargmacros

This C99 feature allows the use of a variable argument list in function-like macros in your C++ applications. The syntax is similar to a variable argument function, and can be used as a masking macro for printf.

For example:

```
#define debug(format, ...) printf(format, __VA_ARGS__)

debug("Hello %s\n", "Chris");
```

preprocesses to::

```
printf("Hello %s\n", "Chris");
```

The token __VA_ARGS__ in the replacement list corresponds to the ellipsis in the parameter. The ellipsis represents the variable arguments in a macro invocation.

Specifying **varargmacros** defines the macro __C99_MACRO_WITH_VA_ARGS to a value of 1.

[no]zeroextarray

This suboption controls whether zero-extent arrays are allowed as the last non-static data member in a class definition.

By default, the compiler allows arrays with zero elements. This is an extension to the C++ standard, and provides compatibility with Microsoft Visual C++. The example declarations below define dimensionless arrays a and b.

```
struct S1 { char a[0]; };
struct S2 { char b[]; };
```

Set **nozeroextarray** for compliance with standard C++ or with the ANSI language level supported by previous versions of VisualAge C++ and predecessor products.

Exceptions to the **stdc89** mode addressed by **classic** are as follows:

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 between **classic** mode and **stdc89** mode. Directives not listed here behave similarly in both modes.

#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 in **classic** mode.

#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.

Related information

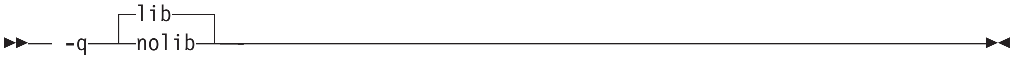
- “-qsuppress” on page 185
- Summary of command line options: Standards compliance
- ″The IBM XL C language extensions″ and ″The IBM XL C++ language extensions″ in *XL C/C++ Language Reference*

-qlib

Description

Instructs the compiler to use the standard system libraries at link time.

Syntax



Notes

If the **-qnolib** compiler option is specified, the standard system libraries are not used. Only those libraries explicitly specified on the command line will be used at link time.

Related information

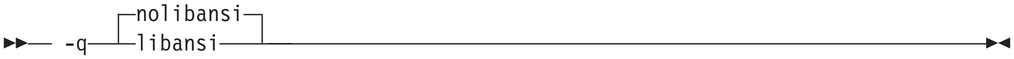
- “-qcrt” on page 68
- Options that control linking: Options for linker input control

-qlibansi

Description

Assumes that all functions with the name of an ANSI C library function are in fact the system functions.

Syntax



See also “#pragma options” on page 248.

Notes

This will allow the optimizer to generate better code because it will know about the behavior of a given function, such as whether or not it has any side effects.

Related information

- Options for performance optimization: Options for ABI performance tuning

-qlinedebug

Description

Generates line number and source file name information for the debugger.

Syntax

```
           ┌─nolinedebug─┐
►►── -q────┴─linedebug───┴──────────────────────────────────────────►◄
```

Notes

This option produces minimal debugging information, so the resulting object size is smaller than that produced if the **-g** debugging option is specified. 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.

Avoid using this option with **-O** (optimization) option. The information produced may be incomplete or misleading.

If you specify the **-qlinedebug** option, the inlining option defaults to **-Q!** (no functions are inlined).

The **-g** option overrides the **-qlinedebug** option. If you specify **-g -qnolinedebug** on the command line, **-qnolinedebug** is ignored and the following warning is issued:

```
1506-... (W) Option -qnolinedebug is incompatible with option -g and is ignored
```

Example

To compile `myprogram.c` to produce an executable program `testing` so you can step through it with a debugger, enter:

```
xlc myprogram.c -o testing -qlinedebug
```

Related information

- “#pragma options” on page 248
- “-g” on page 90
- “-O, -qoptimize” on page 148
- “-Q” on page 164
- Options for error checking and debugging: Options for debugging

-qlist

Description

Produces a compiler listing that includes an object listing. You can use the object listing to help understand the performance characteristics of the generated code and to diagnose execution problems.

Syntax

```
            ┌nolist──────────────────────┐
►►── -q─────┴list──┬──────────────────────┬┴──────────────────────────────────►◄
                   └─=────┬offset───┬─────┘
                          └nooffset─┘
```

Where specifying **-qlist=offset** changes the listing of the instructions in `.lst` file to be offset from the start of the procedure.

Notes

The **-qlist=offset** is only relevant if there are multiple procedures in a compilation unit.

If you specify **-qlist=offset**, the offset of the PDEF header is no longer `00000`, but it now contains the offset from 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 **-qlist=offset** or **-qlist=nooffset** is specified.

Specifying **-qlist** implies **-qlist=nooffset**.

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

Example

To compile `myprogram.C` and produce an object listing, enter:

```
xlc++ myprogram.C -qlist
```

Related information

- "#pragma options" on page 248.
- "-qprint" on page 160
- Options that control listings and messages: Options for listing

-qlistopt

Description

Produces a compiler listing that displays all options in effect at time of compiler invocation.

Syntax

```
            ┌nolistopt─┐
►►── -q─────┴listopt───┴──────────────────────────────────────────────────────►◄
```

Notes

The listing will show options in effect as set by the compiler defaults, default configuration file, and command line settings. Option settings caused by pragma statements in the program source are not shown in the compiler listing.

Specifying **-qnoprint** overrides this compiler option.

Example

To compile `myprogram.C` to produce a compiler listing that shows all options in effect, enter:

```
xlc++ myprogram.C -qlistopt
```

Related information

- "-qprint" on page 160
- "Resolving conflicting compiler options" on page 19
- Options that control listings and messages: Options for listing

-qlonglit

Description

Makes unsuffixed literals into the `long` type in 64-bit mode.

Syntax

```
           ┌─nolonglit─┐
►►── -q────┴─longlit───┴──────────────────────────────────────────────────►◄
```

Notes

▶ C

The following table shows the implicit types for constants in 64-bit mode when compiling in the **stdc89**, **extc89**, or **extended** language level:

	default 64-bit mode	64-bit mode with qlonglit

unsuffixed decimal	`signed int`
	`signed long`
	`unsigned long`
		`signed long`
		`unsigned long`

unsuffixed octal or hex	`signed int`
	`unsigned int`
	`signed long`
	`unsigned long`
		`signed long`
		`unsigned long`

suffixed by u/U	`unsigned int`
	`unsigned long`
		`unsigned long`

suffixed by l/L	`signed long`
	`unsigned long`
		`signed long`
		`unsigned long`

suffixed by ul/UL	`unsigned long`	`unsigned long`

▶ C++

The following table shows the implicit types for constants in 64-bit mode when compiling in the **stdc99**, **extc99**, or **extended** language level:

	Decimal constant	-qlonglit effect on decimal constant

unsuffixed	`int`
	`long int`
		`long int`

u or **U**	`unsigned int`
	`unsigned long int`
		`unsigned long int`

l or **L**	`long int`	`long int`
Both **u** or **U**, and **l** or **L**	`unsigned long int`	`unsigned long int`
ll or **LL**	`long long int`	`long long int`

	Decimal constant	**-qlonglit effect on decimal constant**
Both **u** or **U**, and **ll** or **LL**	`unsigned long long int`	`unsigned long long int`

	Octal or hexadecimal constant	**-qlonglit effect on octal or hexadecimal constant**

unsuffixed	`int`
	`unsigned int`
	`long int`
	`unsigned long int`
		`long int`
		`unsigned long int`

u or **U**	`unsigned int`
	`unsigned long int`
		`unsigned long int`

l or **L**	`long int`
	`unsigned long int`
		`long int`
		`unsigned long int`

Both **u** or **U**, and **l** or **L**	`unsigned long int`	`unsigned long int`

ll or **LL**	`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`

Related information

- "-qlanglvl" on page 119
- Options that control integer and floating-point processing

-qlonglong

Description

Allows `long long` integer types in your program.

Syntax

```
         ┌─longlong───┐
►►── -q──┴─nolonglong─┴──────────────────────────────────────────────►◄
```

Default

The default with **xlc** , **xlC** and **cc** is **-qlonglong**, which defines _LONG_LONG (`long long` types will work in programs). The default with c89 is **-qnolonglong** (`long long` types are not supported).

Notes

▸ C This option cannot be specified when the selected language level is **stdc99** or **extc99**. It is used to control the `long long` support that is provided as an extension to the C89 standard. This extension is slightly different from the `long long` support that is part of the C99 standard.

Example

1. To compile `myprogram.c` so that `long long` integers are not allowed, enter:

   ```
   xlc myprogram.c -qnolonglong
   ```

Related information

- Options that control integer and floating-point processing

-M

Description

Creates an output file that contains targets suitable for inclusion in a description file for the **make** command.

Syntax

```
►►── -M─────────────────────────────────────────────────────────────────►◄
```

Notes

The **-M** option is functionally identical to the **-qmakedep** option.

.d files are not **make** files; .d files must be edited 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:file_name.c
file_name.o:include_file_name
```

Include files are listed according to the search order rules for the `#include` preprocessor directive, described in "Directory search sequence for include files using relative path names" on page 22. 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.

Examples

If you do not specify the **-o** option, the output file generated by the **-M** option is created in the current directory. It has a .d suffix. For example, the command:

```
xlc -M person_years.c
```

produces the output file `person_years.d`.

A .d file is created for every input file with a .c, .C, .cpp, or .i suffix. Also, when compiling C++ programs with the **-+** compiler option in effect, any file suffix is accepted and a .d file produced. Otherwise, output .d files are not created for any other files.

For example, the command:

```
xlc -M conversion.c filter.c /lib/libm.a
```

produces two output files, `conversion.d` and `filter.d`, and an executable file as well. No .d file is created for the library.

If the current directory is not writable, no .d file is created. If you specify **-o** *file_name* along with **-M**, the .d file is placed in the directory implied by **-o** *file_name*. For example, for the following invocation:

```
xlc -M -c t.c -o /tmp/t.o
```

places the .d output file in `/tmp/t.d`.

Related information
- "-qmakedep" on page 142
- -MF
- "-+ (plus sign)" on page 42
- "-o" on page 151
- "-qsourcetype" on page 178
- "Directory search sequence for include files using relative path names" on page 22
- Options that control output: Options for file output

-ma

▶ C

Description

Substitutes inline code for calls to built-in function `alloca`.

Syntax

```
▶▶── -ma──────────────────────────────────────────────────────────▶◀
```

Notes

If **#pragma alloca** is unspecified, or if you do not use **-ma**, `alloca` is treated as a user-defined identifier rather than as a built-in function.

This option does not apply to C++ programs. In C++ programs, you must include the header `malloc.h` to include the `alloca` function declaration.

Example

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

```
xlc myprogram.c -ma
```

Related information
- "-qalloca" on page 48
- "#pragma alloca" on page 218
- Options that control output: Other output options

-MF

Description

Specifies the target for the output generated by the **-qmakedep** or **-M** option.

Syntax

```
▶▶── -MF──file──────────────────────────────────────────────────────▶◀
```

file is the target output path which can be a file or directory.

Example

Table 38.

Command line	Generated dependency file
xlc -c -qmakedep mysource.c	mysource.d
xlc -c -qmakedep foo_src.c -MF mysource.d	mysource.d
xlc -c -qmakedep foo_src.c -MF ../deps/mysource.d	../deps/mysource.d
xlc -c -qmakedep foo_src.c -MF /tmp/mysource.d	/tmp/mysource.d
xlc -c -qmakedep foo_src.c -o foo_obj.o	foo_obj.d
xlc -c -qmakedep foo_src.c -o foo_obj.o -MF mysource.d	mysource.d
xlc -c -qmakedep foo_src.c -MF mysource1.d -MF mysource2.d	mysource2.d
xlc -c -qmakedep foo_src1.c foo_src2.c -MF mysource.d	mysource.d (It contains rules for foo_src2.d source file)
xlc -c -qmakedep foo_src1.c foo_src2.c -MF /tmp	/tmp/foo_src1.d /tmp/foo_src2.d

Notes

-MF has effect only if specified with either the **-qmakedep** or the **-M** option.

If *file* is the name of a directory, the dependency file generated by the compiler will be placed into the specified directory, otherwise if you do not specify any path for *file* , the dependency file will be stored in the current working directory.

If the file specified by **-MF** option already exists, it will be overwritten.

If you specify **-MF** option when compiling multiple source files, only a single dependency file will be generated and it will contain the **make** rule for the last file specified on the command line.

Related information

- "-M" on page 140
- "-qmakedep"
- "-o" on page 151
- "Directory search sequence for include files using relative path names" on page 22
- Options that control output: Options for file output

-qmakedep

Description

Creates an output file that contains targets suitable for inclusion in a description file for the **make** command to describe the dependencies of the main source file in the compilation. If the **gcc** suboption is specified, the description file includes a single target listing all dependencies. Otherwise, there is a separate rule for each dependency in the description file.

Syntax

```
►►──-q──makedep──┬───────┬──────────────────────────────────────────────►◄
                 └─=──gcc─┘
```

The **gcc** suboption controls the format of the generated **make** rule to match the GNU C/C++ format.

Notes

If you specify an invalid suboption , a warning message will be issued and the option is ignored.

Specifying **-qmakedep** without any suboption is functionally equivalent to specifying **-M** option.

.d files are not **make** files; .d files must be edited before they can be used with the **make** command. For more information on this command, see your operating system documentation.

If you do not specify the **-o** option, the output file generated by the **-qmakedep** option is created in the current directory. It has a .d suffix. For example, the command:

```
xlc++ -qmakedep person_years.C
```

produces the output file `person_years.d`.

A .d file is created for every input file with a .c, .C, .cpp, or .i suffix. Also, when compiling C++ programs with the **-+** compiler option in effect, any file suffix is accepted and a .d file produced. Otherwise, output .d files are not created for any other files.

For example, the command:

```
xlc++ -qmakedep conversion.C filter.C /lib/libm.a
```

produces two output files, `conversion.d` and `filter.d` (and an executable file as well). No .d file is created for the library.

If the current directory is not writable, no .d file is created. If you specify **-o** *file_name* along with **-qmakedep**, the .d file is placed in the directory implied by **-o***file_name*. For example, the following invocation:

```
xlc++ -qmakedep -c t.C -o /tmp/t.o
```

places the .d output file in `/tmp/t.d`.

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.C
```

Include files are listed according to the search order rules for the `#include` preprocessor directive, described in "Directory search sequence for include files using relative path names" on page 22. 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.

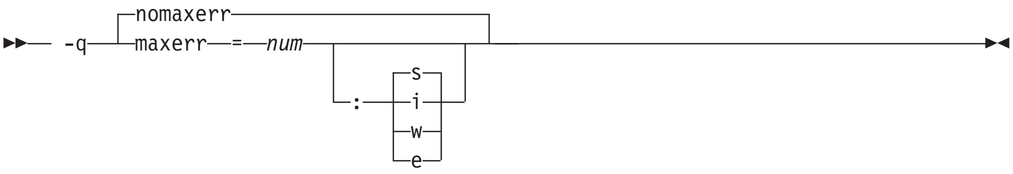
Related information
- "-M" on page 140
- "-MF" on page 141
- "-o" on page 151
- "Directory search sequence for include files using relative path names" on page 22
- Options that control output: Options for file output

-qmaxerr

Description

Instructs the compiler to halt compilation when *num* errors of a specified severity level or higher is reached.

Syntax



where *num* must be an integer. Choices for severity level can be one of the following:

sev_level	**Description**
`i`	Informational
`w`	Warning
`e`	Error (C only)
`s`	Severe error

Notes

If a severity level is not specified, the current value of the **-qhalt** option is used.

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.

An unrecoverable error occurs when the number of errors reached the limit specified. The error message issued is similar to:

```
1506-672 (U) The number of errors has reached the limit of ...
```

If **-qnomaxerr** is specified, the entire source file is compiled regardless of how many errors are encountered.

Diagnostic messages may be controlled by the **-qflag** option.

Examples

1. To stop compilation of `myprogram.c` when 10 warnings are encountered, enter the command:
   ```
   xlc myprogram.c -qmaxerr=10:w
   ```
2. 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:
   ```
   xlc myprogram.c -qmaxerr=5
   ```
3. To stop compilation of `myprogram.c` when 3 informational messages are encountered, enter the command:
   ```
   xlc myprogram.c -qmaxerr=3:i
   ```

   or:
   ```
   xlc myprogram.c -qmaxerr=3 -qhalt=i
   ```

Related information
- “-qflag” on page 82
- “-qhalt” on page 93
- “Message severity levels and compiler response” on page 26
- Options for error checking and debugging: Options for error checking

-qmaxmem

Description

Limits the amount of memory used by the optimizer for local tables of specific, memory-intensive optimizations. The memory size limit is specified in kilobytes.

Syntax

```
►►── -q──maxmem──=──size──────────────────────────────────────────────►◄
```

Defaults

- With -O2 optimization in effect, maxmem=8192.
- With -O3 or greater optimization in effect, maxmem=-1.

Notes

- A *size* value of -1 permits each optimization to take as much memory as it needs without checking for limits. Depending on the source file being compiled, the size of subprograms in the source, the machine configuration, and the workload on the system, this might exceed available system resources.
- The limit set by **-qmaxmem** 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.
- Setting a large limit has no negative effect on the compilation of source files when the compiler needs less memory.
- Limiting the scope of optimization 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.

Depending on the source file being compiled, the size of the subprograms in the source, the machine configuration, and the workload on the system, setting the limit too high might lead to page-space exhaustion. In particular, specifying **-qmaxmem=-1** allows the compiler to try and use an infinite amount of storage, which in the worst case can exhaust the resources of even the most well-equipped machine.

Example

To compile `myprogram.C` so that the memory specified for local table is 16384 kilobytes, enter:

```
xlc++ myprogram.C -qmaxmem=16384
```

Related information

- Options for customizing the compiler: Options for general customization

-qmbcs, -qdbcs

Description

Use the **-qmbcs** option if your program contains multibyte characters. The **-qmbcs** option is equivalent to **-qdbcs**.

Syntax

```
        ┌─nombcs─┐
►►── -q─┼─mbcs───┼──────────────────────────────────────────────────►◄
        ├─nodbcs─┤
        └─dbcs───┘
```

See also “#pragma options” on page 248.

Notes

Multibyte characters are used in certain languages such as Chinese, Japanese, and Korean.

Multibyte characters are also permitted in comments, if you specify the **-qmbcs** or **-qdbcs** compiler option.

If a source file contains multibyte character literals and the default **-qnombcs** or **-qnodbcs** compiler option is in effect, the compiler will treat all literals as single-byte literals.

Example

To compile `myprogram.c` if it contains multibyte characters, enter:

```
xlc myprogram.c -qmbcs
```

Related information

- Options that control input: Other input options

-qminimaltoc

Description

Avoids toc overflow conditions in 64-bit compilations by placing toc entries into a separate data section for each object file.

Syntax

```
          ┌─nominimaltoc─┐
►►── -q───┴─minimaltoc───┴──────────────────────────────────────────►◄
```

Notes

This compiler option applies to 64-bit compilations only.

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. You can avoid such toc overflow errors by compiling with the **-qminimaltoc** option.

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.

Related information

- Options for performance optimization: Options for ABI performance tuning

-qmkshrobj

Description

Creates a shared object from generated object files.

Syntax

```
►►── -q──mkshrobj───────────────────────────────────────────────────►◄
```

Notes

This option, together with the related options described below is used to create a shared object. The advantage of using this option is that the compiler automatically includes and compiles template instantiations in the tempinc directory.

Specifying **-qmkshrobj** implies **-qpic**.

Also, the following related options can be used with the **-qmkshrobj** compiler option:

-o *shared_file* Is 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*. The default is **-enoentry**.

If you use **-qmkshrobj** to create a shared library, the compiler and linkage editor are called with the appropriate options to build a shared object.

Example

To construct the shared library `big_lib.o` from three smaller object files, type:

```
xlc -qmkshrobj -o big_lib.o lib_a.o lib_b.o lib_c.o
```

Related information

- “-qpriority” on page 161
- “#pragma priority” on page 255

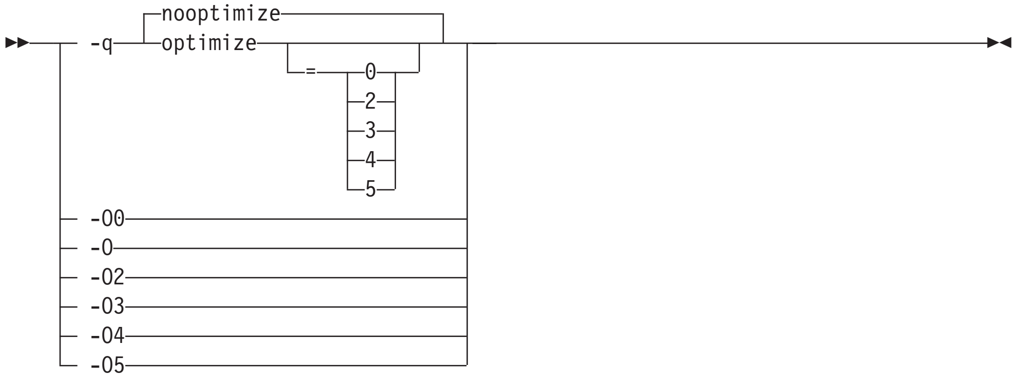
- “-qpic” on page 159
- Options that control linking: Options for linker output control
- "Constructing a library" in the *XL C/C++ Programming Guide*

-O, -qoptimize

Description

Specifies whether to optimize code during compilation, and if so, specifies the optimization level.

Syntax



where optimization settings are:

-O0 -qnooptimize -qoptimize=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 -qoptimize	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**.
-O2 -qoptimize=2	Same as **-O**.
-O3 -qoptimize=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**.

-O3
-qoptimize=3
(*continued*)

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. Starting from version 8.0 of XL C/C++, specifying **-O3** implies **-qhot=level=0**, unless you explicitly specify **-qhot** or **-qhot=level=1** option.

-O3, -qoptimize=3 (*continued*)	Notes • **-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**. • The default **-qmaxmem** value is **-1** at **-O3**. • Refer to "-qflttrap" on page 86 to see the behavior of the compiler when you specify **optimize** options with the **-qflttrap** 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 -qoptimize=4	This option is the same as **-O3**, except that it also: • Sets the **-qarch** and **-qtune** options to the architecture of the compiling machine • Sets the **-qcache** option most appropriate to the characteristics of the compiling machine • 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 -qoptimize=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.

Notes

You can abbreviate **-qoptimize...** to **-qopt...**. For example, **-qnoopt** is equivalent to **-qnooptimize**.

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.

Example

To compile and optimize `myprogram.C`, enter:

```
xlc++ myprogram.C -O3
```

Related information

- Options for performance optimization: Options for defined optimization levels
- "Optimizing your applications" in the *XL C/C++ Programming Guide*.

-o

Description

Specifies an output location for the object, assembler, or executable files created by the compiler. When the **-o** option is used during compiler invocation, *filespec* can be the name of either a file or a directory. When the **-o** option is used during direct linkage-editor invocation, *filespec* can only be the name of a file.

Syntax

```
►►— -o— filespec——————————————————————————————————————————————►◄
```

Notes

When **-o** is specified as part of a compiler invocation, *filespec* can be the relative or absolute path name of either a directory or a file.

1. If *filespec* is the name of a directory, files created by the compiler are placed into that directory.
2. If a directory with the name *filespec* does not exist, the **-o** option specifies that the name of the file produced by the compiler will be *filespec*. For example, the compiler invocation:

   ```
   xlc test.c -c -o new.o
   ```

   produces the object file `new.o` instead of `test.o` , and

   ```
   xlc test.c -o new
   ```

   produces the object file `new` instead of `a.out`, provided there is no directory also named `new`. Otherwise, the default object name `a.out` is used and placed in the `new` directory.

   A *filespec* with a C or C++ source file suffix (.C, .c, .cpp, or .i), such as `myprog.c` or `myprog.i`, results in an error and neither the compiler nor the linkage editor is invoked.

   If you use **-c** and **-o** together and the *filespec* does not specify a 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***filename* option.

Example

To compile `myprogram.c` so that the resulting file is called `myaccount`, assuming that no directory with name `myaccount` exists, enter:

```
xlc myprogram.c -o myaccount
```

If the directory `myaccount` does exist, the compiler produces the executable file `a.out` and places it in the `myaccount` directory.

Related information
- "-c" on page 57
- "-E" on page 75
- "-P"
- "-qsyntaxonly" on page 186
- Options that control output: Options for file output

-P

Description

Preprocesses the C or C++ source files named in the compiler invocation and creates an output preprocessed source file, *file_name*.i for each input source file *file_name*.c, *file_name*.C, or *file_name*.cpp. The default is to compile and link-edit C or C++ source files to produce an executable file.

Syntax

```
►►— -P——————————————————————————————————————————————————►◄
```

Notes

The **-P** option calls the preprocessor directly.

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.

#line directives are not issued.

The **-P** option cannot accept a preprocessed source file, such as *file_name***.i** as input. The compiler will issue an error message.

Source files with unrecognized file name suffixes are treated and preprocessed as C files, and no error message is generated.

In extended mode, the preprocessor interprets the backslash character when it is followed by a new-line character as line-continuation in:
- macro replacement text
- macro arguments
- comments that are on the same line as a preprocessor directive.

Line continuations elsewhere are processed in **ANSI** mode only.

The **-P** option is overridden by the **-E** option. The **-P** option overrides the **-c**, **-o,** and **-qsyntaxonly** option. The **-C** option may used in conjunction with both the **-E** and **-P** options.

Related information
- "-C" on page 56
- "-c" on page 57
- "-E" on page 75
- "-o" on page 151

- "-qsyntaxonly" on page 186
- Options that control output: Options for file output

-p

Description

Sets up the object files produced by the compiler for profiling.

Syntax

```
►►── -p──────────────────────────────────────────────────────────────►◄
```

Notes

If the **-qtbtable** option is not set, the **-p** option will generate full traceback tables.

When compiling and linking in separate steps, the **-p** option must be specified in both steps.

Example

To compile `myprogram.c` so that it can be used with your operating system's **gprof** command, enter:

```
xlc++ myprogram.C -p
```

Related information

- "-qtbtable" on page 188
- Options for error checking and debugging: Options for profiling

-qpath

Description

Constructs alternate program names for compiler components. The program and directory *path* specified by this option is used in place of the regular compiler component or program.

Syntax

```
►►── -q──path──=──┬─c─┬──:──path─────────────────────────────────────►◄
                  ├─b─┤
                  ├─p─┤
                  ├─a─┤
                  ├─I─┤
                  ├─L─┤
                  └─l─┘
```

where the available compiler component and program names are:

Program	Description
c	Compiler front end
b	Compiler back end
p	Compiler preprocessor
a	Assembler
I	Interprocedural analysis - compile phase
L	Interprocedural analysis - link phase
l	Linkage editor

Notes

The **-qpath** option overrides the **-F***config_file*, **-t**, and **-B** options.

Examples

To compile `myprogram.C` using a substitute **xlc++** compiler in `/lib/tmp/mine/` enter:

```
xlc++ myprogram.C -qpath=c:/lib/tmp/mine/
```

To compile `myprogram.C` using a substitute linker in `/lib/tmp/mine/`, enter:

```
xlc++ myprogram.C -qpath=l:/lib/tmp/mine/
```

Related information

- "-B" on page 55
- "-F" on page 82
- "-t" on page 187
- Options for customizing the compiler: Options for general customization

-qpdf1, -qpdf2

Description

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.

Syntax

```
             ┌─nopdf2─┐
             ├─nopdf1─┤
►►─ -q──────┼─pdf1───┼────────────────────────────────────────────►◄
             └─pdf2───┘
```

Notes

To use PDF, follow these steps:

1. Compile some or all of the source files in a program with the **-qpdf1** option. You need to specify at least the **-O2** optimizing option and you also need to link with at least **-O2** in effect. Pay special attention to the compiler options that you use to compile the files, because you will need to use the same options later.

   In a large application, concentrate on those areas of the code that can benefit most from optimization. You do not need to compile all of the application's code with the **-qpdf1** option.
2. Run the program all the way through using a typical data set. The program records profiling information when it finishes. You can run the program multiple times with different data sets, and the profiling information is accumulated to provide an accurate count of how often branches are taken and blocks of code are executed.

   Important: Use data that is representative of the data that will be used during a normal run of your finished program.
3. Relink your program using the same compiler options as before, but change **-qpdf1** to **-qpdf2**. Remember that **-L**, **-l**, and some others are linker options, and you can change them at this point. In this second compilation, the accumulated profiling information is used to fine-tune the optimizations. The resulting program contains no profiling overhead and runs at full speed.

As an intermediate step, you can use **-qpdf2** to link the object files created by the **-qpdf1** pass without recompiling the source on the **-qpdf2** pass. This can save considerable time and help fine tune large applications for optimization. You can create and test different flavors of PDF optimized binaries by using different options on the **-qpdf2** pass.

For best performance, use the **-O3**, **-O4**, or **-O5** option with all compilations when you use PDF.

The profile is placed in the current working directory or in the directory that the PDFDIR environment variable names, if that variable is set.

To avoid wasting compilation and execution time, make sure that the PDFDIR environment variable is set to an absolute path. Otherwise, you might run the application from the wrong directory, and it will not be able to locate the profile data files. When that happens, the program may not be optimized correctly or may be stopped by a segmentation fault. A segmentation fault might also happen if you change the value of the PDFDIR variable and execute the application before finishing the PDF process.

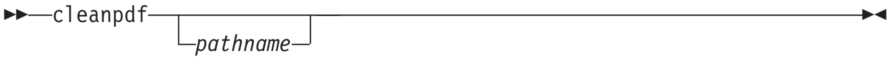
Because this option requires compiling the entire application twice, it is intended to be used after other debugging and tuning is finished, as one of the last steps before putting the application into production.

Restrictions

- PDF optimizations require at least the **-O2** optimization level.
- You must compile the main program with PDF for profiling information to be collected at run time.
- Do not compile or run two different applications that use the same PDFDIR directory at the same time, unless you have used the **-qipa=pdfname** suboption to distinguish the sets of profiling information.
- You must use the same set of compiler options at all compilation steps for a particular program. Otherwise, PDF cannot optimize your program correctly and may even slow it down. All compiler settings must be the same, including any supplied by configuration files.
- Avoid mixing PDF files created by the current version level of XL C/C++ with PDF files created by other version levels of the compiler.
- If **-qipa** is not invoked either directly or through other options, **-qpdf1** and **-qpdf2** will invoke the **-qipa=level=0** option.
- If you compile a program with **-qpdf1**, remember that it will generate profiling information when it runs, which involves some performance overhead. This overhead goes away when you recompile with **-qpdf2** or with no PDF at all.

The following utility programs, found in `/opt/ibmcmp/vacpp/8.0/bin/`, are available for managing the PDFDIR directory:

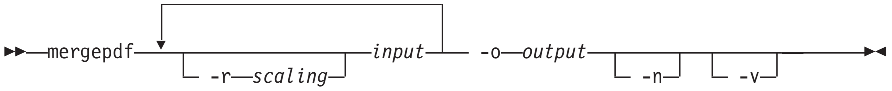
cleanpdf



Removes all profiling information from the *pathname* directory; or if *pathname* is not specified, from the PDFDIR directory; 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**.

mergepdf



Merges two or more PDF records into a single PDF output record.

-r *scaling*
: Specifies the scaling ratio for the PDF record file. This value must be greater than zero and can be either an integer or floating point value. If not specified, a ratio of 1.0 is assumed.

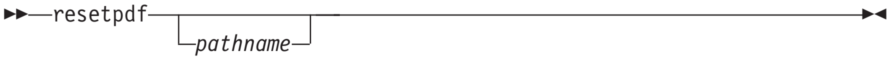
input
: Specifies the name of a PDF input record file, or a directory that contains PDF record files.

-o *output*
: Specifies the name of the PDF output record file, or a directory to which the merged output will be written.

-n
: If specified, PDF record files are not normalized. If not specified, **mergepdf** normalizes records based on an internally-calculated ratio before applying any user-defined scaling factor.

-v
: Specifies verbose mode, and causes internal and user-specified scaling ratios to be displayed to the screen.

resetpdf



Same as **cleanpdf**, described above.

showpdf

Displays the call and block counts for all procedures executed in a program run. To use this command, you must first compile your application specifying both **-qpdf1** and **-qshowpdf** compiler options on the command line.

Examples

Here is a simple example:

```
/* Set the PDFDIR variable.                    */
export PDFDIR=$HOME/project_dir

/* Compile all files with -qpdf1.              */
xlc++ -qpdf1 -O3 file1.C file2.C file3.C

/* Run with one set of input data.             */
a.out <sample.data
```

```
/* Recompile all files with -qpdf2.             */
xlc++ -qpdf2 -O3 file1.C file2.C file3.C

/* The program should now run faster than
   without PDF if the sample data is typical.   */
```

Here is a more elaborate example.

```
/* Set the PDFDIR variable.                     */
export PDFDIR=$HOME/project_dir

/* Compile most of the files with -qpdf1.       */
xlc++ -qpdf1 -O3 -c file1.C file2.C file3.C

/* This file is not so important to optimize.
xlc++ -c file4.C

/* Non-PDF object files such as file4.o can be linked in.  */
xlc++ -qpdf1 -O3 file1.o file2.o file3.o file4.o

/* Run several times with different input data.            */
a.out <polar_orbit.data
a.out <elliptical_orbit.data
a.out <geosynchronous_orbit.data

/* No need to recompile the source of non-PDF object files (file4.C). */
xlc++ -qpdf2 -O3 file1.C file2.C file3.C

/* Link all the object files into the final application.   */
xlc++ -qpdf2 -O3 file1.o file2.o file3.o file4.o
```

Here is an example of using **-qpdf1** and **-qpdf2** objects.

```
/* Set the PDFDIR variable.                     */
export PDFDIR=$HOME/project_dir

/* Compile source with -qpdf1.                  */
xlc++ -c -qpdf1 -O3 file1.C file2.C

/* Link in object files.                        */
xlc++ -qpdf1 -O3 file1.o file2.o

/*  Run with one set of input data.             */
 a.out < sample.data

/* Link in the mix of pdf1 and pdf2 objects.    */
xlc++ -qpdf2 -O3 file1.o file2.o
```

Related information

- “-qshowpdf” on page 174
- “-qipa” on page 106
- Options for performance optimization: Options for performance data allocation

-pg

Description

Sets up the object files for profiling.

If the **-qtbtable** option is not set, the **-pg** option will generate full traceback tables.

Syntax

```
►►── -pg──────────────────────────────────────────────────────────────►◄
```

Example

To compile `myprogram.c` for use with your operating system's **gprof** command, enter:

```
xlc myprogram.c -pg
```

Remember to compile *and* link with the **-pg** option. For example:

```
xlc myprogram.c -pg -c
xlc myprogram.o -pg -o program
```

Related information

- "-qtbtable" on page 188
- Options for error checking and debugging: Options for profiling

-qphsinfo

Description

Reports the time taken in each compilation phase. Phase information is sent to standard output.

Syntax

```
            ┌─nophsinfo─┐
►►── -q─────┴─phsinfo───┴─────────────────────────────────────────────►◄
```

Notes

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.

Example

To compile `myprogram.C` and report the time taken for each phase of the compilation, enter:

```
xlc++ 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
```

Related information

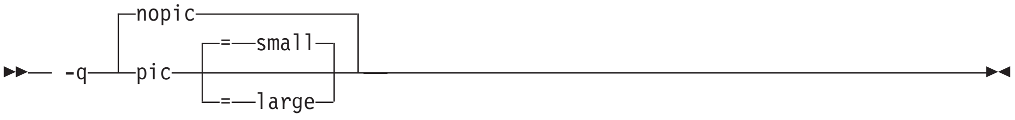
- Options that control listings and messages: Options for messages

-qpic

Description

Instructs the compiler to generate Position-Independent Code suitable for use in shared libraries.

Syntax



where

nopic Instructs the compiler to not generate Position Independant Code.

pic Instructs the compiler to generate Position Independant Code.

small Instructs the compiler to assume that the size of the Global Offset Table 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**.

Notes

If **-qpic** is specified without any suboptions, **-qpic=small** is assumed.

The **-qpic** option is implied if the **-qmkshrobj** compiler option is specified.

Specifying **-q64** automatically implies **-qpic**.

Example

To compile a shared library **libmylib.so**, use the following command:

```
xlc mylib.c -qpic -Wl, -shared, -soname="libmylib.so.1" -o libmylib.so.1
```

Refer to the **ld** command in your operating system documentation for more information about the **-shared** and **-soname** options.

Related information

- “-q32, -q64” on page 44
- “-qmkshrobj” on page 147
- Options that control output: Options that control the characteristics of the object code

-qppline

Description

Enables generation of `#line` directives in the preprocessed output.

Syntax

```
        ┌─ppline───┐
►►── -q─┴─noppline─┴───────────────────────────────────────────────►◄
```

Notes

If the **-P** option is used, the default is **-qnoppline**

This option overrides the behavior of the **-E** and **-P** option.

Example

To compile `myprogram.C` using **-qppline** option, enter:

```
xlc++ myprogram.C -qppline
```

Related information

- Options that control output: Options for file output

-qprefetch

Description

Enables generation of prefetching instructions such as dcbt and dcbz in compiled code.

Syntax

```
        ┌─prefetch───┐
►►── -q─┴─noprefetch─┴─────────────────────────────────────────────►◄
```

Notes

By default, the compiler may insert prefetch instructions in compiled code. The **-qnoprefetch** option lets you disable this feature.

The **-qnoprefetch** option will not prevent built-in functions such as `__prefetch_by_stream()` from generating prefetch instructions.

Related information

- Options for performance optimization: Options that restrict optimization

-qprint

Description

Enables or suppresses listings. Specifying **-qnoprint** overrides all listing-producing options, regardless of where they are specified, to suppress listings.

Syntax

```
        ┌─print───┐
►►── -q─┴─noprint─┴────────────────────────────────────────────────►◄
```

Notes

The default of **-qprint** enables listings if they are requested by other compiler options. These options are:

- -qattr
- -qlist

- -qlistopt
- -qsource
- -qxref

Example

To compile myprogram.C and suppress all listings, even if some files have **#pragma options source** and similar directives, enter:

```
xlc myprogram.c -qnoprint
```

Related information

- Options that control listings and messages: Options for listing

-qpriority

▶ C++

Description

Specifies the priority level for the initialization of static objects.

Syntax

```
►►── -q──priority──=──number──────────────────────────────────────────►◄
```

where

number Is the initialization priority level assigned to the static objects within a file, or the priority level of a shared or non-shared file or library.

You can specify a priority level from 101 (highest priority) to 65535 (lowest priority).

If not specified, the default priority level is 65535.

See also “#pragma priority” on page 255 and “#pragma options” on page 248.

Example

To compile the file myprogram.C to produce an object file myprogram.o so that objects within that file have an initialization priority of 2000, enter:

```
 xlc++ myprogram.C -c -qpriority=2000
```

All objects in the resulting object file will be given an initialization priority of 2000, provided that the source file contains no **#pragma priority(***number***)** directives specifying a different priority level.

Related information

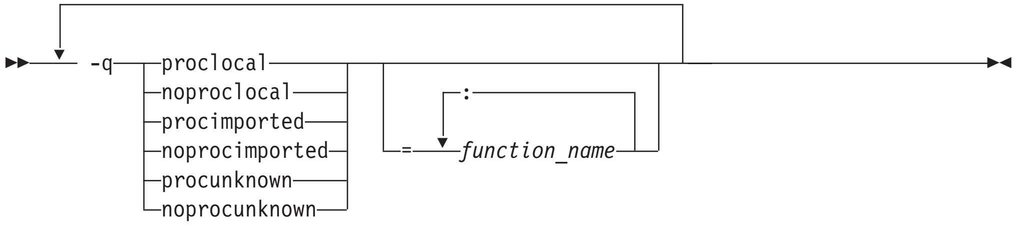
- Options that control linking: Other linker options

-qproclocal, -qprocimported, -qprocunknown

Description

Marks functions as local, imported, or unknown in 64-bit compilations.

Syntax



See also “#pragma options” on page 248.

Default

The default is to assume that all functions whose definition is in the current compilation unit are local **proclocal**, and that all other functions are unknown **procunknown**. If any functions that are marked as local resolve to shared library functions, the linkage editor will detect the error and issue warnings.

Notes

This compiler option applies to 64-bit compilations only.

Available suboptions are:

Local functions
: Local functions are statically bound with the functions that call them. Specifying **-qproclocal** changes the default to assume that all functions are local. **-qproclocal=***names* marks the named functions as local, where *names* is a list of function identifiers separated by colons (**:**). The default is not changed.

Smaller, faster code is generated for calls to functions marked as local.

Imported functions
: Imported functions are dynamically bound with a shared portion of a library. **-qprocimported** changes the default to assume that all functions are imported. Specifying **-qprocimported=***names* marks the named functions as imported, where *names* is a list of function identifiers separated by colons (**:**). The default is not changed.

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. If marked functions resolve to statically bound objects, the generated code may be larger and run more slowly than the default code sequence generated for unknown functions.

Unknown functions
: Unknown functions are resolved to either statically or dynamically bound objects during link-editing. Specifying **-qprocunknown** changes the default to assume that all functions are unknown. **-qprocunknown=***names* marks the named functions as unknown, where *names* is a list of function identifiers separated by colons (**:**). The default is not changed.

▶ C++ In C++ programs, function *names* must be specified using their mangled names.

Conflicts among the procedure-marking options are resolved in the following manner:

Options that list function names	The last explicit specification for a particular function name is used.
Options that change the default	This form does not specify a name list. The last option specified is the default for functions not explicitly listed in the name-list form.

Examples

1. 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**, and,
   - function `venus` is specified as **unknown**,

   enter:

   ```
   xlc++ myprogram.c oldprogs.a -qprolocal=fun(int):sun()
     -qprocimported=moon():stars(float) -qprocunknown=venus()
   ```
2. The following example shows typical error messages that result when a function marked as local instead resolves to a shared library function.

   ```
   int main(void)
   {
       printf("Just in function foo1()\n");
       printf("Just in function foo1()\n");
   }
   ```

   Compiling this source code with `xlc -q64 -qproclocal -O -qlist t.c` gives results similar to the following:

   ```
   /usr/lib64: t.o(.text+0x10): unresolvable relocation \
     against symbol `.printf@@GLIBC_2.2.5'
       t.o: In function .main':
       t.o(.text+0x10): relocation truncated to fit: R_PPC64_REL24 .printf@@GLIBC_2.2.5
   /usr/lib64: t.o(.text+0x18): unresolvable relocation \
     against symbol `.printf@@GLIBC_2.2.5'
       t.o(.text+0x18): relocation truncated to fit: R_PPC64_REL24 .printf@@GLIBC_2.2.5
   ```

   An executable file is produced, but it will not run. The error message indicates that a call to `printf` in object file `t.o` caused the problem. When you have confirmed that the called routine should be imported from a shared object, recompile the source file that caused the warning and explicitly mark `printf` as imported. For example:

   ```
   xlc -c -qprocimported=printf t.c
   ```

Related information

- Options for performance optimization: Options for ABI performance tuning

-qproto

▶ C

Description

If this option is set, the compiler assumes that all functions are prototyped.

Syntax

```
             ┌noproto┐
►►── -q──────┴proto──┴──────────────────────────────────────────────►◄
```

Notes

This option asserts that procedure call points agree with their declarations even if the procedure has not been prototyped.

Callers can pass floating-point arguments in floating-point registers only and not in General-Purpose Registers (GPRs). The compiler assumes that the arguments on procedure calls are the same types as the corresponding parameters of the procedure definition.

The compiler will issue warnings for functions that do not have prototypes.

Example

To compile `my_c_program.c` to assume that all functions are prototyped, enter:

```
xlc my_c_program.c -qproto
```

Related information

- Options for error checking and debugging: Other error checking and debugging options

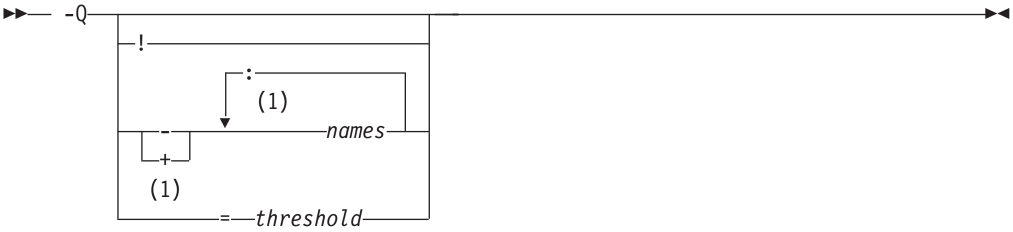
-Q

Description

In C++ language applications, this option instructs the compiler to try to inline functions. Inlining is performed if possible but, depending on which optimizations are performed, some functions might not be inlined.

In C language applications, this option specifies which specific functions the compiler should attempt to inline.

Syntax



Notes:

1 C only

C++ In the C++ language, the following **-Q** options apply:

-Q Compiler inlines all functions that it can.
-Q! Compiler does not inline any functions.

C In the C language, the following **-Q** options apply:

-Q Attempts to inline all appropriate functions with 20 executable source statements or fewer, subject to the setting of any of the suboptions to the **-Q** option. If **-Q** is specified last, all functions are inlined.

-Q! Does not inline any functions. If **-Q!** is specified last, no functions are inlined.

-Q-*names*
: Does not inline functions listed by *names*. Separate each function name in *names* with a colon (**:**). All other appropriate functions are inlined. The option implies **-Q**.

For example:

```
-Q-salary:taxes:expenses:benefits
```

causes all functions except those named `salary`, `taxes`, `expenses`, or `benefits` to be inlined if possible.

A warning message is issued for functions that are not defined in the source file.

-Q+*names*
: Attempts to inline the functions listed by *names* and any other appropriate functions. Each function name in *names* must be separated by a colon (**:**). The option implies **-Q**.

For example,

```
    -Q+food:clothes:vacation
```

causes all functions named`food` , `clothes`, or `vacation` to be inlined if possible, along with any other functions eligible for inlining.

A warning message is issued for functions that are not defined in the source file or that are defined but cannot be inlined.

This suboption overrides any setting of the *threshold* value. You can use a threshold value of zero along with **-Q+***names* to inline specific functions. For example:

```
-Q=0
```

followed by:

```
-Q+salary:taxes:benefits
```

causes *only* the functions named **salary**, **taxes**, or **benefits** to be inlined, if possible, and no others.

-Q=*threshold*
: Sets a size limit on the functions to be inlined. The number of executable statements must be less than or equal to *threshold* for the function to be inlined. *threshold* must be a positive integer. The default value is 20. Specifying a threshold value of **0** causes no functions to be inlined except those functions marked with supported forms of the `inline` function specifier.

The *threshold* value applies to logical C statements. 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 */
  }
}
```

Default

The default is to treat inline specifications as a hint to the compiler. Whether or not inlining occurs may also be dependent on other options that you select:

- If you optimize your programs, (specify the **-O** option) the compiler attempts to inline the functions declared as inline.

Notes

The **-Q** option is functionally equivalent to the **-qinline** option.

If you specify the **-g** option (to generate debug information), inlining may be affected. See the information for the "-g" on page 90 compiler option.

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.

Normally, application performance is optimized if you request optimization (**-O** option), and compiler performance is optimized if you do not request optimization.

The `inline`, `_inline`, `_Inline`, `__inline__` and `__inline` language keywords override all **-Q** options except **-Q!**. The compiler will try to inline functions marked with these keywords regardless of other **-Q** option settings.

To maximize inlining:

- for C programs, specify optimization (**-O**) and also specify the appropriate **-Q** options for the C language.
- for C++ programs, specify optimization (**-O**) but do not specify the **-Q** option.

Examples

To compile the program `myprogram.c` so that no functions are inlined, enter:

```
xlc myprogram.c -O -Q!
```

To compile the program `my_c_program.c` so that the compiler attempts to inline functions of fewer than 12 lines, enter:

```
xlc my_c_program.c -O -Q=12
```

Related information

- "-g" on page 90
- Options for performance optimization: Options for function inlining

-R

Description

At run time, searches the path directory for shared libraries.

Syntax

```
►►— -R—directory————————————————————————————————————————————►◄
```

Notes

If the **-R***directory* 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**.

Default

The default is to search only the standard directories.

Example

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:

```
xlc++ myprogram.C -lspfiles -R/usr/tmp/old
```

Related information

- Options that control linking: Options for linker input control

-r

Description

Produces a relocatable object. This permits the output file to be produced even though it contains unresolved symbols.

Syntax

```
►►── -r──────────────────────────────────────────────────────────►◄
```

Notes

A file produced with this flag is expected to be used as a file parameter in another call to **xlc++**.

Example

To compile `myprogram.c` and `myprog2.c` into a single object file `mytest.o`, enter:

```
xlc myprogram.c myprog2.c -r -o mytest.o
```

Related information

- Options that control linking: Options for linker output control

-qreport

Description

Instructs the compiler to produce transformation reports that show how program loops are parallelized and/or optimized and also on the procedures that are cloned for the architectures specified by **-qipa=clonearch** compiler option. The transformation reports are included as part of the compiler listing.

Syntax

```
          ┌─noreport─┐
►►── -q───┴─report───┴───────────────────────────────────────────►◄
```

Notes

This option has no effect unless **-qhot** ,**-qsmp** or **-qipa=clonearch** are also in effect.

Specifying **-qreport** together with **-qhot** instructs the compiler to produce a pseudo-C code listing and summary showing how loops are transformed. You can use this information to tune the performance of loops in your program.

Specifying **-qreport** together with **-qsmp** instructs the compiler to also produce a report showing how the program deals with data and automatic parallelization of loops in your program. You can use this information to determine how loops in your program are or are not parallelized.

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.

Example

To compile `myprogram.C` so the compiler listing includes a report showing how loops are optimized, enter:

```
xlc++_r -qhot -O3 -qreport myprogram.C
```

To compile `myprogram.C` so the compiler listing also includes a report showing how parallelized loops are transformed, enter:

```
xlc++_r -qsmp -O3 -qreport myprogram.C
```

Related information
- "-qhot" on page 94
- "-qsmp" on page 175
- Options that control listings and messages: Options for messages

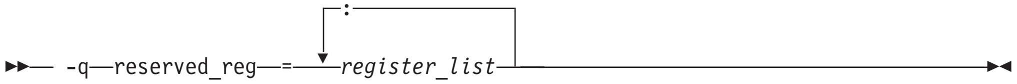
-qreserved_reg

C

Description

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



Notes

You must use valid register names on the target platform; otherwise the compiler issues a warning message. Duplicate register names are ignored silently.

-qreserved_reg is cumulative, for example, specifying `-qreserved_reg=r14` and `-qreserved_reg=r15` is equivalent to specifying `-qreserved_reg=r14:r15`. The valid register names are as follows:
- r0-r31
- f0-f31
- v0-v31

Example

```
xlc myprogram.c -qreserved_reg=r3:r4
```

indicates that r3 and r4 cannot be used in the generated code other than in their fixed role to pass parameters to a function and receive the return value.

Related information
- Options that control output: Options that control the characteristics of the object code
- "Global variables in specified registers" in the *XL C/C++ Language Reference*

-qro

Description

Specifies the storage type for string literals.

Syntax

```
          ┌─ro───┐
▶▶── -q───┴─noro─┴──────────────────────────────────────────▶◀
```

See also "#pragma options" on page 248.

Default

The default for all compiler invocations except **cc** and its derivatives is **-qro**. The default for the **cc** compiler invocation is **-qnoro**.

Notes

If **-qro** is specified, the compiler places string literals in read-only storage. If **-qnoro** is specified, string literals are placed in read/write storage.

You can also specify the storage type in your source program using:

```
#pragma strings storage_type
```

where *storage_type* is **read-only** or **writable**.

Placing string literals in read-only memory can improve runtime performance and save storage, but code that attempts to modify a read-only string literal may generate a memory error.

Example

To compile `myprogram.c` so that the storage type is **writable**, enter:

```
xlc myprogram.c -qnoro
```

Related information
- "#pragma strings" on page 261
- "-qroconst"
- Options that control output: Options that control the placement of strings and constant data

-qroconst

Description

Specifies the storage location for constant values.

Syntax

```
          ┌─roconst───┐
▶▶── -q───┴─noroconst─┴─────────────────────────────────────▶◀
```

See also “#pragma options” on page 248.

Default

The default with **xlc**, **xlC**, and **c89** is **-qroconst**. The default with **cc** is **-qnoroconst**.

Notes

If **-qroconst** is specified, the compiler places constants in read-only storage. If **-qnoroconst** is specified, constant values are placed in read/write storage.

Placing constant values in read-only memory can improve runtime performance, save storage, and provide shared access. Code that attempts to modify a read-only constant value generates a memory error.

Constant value 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 variables do not apply to 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**).

Related information

- “-qro” on page 169
- Options that control output: Options that control the placement of strings and constant data

-qrtti

▶ C++

Description

Use this option to generate runtime type identification (RTTI) information for exception handling and for use by the typeid and dynamic_cast operators.

Syntax

```
          ┌─rtti───┐
►►── -q───┴─nortti─┴─────────────────────────────────────────────►◄
```

where available suboptions are:

rtti The compiler generates the information needed for the RTTI typeid and dynamic_cast operators.

nortti The compiler does not generate RTTI information.

Notes

For best runtime performance, suppress RTTI information generation with the default **-qnortti** setting.

The C++ language offers a (RTTI) mechanism for determining the class of an object at run time. It consists of two operators:

- one for determining the runtime type of an object (typeid), and,
- one for doing type conversions that are checked at run time (dynamic_cast).

A type_info class describes the RTTI available and defines the type returned by the typeid operator.

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.

Related information

- "-qeh" on page 77
- Options that control output: Other output options

-S

Description

Generates an assembler language file (.s) for each source file. The resulting .s files can be assembled to produce object .o files or an executable file (`a.out`).

Syntax

```
►►— -S——————————————————————————————————————————————————————————►◄
```

Notes

You can invoke the assembler with any XL C/C++ invocation command. For example,

```
xlc++ myprogram.s
```

will invoke the assembler, and if successful, the loader 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:

```
xlc++ myprogram1.C myprogram2.C -o -S
```

Examples

1. To compile `myprogram.C` to produce an assembler language file `myprogram.s`, enter:

   ```
   xlc++ myprogram.C -S
   ```

2. To assemble this program to produce an object file `myprogram.o`, enter:

   ```
   xlc++ myprogram.s -c
   ```

3. To compile `myprogram.C` to produce an assembler language file `asmprogram.s`, enter:

   ```
   xlc++ myprogram.C -S -o asmprogram.s
   ```

Related information
- "-E" on page 75
- "-g" on page 90
- "-qipa" on page 106
- "-o" on page 151
- "-P" on page 152
- "-qtbtable" on page 188
- Options that control output: Options for file output

-s

Description

This option strips the symbol table, line number information, and relocation information from the output file. Specifying **-s** saves space, but limits the usefulness of traditional debug programs when you are generating debug information using options such as **-g**.

Syntax

```
►►── -s──────────────────────────────────────────────────────────────────────►◄
```

Notes

Using the strip command has the same effect.

Related information
- "-g" on page 90
- Options that control output: Options for file output

-qsaveopt

Description

Saves the compiler options into an object file.

Syntax

```
          ┌─nosaveopt─┐
►►── -q───┴─saveopt───┴──────────────────────────────────────────────────────►◄
```

Notes

This option lets you save the compiler options into the object file you are compiling. The option has effect only when compiling to an object (.o) file.

The string is saved in the following format:

```
►►──@(#)opt──B───┬─f─┬──B──stanza──B──options──────────────────────────────►◄
                 ├─c─┤
                 └─C─┘
```

where:

B Indicates a space.

f Signifies a Fortran language compilation.

c Signifies a C language compilation.

C Signifies a C++ language compilation.

stanza Specifies the driver used for the compilation, for example, c89 or xlc++.

options The list of command line options specified on the command line, with individual options separated by spaces.

Related information

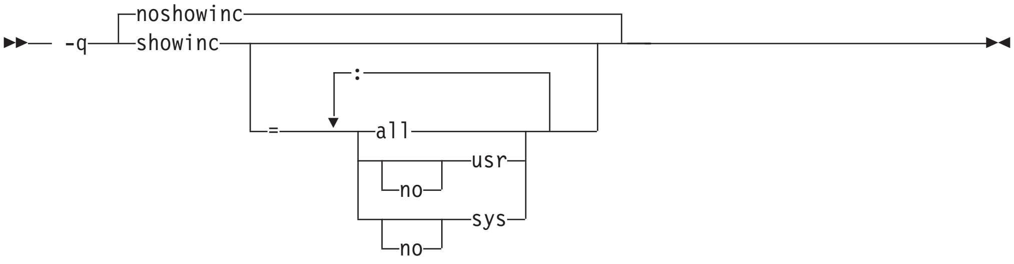
- Options that control output: Other output options

-qshowinc

Description

Used with **-qsource** to selectively show user header files (includes using ″ ″) or system header files (includes using < >) in the program source listing.

Syntax



where options are:

noshowinc Do not show user or system include files in the program source listing. This is the same as specifying **-qshowinc=nousr:nosys**.

showinc Show both user and system include files in the program source listing. This is the same as specifying **-qshowinc=usr:sys** or **-qshowinc=all**.

all Show both user and system include files in the program source listing. This is the same as specifying **-qshowinc** or **-qshowinc=usr:sys**.

usr Show user include files in the program source listing.

sys Show system include files in the program source listing.

See also “#pragma options” on page 248.

Notes

This option has effect only when the **-qlist** or **-qsource** compiler options are in effect.

Example

To compile `myprogram.C` so that all included files appear in the source listing, enter:

```
xlc++ myprogram.C -qsource -qshowinc
```

Related information

- “-qsource” on page 177
- Options that control listings and messages: Options for listing

-qshowpdf

Description

Used with **-qpdf1** and a minimum optimization level of **-O** to add additional call and block count profiling information to an executable.

Syntax

```
               ┌─noshowpdf─┐
►►── -q────────┴─showpdf───┴──────────────────────────────────────────────►◄
```

Notes

This option has effect only when specified together with the **-qpdf1** compiler option.

When specified with **-qpdf1** and a minimum optimization level of **-O**, the compiler inserts additional profiling information into the compiled application to collect call and block counts for all procedures in the application. Running the compiled application will record the call and block counts to the file ._pdf .

After you run your application with training data, you can retrieve the contents of the ._pdf file with the **showpdf** utility. This utility is described in the **-qpdf** pages.

Example

The example assumes the following source for program file `hello.c`:

```
#include <stdio.h>

void HelloWorld()
{
 printf("Hello World");
}

main()
{
 HelloWorld();
}
```

Compile the source with:

```
xlc -qpdf1 -O -qshowpdf hello.c
```

Run the resulting program executable:

```
a.out
```

Run the **showpdf** utility to display the call and block counts for the executable:

```
showpdf
```

Something similar to the following will be returned by the **showpdf** utility:

```
HelloWorld(4):  1 (hello.c)

Call Counters:
  5 | 1  printf(6)

Call coverage = 100% ( 1/1 )

Block Counters:
  3-5 | 1
  6 |
  6 | 1
```

```
Block coverage = 100% ( 2/2 )


-----------------------------------
main(5):  1 (hello.c)

Call Counters:
  10 | 1  HelloWorld(4)

Call coverage = 100% ( 1/1 )

Block Counters:
  8-11 | 1
  11 |

Block coverage = 100% ( 1/1 )

Total Call coverage = 100% ( 2/2 )
Total Block coverage = 100% ( 3/3 )
```

Related information

- "-qpdf1, -qpdf2" on page 154
- Options for performance optimization: Options for performance data allocation

-qsmallstack

Description

Instructs the compiler to reduce the size of the stack frame.

Syntax

```
            ┌─nosmallstack─┐
►►── -q─────┴─smallstack───┴──────────────────────────────────────────►◄
```

Notes

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.

Example

To compile `myprogram.c` to use a small stack frame, enter:

```
xlc myprogram.c -qipa -qsmallstack
```

Related information

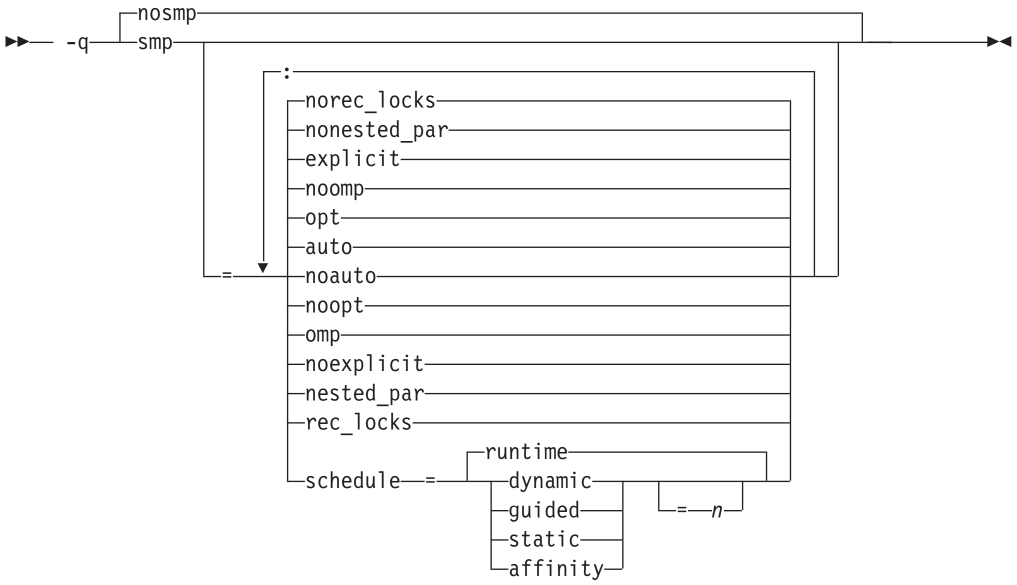
- "-g" on page 90
- "-qipa" on page 106
- Options for performance optimization: Options that restrict optimization

-qsmp

Description

Enables parallelization of program code.

Syntax



where:

auto
Enables automatic parallelization and optimization of program code.

noauto
Disables automatic parallelization of program code. Program code explicitly parallelized with OpenMP pragma statements is optimized.

opt
Enables automatic parallelization and optimization of program code.

noopt
Enables automatic parallelization, but disables optimization of parallelized program code. Use this setting when debugging parallelized program code.

omp
Enables strict compliance to the OpenMP standard. Automatic parallelization is disabled. Parallelized program code is optimized. Only OpenMP parallelization pragmas are recognized.

noomp
Enables automatic parallelization and optimization of program code.

explicit
Enables pragmas controlling explicit parallelization of loops.

noexplicit
Disables pragmas controlling explicit parallelization of loops.

nested_par
If specified, nested parallel constructs are not serialized. **nested_par** does not provide true nested parallelism because it does not cause new team of threads to be created for nested parallel regions. Instead, threads that are currently available are re-used.

This option should be used with caution. Depending on the number of threads available and the amount of work in an outer loop, inner loops could be executed sequentially even if this option is in effect. Parallelization overhead may not necessarily be offset by program performance gains.

nonested_par
Disables parallization of nested parallel constructs.

rec_locks
If specified, recursive locks are used, and nested critical sections will not cause a deadlock.

norec_locks
If specified, recursive locks are not used.

schedule=*sched_type*[=*n*]

Specifies what kind of scheduling algorithms and chunk size (*n*) are used for loops to which no other scheduling algorithm has been explicitly assigned in the source code. If *sched_type* is not specified, **schedule=runtime** is assumed for the default setting.

Notes

- **-qsmp** must be used only with thread-safe compiler mode invocations such as **xlc_r**. These invocations ensure that the **Pthreads**, **xlsmp**, and thread-safe versions of all default runtime libraries are linked to the resulting executable.
- The **-qnosmp** default option setting specifies that no code should be generated for parallelization directives, though syntax checking will still be performed. Use **-qignprag=omp** to completely ignore parallelization directives.
- Specifying **-qsmp** without suboptions is equivalent to specifying **-qsmp=auto:explicit:noomp:norec_locks:nonested_par:schedule=runtime** or **-qsmp=opt:explicit:noomp:norec_locks:nonested_par:schedule=runtime**.
- Specifying **-qsmp** implicitly sets **-O2**. The **-qsmp** option overrides **-qnooptimize**, but does not override **-O3**, **-O4**, or **-O5**. When debugging parallelized program code, you can disable optimization in parallelized program code by specifying **qsmp=noopt**.
- Specifying **-qsmp** implies **-qhot=level=1** is in effect.

Related information

- “-O, -qoptimize” on page 148
- “-qthreaded” on page 192
- “Pragma directives for parallel processing” on page 266
- “Built-in functions for parallel processing” on page 298
- Summary of command line options: Optimization flags
- “Summary of OpenMP pragma directives” on page 216

-qsource

Description

Produces a compiler listing and includes source code.

Syntax

```
          ┌─nosource─┐
►►── -q───┴─source───┴──────────────────────────────────────────────►◄
```

See also “#pragma options” on page 248.

Notes

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

Parts of the source can be selectively printed 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.

Examples

To compile `myprogram.C` to produce a compiler listing that includes the source for `myprogram.C`, enter:

```
xlc++ myprogram.C -qsource
```

Do not use the **-qsource** compiler option if you want the compiler listing to show only selected parts of your program source. The following code causes the source found between the **#pragma options source** and **#pragma options nosource** directives to be included in the compiler listing:

```
#pragma options source
   . . .
/* Source code to be included in the compiler listing
   is bracketed by #pragma options directives.
*/
   . . .
#pragma options nosource
```

Related information
- “-qprint” on page 160
- Options that control listings and messages: Options for listing

-qsourcetype

Description

Instructs the compiler to treat all recognized source files as if they are the source type specified by this option, regardless of actual source file name suffix.

Syntax

```
                           ┌default──────────────┐
►►── -q──sourcetype──=──┼c────────────────────┼──────────────────────────────────►◄
                           ├c++──────────────────┤
                           ├assembler────────────┤
                           └assembler-with-cpp───┘
```

where:

Source type	Suffix	Behavior
default	-	The compiler assumes that the programming language of a source file will be implied by its file name suffix.
c	• .c • .i (for preprocessed files)	The compiler compiles all source files following this option as if they are C language source files.
c++	• .C, .cc, .cpp, .cxx • .cp, .c++	The compiler compiles all source files following this option as if they are C++ language source files.
assembler	• .s	The compiler compiles all source files following this option as if they are assembler language source files.
assembler-with-cpp	• .S	The compiler compiles all source files following this option as if they are Assembler language source files that needs preprocessing.

Notes

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, a **.C** suffix normally implies C++ source code, and the compiler will treat them as follows:

`hello.c`	The file is compiled as a C file.
`hello.C`	The file is compiled as a C++ file.

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. This applies whether the file system is case-sensitive or not. However, in a case-insensitive file system, the above two compilations refer to the same physical file. That is, the compiler still recognizes the case difference of the file name argument on the command line and determines the source type accordingly, but will ignore the case when retrieving the file from the file system.

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:

```
xlc 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.

Examples

To treat the source file `hello.C` as being a C language source file, enter:

```
xlc -qsourcetype=c hello.C
```

Related information

- "-+ (plus sign)" on page 42
- Options that control input: Other input options

-qspill

Description

Specifies the register allocation spill area as being *size* bytes.

Syntax

```
                   ┌─512──┐
►►─ -q─spill──=───┴─size─┴──────────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

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.

Example

If you received a warning message when compiling `myprogram.c` and want to compile it specifying a spill area of 900 entries, enter:

```
xlc myprogram.c -qspill=900
```

Related information

- Options for performance optimization: Options that restrict optimization

-qsrcmsg

▶ C

Description

Adds the corresponding source code lines to the diagnostic messages in the `stderr` file.

Syntax

```
            ┌─nosrcmsg─┐
►►── -q──┴─srcmsg───┴────────────────────────────────────►◄
```

See also “#pragma options” on page 248.

Notes

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. Specifying **-qnosrcmsg** suppresses the generation of both the source line and the finger line, and the error message simply shows the file, line and column where the error occurred.

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.

The default (**-qnosrcmsg**) displays concise messages that can be parsed. Instead of giving the source line and pointers for each error, a single line is displayed, showing the name of the source file with the error, the line and character column position of the error, and the message itself.

Example

To compile `myprogram.c` so that the source line is displayed along with the diagnostic message when an error occurs, enter:

```
xlc myprogram.c -qsrcmsg
```

Related information

- Options that control listings and messages: Options for messages

-qstaticinline

▶ C++

Description

This option controls whether inline functions are treated as static or extern. By default, XL C/C++ 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 function appear in different source files.

Syntax

```
          ┌─nostaticinline─┐
►►── -q───┴─staticinline───┴──────────────────────────────────────────────►◄
```

Example

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() {/*...*/};
```

Using the default, **-qnostaticinline**, gives **f** external linkage.

Related information

- Options that control output: Options that control the characteristics of the object code

-qstaticlink

Description

The **-qstaticlink** compiler option controls how shared and non-shared runtime libraries are linked into an application. 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

```
          ┌─nostaticlink─┐
►►── -q───┴─staticlink───┴──┬────────────┬──────────────────────────────►◄
                            └─=──libgcc──┘
```

where

nostaticlink — Instructs the compiler not to link statically with `libgcc.a`

staticlink — Objects generated with this compiler option in effect will link only with static libraries.

libgcc — When this suboption is 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`.

Notes

GNU support for shared and non-shared libraries is controlled by the options shown in the following table.

Table 39. Option mappings: control of the Linux linker

GNU option	Meaning	XL C/C++ option
-shared	Build a shared object.	-qmkshrobj

Table 39. Option mappings: control of the Linux linker (continued)

GNU option	Meaning	XL C/C++ option
-static	Build a static object and prevent linking with shared libraries. Every library linked to must be a static library. Ignore when specified with **-shared**.	-qstaticlink
-shared-libgcc	Use the shared version of `libgcc`. Ignore when specified with **-static**.	-qnostaticlink=libgcc
-static-libgcc	Use the static version of `libgcc`.	-qstaticlink=libgcc

Related information

- Options that control linking: Options for linker output control

-qstatsym

Description

Adds user-defined, nonexternal names that have a persistent storage class, such as initialized and uninitialized static variables, to the name list (the symbol table of objects).

Syntax

```
           ┌─nostatsym─┐
►►── -q────┴─statsym───┴──────────────────────────────────────────►◄
```

Default

The default is to not add static variables to the symbol table. However, static functions are added to the symbol table.

Example

To compile `myprogram.C` so that static symbols are added to the symbol table, enter:

```
xlc++ myprogram.C -qstatsym
```

Related information

- Options that control output: Options that control the characteristics of the object code

-qstdinc

Description

Specifies which directories are used for files included by the **#include** <*file_name*> and **#include** "*file_name*" directives. The **-qnostdinc** option excludes the standard include directories from the search path.

Syntax

```
           ┌─stdinc───┐
►►── -q────┴─nostdinc─┴───────────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

If you specify **-qnostdinc**, the compiler will not search the default search path directories unless you explicitly add them with the **-I***directory* option.

If a full (absolute) path name is specified, this option has no effect on that path name. It will still have an effect on all relative path names.

-qnostdinc is independent of **-qidirfirst**. (**-qidirfirst** searches the directory specified with **-I** *directory* before searching the directory where the current source file resides.

The search order for files is described in “Directory search sequence for include files using relative path names” on page 22.

The last valid **#pragma options [NO]STDINC** remains in effect until replaced by a subsequent **#pragma options [NO]STDINC**.

Example

To compile `myprogram.c` so that the directory `/tmp/myfiles` is searched for a file included in `myprogram.c` with the `#include "myinc.h"` directive, enter:

```
xlc myprogram.c -qnostdinc -I/tmp/myfiles
```

Related information

- “-I” on page 97
- “-qidirfirst” on page 97
- “Directory search sequence for include files using relative path names” on page 22
- Options that control input: Options for search paths

-qstrict

Description

Turns off the aggressive optimizations that have the potential to alter the semantics of your program.

Syntax

```
►►── -q──┬─nostrict─┬──────────────────────────────────────────────────►◄
         └─strict───┘
```

See also “#pragma options” on page 248.

Default

- **-qnostrict** with optimization levels of **-O3** or higher.
- **-qstrict** otherwise.

Notes

-qstrict turns off 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**.

You can use **-qfloat=rsqrt** to override the **-qstrict** settings.

For example:

- Using **-O3 -qnostrict -qfloat=norsqrt** means that the compiler performs all aggressive optimizations except **-qfloat=rsqrt**.

If there is a conflict between the options set with **-qnostrict** and **-qfloat=***options*, the last option specified is recognized.

Example

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:

```
xlc++ myprogram.C -O3 -qstrict -qfloat=rsqrt
```

Related information

- "-qfloat" on page 83
- "-O, -qoptimize" on page 148
- Options for performance optimization: Options that restrict optimization

-qstrict_induction

Description

Disables loop induction variable optimizations that have the potential to alter the semantics of your program. Such optimizations can 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.

Syntax

```
►►── -q─┬─nostrict_induction─┬──────────────────────────────────────►◄
        └─strict_induction───┘
```

Default

- **-qnostrict_induction** with optimization levels 2 or higher.
- **-qstrict_induction** otherwise.

Notes

Specifying **-O2** implies **-qnostrict_induction**. Specifying both is unnecessary.

Use of **-qstrict_induction** is generally not recommended because it can cause considerable performance degradation.

Related information

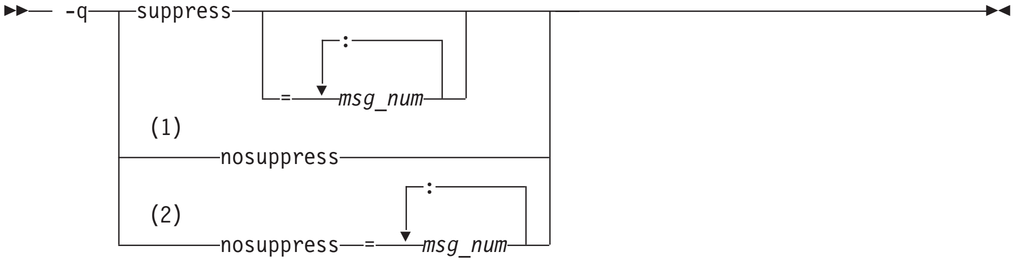
- "-O, -qoptimize" on page 148
- Options for performance optimization: Options for loop optimization

-qsuppress

Description

Prevents the specified compiler or driver informational or warning messages from being displayed or added to the listings.

Syntax



Notes:

1 C only

2 C++ only

Notes

This option suppresses compiler messages only, and has no effect on linker or operating system messages.

To suppress IPA messages, enter **-qsuppress** before **-qipa** on the command line.

Compiler messages that cause compilation to stop, such as (S) and (U) level messages cannot be suppressed.

The **-qnosuppress** compiler option cancels previous settings of **-qsuppress**.

Example

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:

```
xlc++ myprogram.C -qsuppress=1506-224
```

Related information

- "-qhalt" on page 93
- "-qipa" on page 106
- Options that control listings and messages: Options for messages

-qsymtab

C

Description

Settings for this option determine what information appears in the symbol table.

Syntax

```
►►── -q──symtab──=──┬─unref──┬──────────────────────────────────────────────►◄
                    └─static─┘
```

where:

unref Specifies that all typedef declarations, struct, union, and enum type definitions are included for processing by the GNU GDB Debugger.

Use this option with the **-g** option to produce additional debugging information for use with the debugger.

When you specify the **-g** option, debugging information is included in the object file. To minimize the size of object and executable files, the compiler only includes information for symbols that are referenced. Debugging information is not produced for unreferenced arrays, pointers, or file-scope variables unless **-qsymtab=unref** is specified.

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 name list.

The default is to not add static variables to the symbol table.

Examples

To compile myprogram.c so that static symbols are added to the symbol table, enter:

```
xlc myprogram.c -qsymtab=static
```

To include all symbols in myprogram.c in the symbols table for use with a debugger, enter:

```
xlc myprogram.c -g -qsymtab=unref
```

Related information

- "-g" on page 90
- Options for error checking and debugging: Options for debugging

-qsyntaxonly

► C

Description

Causes the compiler to perform syntax checking without generating an object file.

Syntax

```
►►── -q──syntaxonly──────────────────────────────────────────────────────────►◄
```

Notes

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.

Examples

To check the syntax of `myprogram.c` without generating an object file, enter:

```
xlc myprogram.c -qsyntaxonly
```

or

```
xlc myprogram.c -o testing -qsyntaxonly
```

Note that in the second example, the **-qsyntaxonly** option overrides the **-o** option so no object file is produced.

Related information

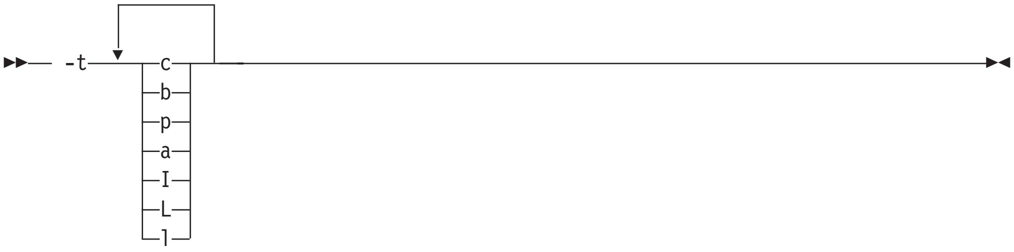
- "-C" on page 56
- "-c" on page 57
- "-E" on page 75
- "-o" on page 151
- "-P" on page 152
- Options that control input: Other input options

-t

Description

Adds the prefix specified by the **-B** option to the designated programs.

Syntax



where programs are:

Program	Description
c	Compiler front end
b	Compiler back end
p	Compiler preprocessor
a	Assembler
I	Interprocedural analysis - compile phase
L	Interprocedural analysis - link phase
l	Linkage editor

Default

If **-B** is specified but *prefix* is not, the default prefix is `/lib/o`. If **-B***prefix* is not specified at all, the prefix of the standard program names is `/lib/n`.

If **-B** is specified but **-t***programs* is not, the default is to construct path names for all the standard program names.

Example

To compile `myprogram.c` so that the name `/u/newones/compilers/` is prefixed to the compiler and assembler program names, enter:

```
xlc myprogram.c -B/u/newones/compilers/ -tca
```

Related information

- "-B" on page 55
- Options for customizing the compiler: Options for general customization

-qtabsize

Description

Changes the length of tabs as perceived by the compiler.

Syntax

```
                          ┌─8─┐
▶▶── -q──tabsize──=───────┴─n─┴──────────────────────────────────────▶◀
```

where *n* is the number of character spaces representing a tab in your source program.

Notes

This option only affects error messages that specify the column number at which an error occurred. For example, the compiler will consider tabs as having a width of one character if you specify **-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.

Related information

- Options that control listings and messages: Options for listing

-qtbtable

Description

Generates a traceback table that contains information about each function, including the type of function as well as stack frame and register information. The traceback table is placed in the text segment at the end of its code.

Syntax

```
▶▶── -q──tbtable──=───┬─none──┬──────────────────────────────────────▶◀
                      ├─full──┤
                      └─small─┘
```

where suboptions are:

none No traceback table is generated. The stack frame cannot be unwound so exception handling is disabled.

full A full traceback table is generated, complete with name and parameter information. This is the default if **-qnoopt** or **-g** are specified.

small The traceback table generated has no name or parameter information, but otherwise has full traceback capability. This is the default if you have specified optimization and have not specified **-g**.

See also “#pragma options” on page 248.

Notes

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.

Many performance measurement tools require a full traceback table to properly analyze optimized code. The compiler configuration file contains entries to accomodate this requirement. If you do not require full traceback tables for your optimized code, you can save file space by making the following changes to your compiler configuration file:

1. Remove the **-qtbtable=full** option from the **options** lines of the C or C++ compilation stanzas.
2. Remove the **-qtbtable=full** option from the **xlCopt** line of the **DFLT** stanza.

With these changes, the defaults for the **tbtable** option are:

- When compiling with optimization options set, **-qtbtable=small**
- When compiling with no optimization options set, **-qtbtable=full**

Related information

- “-g” on page 90
- Summary of command line options: Other error checking and debugging options

-qtempinc

C++

Description

Generates separate template include files for template functions and class declarations, and places these files in a directory which can be optionally specified.

Syntax

```
          ┌─notempinc───────────────────┐
►►── -q───┴─tempinc──┬─────────────────┬┴──────────────────────────────────►◄
                     └─=──directory────┘
```

Notes

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**.

When you specify **-qtempinc**, the compiler assigns a value of 1 to the __TEMPINC__ macro. This assignment will not occur if **-qnotempinc** has been specified.

Example

To compile the file `myprogram.c` and place the generated include files for the template functions in the `/tmp/mytemplates` directory, enter:

```
xlc++ myprogram.C -qtempinc=/tmp/mytemplates
```

Related information
- “-qtmplinst” on page 193
- “-qtemplateregistry”
- “-qtemplaterecompile”
- Options for customizing the compiler: Template-related options
- ″Using C++ templates″ in the *XL C/C++ Programming Guide*.

-qtemplaterecompile

▶ C++

Description

Helps manage dependencies between compilation units that have been compiled using the **-qtemplateregistry** compiler option.

Syntax

```
          ┌─templaterecompile───┐
►►── -q───┴─notemplaterecompile─┴────────────────────────────────────►◄
```

Notes

The **-qtemplaterecompile** option is intended to be used with the **-qtemplateregistry** option. Given a program in which multiple compilation units reference the same template instantiation, the **-qtemplateregistry** option specifies a single compilation unit to contain the instantiation. No other compilation units will contain this instantiation, and duplication of object code is avoided.

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.

Related information
- “-qtmplinst” on page 193
- “-qtempinc” on page 189
- “-qtemplateregistry”
- Options for customizing the compiler: Template-related options
- ″Using C++ templates″ in the *XL C/C++ Programming Guide*.

-qtemplateregistry

▶ C++

Description

Maintains records of all templates as they are encountered in the source and ensures that only one instantiation of each template is made.

Syntax

```
           ┌─notemplateregistry──────────────────┐
►►── -q────┴─templateregistry──┬────────────────┬┴──────────────────────────────►◄
                               └─=──registry_file─┘
```

Notes

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.

If you do not specify a location, the compiler will save all template registry information to the file **templateregistry** stored in the current working directory. 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 will result in this situation, and 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 **-qnotempinc** does not imply **-qtemplateregistry**.

Specifying either **-qtempinc** or **-qtemplateregistry** implies **-qtmplinst=auto**.

Example

To compile the file `myprogram.C` and place the template registry information into the `/tmp/mytemplateregistry` file, enter:

```
xlc++ myprogram.C -qtemplateregistry=/tmp/mytemplateregistry
```

Related information

- "-qtmplinst" on page 193
- "-qtempinc" on page 189
- "-qtemplaterecompile" on page 190
- Options for customizing the compiler: Template-related options
- ″Using C++ templates″ in the *XL C/C++ Programming Guide*.

-qtempmax

C++

Description

Specifies the maximum number of template include files to be generated by the **-qtempinc** option for each header file.

Syntax

```
                      ┌─1──────┐
►►── -q──tempmax──=───┴─number─┴──────────────────────────────────────────►◄
```

Notes

Specify the maximum number of template files by giving *number* a value between 1 and 99999.

Instantiations are spread among the template include files.

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.

Related information

- “-qtempinc” on page 189
- Options for customizing the compiler: Template-related options
- ″Using C++ templates″ in the *XL C/C++ Programming Guide*.

-qthreaded

Description

Indicates to the compiler that the program uses multiple threads. Always use this option when compiling or linking multi-threaded applications. This option ensures that all optimizations are thread-safe.

Syntax

```
►►── -q──┬─nothreaded─┬──────────────────────────────────────────────────►◄
         └─threaded───┘
```

Default

The default is **-qthreaded** when compiling with **_r** invocation modes, and **-qnothreaded** when compiling with other invocation modes.

Notes

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.

This option does not make code thread-safe, but it will ensure that code already thread-safe will remain so after compile and linking.

Related information

- “-qsmp” on page 175
- Options that control output: Other output options

-qtls

Description

Specifies the thread-local storage model to be used by the application.

Syntax

```
►►── -q──┬─tls──┬────────────────────────────────┬─┬──────────────────────────►◄
         │      │      (2)                       │ │
         │      │    ┌──────────global-dynamic─┐ │ │
         │      │    │ (1)                     │ │ │
         │      │    ├──────────initial-exec───┤ │ │
         │      └─=──┼─local-exec──────────────┼─┘ │
         │           └─local-dynamic───────────┘   │
         └─notls───────────────────────────────────┘
```

Notes:

1 Default if the **-qnopic** compiler option is in effect.

2 Default if the **-qpic** compiler option is in effect.

Notes

This option selects the model used to access thread-local storage.

On systems that support the GNU **__thread** keyword, the **vac_configure** tool adds **-qtls** to the set of default options in the compiler configuration file.

If **-qtls** is specified without suboptions, the compiler assumes the following settings:

- **-qtls=initial-exec** if **-qnopic** is in effect.
- **-qtls=global-dynamic** if **-qpic** is in effect.

Related information

- "-qpic" on page 159
- Options for customizing the compiler: Options for general customization

-qtmplinst

C++

Description

Manages the implicit instantiation of templates.

Syntax

```
►►── -q──tmplinst──=──┬─always───┬─────────────────────────────────────►◄
                      ├─noinline─┤
                      └─none─────┘
```

where the suboptions are:

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 both or any of the options are enabled, the compiler manages the implicit instantiation using either option which is enabled.

always — Instruct the compiler to always perform implicit instantiation. If specified, **-qtempinc** and **-qtemplateregistry** compiler options are ignored.

noinline — Instructs the compiler to do not perform any implicit instantiations. If specified, **-qtempinc** and **-qtemplateregistry** compiler options are ignored.

none — Instruct the compiler to instantiate only inline functions. No other implicit instantiation is performed. If specified, **-qtempinc** and **-qtemplateregistry** compiler options are ignored.

Notes

- The **-qtempinc** or **-qtemplateregistry** options imply **-qtmplinst=auto**.
- If you specify both **-qtempinc** and **-qtemplateregistry** options along with **-qtmplinst** , then the last one takes precedence. For example, if you specify **-qtmplinst** and then **-qtemplateregistry**, the end result will be **-qtmplinst=auto** and **-qtemplateregistry**.
- If **-qtmplinst=auto** is specified, it doesn't matter which order it is seen relative to the **-qtempinc** and **-qtemplateregistry** options.

Related information

- "-qtemplateregistry" on page 190
- "-qtempinc" on page 189
- "-qtemplaterecompile" on page 190
- Options for customizing the compiler: Template-related options

-qtmplparse

C++

Description

This option controls whether parsing and semantic checking are applied to template definitions (class template definitions, function bodies, member function bodies, and static data member initializers) or only to template instantiations. The compiler can check function bodies and variable initializers in template definitions and produce error or warning messages.

Syntax

```
                            ┌─no────┐
►►── -q──tmplparse──=───────┼─warn──┼───────────────────────────────────────────►◄
                            └─error─┘
```

where suboptions are:

no
: Do not parse the template definitions. This reduces the number of errors issued in code written for previous versions of VisualAge C++ and predecessor products. This is the default.

warn
: Parses template definitions and issues warning messages for semantic errors.

error
: Treats problems in template definitions as errors, even if the template is not instantiated.

Notes

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, errors found during the parsing or semantic checking of constructs such as the following, always cause error messages:

- return type of a function template
- parameter list of a function template

Example

Example 1:

In the following example the template class is not instantiated, therefore it is never parsed by the compile and if you do not use **-qtmplparse=error** option, the compiler do not find any syntax error. However; if you use **-qtmplparse=error** the template class is parsed and the compiler flags the error message.

```
template <class A> struct container
{
   A a1;
   A foo1()      //syntax error
   int _data;
};

xlC -c -qtmplparse=error myprogram.cpp
```

Example 2:

In the following example a containing class is not instantiated, therefore its out-of-line member definition is not parsed. If you do not use **-qtmplparse=error** the compiler does not issue an error message for the mismatch between the out-of-line definition and the original definition.

```
template <class A> struct container
{
   void member(A a);
};

// error - this member is not declared in the struct container
template <class B> void container<B>::member()   {
}
xlC -c -qtmplparse=error myprogram.cpp
```

Note: Whether you use **-qtmplparse=error** or not , if you try to instantiate the class compiler will issue an error message.

Related information
- Options for customizing the compiler: Template-related options
- "Using C++ templates" in the *XL C/C++ Programming Guide*.

-qtocdata

Description

Marks data as local.

Syntax

```
              ┌─notocdata─┐
►►── -q───────┴─tocdata───┴──────────────────────────────────────────────────►◄
```

Notes

This option applies only to 64-bit compilations, and is ignored if specified for a 32-bit compilation.

Local variables are statically bound to the functions that use them. **-qtocdata** instructs the compiler to assume that all variables are local.

If an imported variable is assumed to be local, incorrect code may be generated and performance may decrease. Imported variables are dynamically bound to a shared portion of a library. **-qnotocdata** instructs the compiler to assume that all variables are imported.

Conflicts among the data-marking options are resolved in the following manner:

Options that list variable names	The last explicit specification for a particular variable name is used.
Options that change the default	This form does not specify a name list. The last option specified is the default for variables not explicitly listed in the name-list form.

Related information

- Options for performance optimization: Options for ABI performance tuning

-qtrigraph

Description

Instructs the compiler to recognize trigraph key combinations used to represent characters not found on some keyboards.

Syntax

```
            ┌─trigraph───┐
►►── -q─────┴─notrigraph─┴──────────────────────────────────────────────►◄
```

Notes

A trigraph is a combination of three-key character combinations that let you produce a character that is not available on all keyboards.

The trigraph key combinations are:

Key combination	Character produced
??=	#
??(	[
??)	]
??/	\
??′	^
??<	{
??>	}
??!	|
??-	~

▶ C The default **-qtrigraph** setting can be overridden by explicitly setting the **-qnotrigraph** option on the command line.

An explicit **-qnotrigraph** specification on the command line takes precedence over the **-qtrigraph** setting normally associated with a given **-qlanglvl** compiler option, regardless of where the **-qnotrigraph** specification appears on the command line.

▶ C++ The same is true for C++ programs.

Examples

To disable trigraph character sequences when compiling your C program, enter:

```
xlc myprogram.c -qnotrigraph
```

1. To disable trigraph character sequences when compiling your C++ program, enter:

```
xlc++ myprogram.C -qnotrigraph
```

Related information

- “-qdigraph” on page 72
- “-qlanglvl” on page 119
- Options that control input: Options for language extensions

-qtune

Description

Specifies the architecture system for which the executable program is optimized.

Syntax

```
                     ┌pwr4───┐
►►── -q──tune──=─────┼auto───┼────────────────────────────────────────►◄
                     ├ppc970─┤
                     ├pwr3───┤
                     ├pwr5───┤
                     ├rs64b──┤
                     └rs64c──┘
```

where architecture suboptions are:

auto Produces object code optimized for the platform on which it is compiled.

ppc970 Produces object code optimized for the PowerPC 970 processor.

pwr3 Produces object code optimized for the POWER3 hardware platforms.

pwr4 Produces object code optimized for the POWER4 hardware platforms.

pwr5 Produces object code optimized for the POWER5 hardware platforms.

rs64b Produces object code optimized for the RS64II processor.

rs64c Produces object code optimized for the RS64III processor.

See also “#pragma options” on page 248.

Default

The default setting of the **-qtune** option depends on the setting of the **-qarch** option.

- If **-qtune** is specified without **-qarch**, the compiler uses **-qarch** setting to specify the appropriate default based on the compilation mode.
- If **-qarch** is specified without **-qtune**, the compiler uses the default tuning option for the specified architecture.

Default **-qtune** settings for specific **-qarch** settings are described in “Acceptable compiler mode and processor architecture combinations” on page 208.

Notes

You can use **-qtune=***suboption* with **-qarch=***suboption*.

- **-qarch=***suboption* specifies the architecture for which the instructions are to be generated.
- **-qtune=***suboption* specifies the target platform for which the code is optimized.
- Specifying an invalid **-qtune** option for the effective **-qarch** option issues a warning message with the **-qtune** being set to the default for the effective **-qarch** option.

Example

To specify that the executable program testing compiled from `myprogram.C` is to be optimized for a POWER3 hardware platform, enter:

```
xlc++ -o testing myprogram.C -qtune=pwr3
```

Related information

- “-qarch” on page 49
- “Specifying compiler options for architecture-specific, 32-bit or 64-bit compilation” on page 20
- Options for performance optimization: Options for processor and architectural optimization
- "Optimizing your applications"in the *XL C/C++ Programming Guide*

-U

Description

Undefines the identifier *name* defined by the compiler or by the **-D***name* option.

Syntax

```
►►— -U—name————————————————————————————————————————————►◄
```

Notes

The **-U***name* 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***name* option.

The identifier name can also be undefined in your source program using the `#undef` preprocessor directive.

The **-U***name* option has a higher precedence than the **-D***name* option.

Example

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:

```
xlc myprogram.c  -U__unix
```

Related information

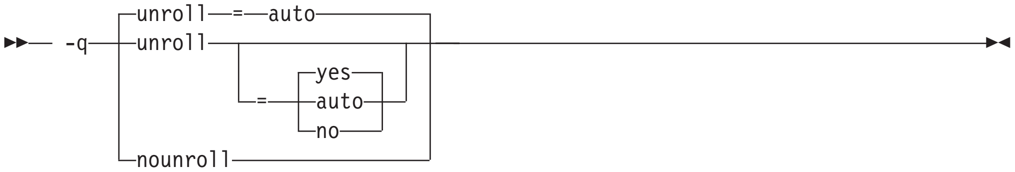
- “-D” on page 69
- Summary of command line options: Other input options

-qunroll

Description

Unrolls inner loops in the program. This can help improve program performance.

Syntax



where:

-qunroll=auto Leaves the decision to unroll loops to the compiler. This is the compiler default.

-qunroll or -qunroll=yes Suggests to the compiler that it unroll loops.

-qnounroll or -qunroll=no Instructs the compiler to not unroll loops.

See also "#pragma unroll" on page 261 and "#pragma options" on page 248.

Notes

The compiler default for this option, unless explicitly specified otherwise on the command line, is **-qunroll=auto**.

Specifying **-qunroll** without any suboptions is equivalent to specifying **-qunroll=yes**.

When **-qunroll**, **-qunroll=yes**, or **-qunroll=auto** is specified, the bodies of inner loops will be unrolled, or duplicated, by the optimizer. 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.

To see if the **unroll** option improves performance of a particular application, you should first compile the program with usual options, then run it with a representative workload. You should then recompile with command line **-qunroll** option and/or the **unroll** pragmas enabled, then rerun the program under the same conditions to see if performance improves.

You can use the **#pragma unroll** directive to gain more control over unrolling. Setting this pragma overrides the **-qunroll** compiler option setting.

Examples

1. In the following examples, unrolling is disabled:
   ```
   xlc++ -qnounroll file.C
   ```
   ```
   xlc++ -qunroll=no file.C
   ```
2. In the following examples, unrolling is enabled:
   ```
   xlc++ -qunroll file.C
   ```
   ```
   xlc++ -qunroll=yes file.C
   ```
   ```
   xlc++ -qunroll=auto file.C
   ```
3. See "#pragma unroll" on page 261 for examples of how program code is unrolled by the compiler.

Related information

- Options for performance optimization: Options for loop optimization

-qunwind

Description

Informs the compiler that the stack can be unwound while a routine in the compilation is active.

Syntax

```
            ┌unwind───┐
►►── -q─────┴nounwind─┴────────────────────────────────────────────►◄
```

Notes

Specifying **-qnounwind** can improve optimization of non-volatile register saves and restores.

C++ For C++ programs, specifying **-qnounwind** also implies **-qnoeh**.

Related information
- "-qeh" on page 77
- Options for performance optimization: Options for ABI performance tuning

-qupconv

C

Description

Preserves the `unsigned` specification when performing integral promotions.

Syntax

```
            ┌noupconv─┐
►►── -q─────┴upconv───┴────────────────────────────────────────────►◄
```

See also "#pragma options" on page 248.

Notes

The **-qupconv** option promotes any `unsigned` type smaller than an `int` to an `unsigned int` instead of to an `int`.

Sign preservation is provided for compatibility with older dialects of C. The ANSI C standard requires value preservation as opposed to sign preservation.

Default

The default is **-qnoupconv**, except when **-qlanglvl** is set to **classic** or **extended**, in which case the default is **-qupconv**. The compiler does not preserve the `unsigned` specification.

The default compiler action is for integral promotions to convert a `char`, `short int`, `int` bit field or their `signed` or`unsigned` types, or an `enum` type to an `int`. Otherwise, the type is converted to an `unsigned int`.

Example

To compile `myprogram.c` so that all `unsigned` types smaller than `int` are converted to `unsigned int`, enter:

```
xlc 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

- “-qlanglvl” on page 119
- Summary of command line options: Options for signedness

-qutf

Description

Enables recognition of UTF literal syntax.

Syntax

```
           ┌─noutf─┐
►►─ -q─────┴─utf───┴──────────────────────────────────────────────────►◄
```

Notes

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.

Related information

- Options that control input: Options for language extensions
- "UTF literals"in the *XL C/C++ Language Reference*

-V

Description

Instructs the compiler to report information on the progress of the compilation, names the programs being invoked within the compiler and the options being specified to each program. Information is displayed in a space-separated list.

Syntax

```
►►─ -V──────────────────────────────────────────────────────────────────►◄
```

Notes

The **-V** option is overridden by the **-#** option.

Example

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:

```
xlc++ myprogram.C -V
```

Related information

- “-# (pound sign)” on page 43
- “-v”
- Options that control listings and messages: Options for messages

-v

Description

Instructs the compiler to report information on the progress of the compilation, names the programs being invoked within the compiler and the options being specified to each program. Information is displayed in a comma-separated list.

Syntax

```
►►── -v────────────────────────────────────────────────────────────►◄
```

Notes

The **-v** option is overridden by the **-#** option.

Example

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:

```
xlc myprogram.c -v
```

Related information

- “-# (pound sign)” on page 43
- “-V” on page 201
- Options that control listings and messages: Options for messages

-qversion

Description

Displays the version of the compiler being invoked. The output is the official product name and the compiler version found on the system.

Syntax

```
►►── -q──version───────────────────────────────────────────────────►◄
```

Notes

Specify this option on its own with the compiler command. For example:

```
 xlC -qversion
```

Related information

- Options that control listings and messages: Options for messages

-qvftable

C++

Description

Controls the generation of virtual function tables.

Syntax

```
          ┌─vftable───┐
►►── -q───┴─novftable─┴──────────────────────────────────────────────►◄
```

Default

The default is to define the virtual function table for a class if the current compilation unit contains the body of the first non-inline virtual member function declared in the class member list.

Notes

Specifying **-qvftable** generates virtual function tables for all classes with virtual functions that are defined in the current compilation unit.

If you specify **-qnovftable**, no virtual function tables are generated in the current compilation unit.

Example

To compile the file `myprogram.C` so that no virtual function tables are generated, enter:

```
xlc++ myprogram.C -qnovftable
```

Related information

- Options that control output: Options that control the characteristics of the object code

-qvrsave

Description

Enables code in function prologs and epilogs to maintain the VRSAVE register.

Syntax

```
          ┌─vrsave───┐
►►── -q───┴─novrsave─┴───────────────────────────────────────────────►◄
```

where:

vrsave
: Prologs and epilogs of functions in the compilation unit include code needed to maintain the VRSAVE register.

novrsave
: Prologs and epilogs of functions in the compilation unit do not include code needed to maintain the VRSAVE register.

Notes

Use **#pragma altivec_vrsave** to override the current setting of this compiler option for individual functions within your program source.

Related information

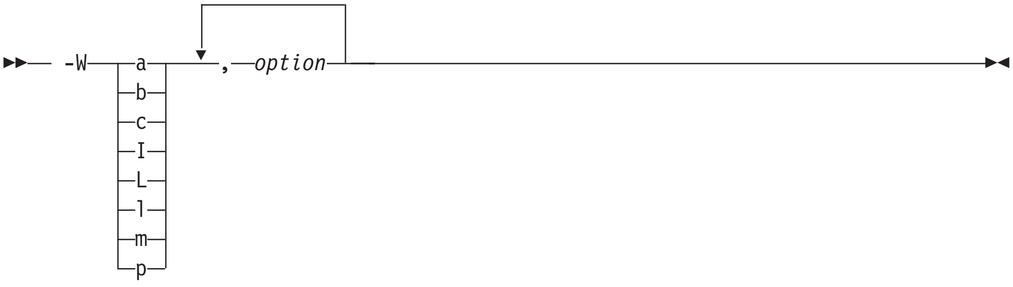
- "#pragma altivec_vrsave" on page 219
- Options that control output: Options that control the characteristics of the object code

-W

Description

Passes the listed option to a designated compiler component.

Syntax



where programs are:

Program	Description
a	Assembler
b	Compiler back end
c	Compiler front end
I	Interprocedural analysis - compile phase
L	Interprocedural analysis - link phase
l	linkage editor
p	compiler preprocessor

Notes

When used in the configuration file, the **-W** option accepts the escape sequence backslash comma (\,) to represent a comma in the parameter string.

Examples

1. To compile `myprogram.c` so that the *option* **-pg** is passed to the linkage editor (**l**) and the assembler (**a**), enter:

   ```
   xlc myprogram.c -Wl,-pg -Wa,-pg
   ```

2. In a configuration file, use the **\,** sequence to represent the comma (,).

   ```
   -Wl\,-pg,-Wa\,-pg
   ```

Related information

- "Invoking the compiler" on page 11
- Options for customizing the compiler: Options for general customization

-w

Description

Requests that warnings and lower-level messages be suppressed. Specifying this option is equivalent to specifying **-qflag=e:e**.

Syntax

```
►►── -w──────────────────────────────────────────────────────────────────────►◄
```

Notes

Informational and warning messages that supply additional information to a severe error are not disabled by this option. For example, a severe error caused by problems with overload resolution will also produce information messages. These informational messages are not disabled with **-w** option:

```
void func(int a){}
void func(int a, int b){}
int main(void)
{
func(1,2,3);
return 0;
}


"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)".
```

Example

To compile `myprogram.c` so that no warning messages are displayed, enter:

```
xlc++ myprogram.C -w
```

Related information

- "-qflag" on page 82
- Options that control listings and messages: Options for messages

-qwarn64

Description

Enables checking for possible data conversion problems between 32-bit and 64-bit compiler modes.

Syntax

```
              ┌─nowarn64─┐
►►── -q──────┴─warn64───┴──────────────────────────────────────────────────►◄
```

Notes

All generated messages have level Informational.

The **-qwarn64** 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.

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
- Conflicts with pragma options **arch** in source files and on the command line

Related information

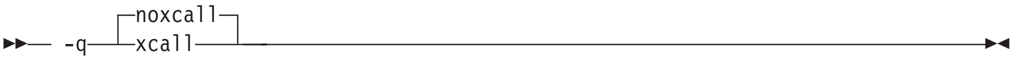
- -q32, -q64
- "Compiler messages" on page 25
- Options for error checking and debugging: Options for error checking

-qxcall

Description

Generates code to treat static functions within a compilation unit as if they were external functions.

Syntax



Notes

-qxcall generates slower code than **-qnoxcall**.

Example

To compile `myprogram.c` so that all static functions are compiled as external functions, enter:

```
xlc myprogram.c -qxcall
```

Related information

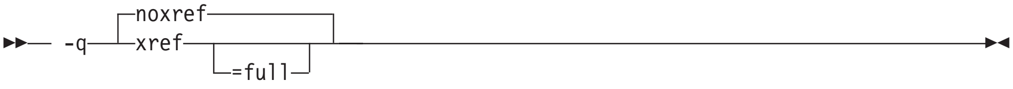
- Options that control output: Options that control the characteristics of the object code

-qxref

Description

Produces a compiler listing that includes a cross-reference listing of all identifiers.

Syntax



where:

noxref Do not report identifiers in the program.
xref Reports only those identifiers that are used.
xref=full Reports all identifiers in the program.

See also “#pragma options” on page 248.

Notes

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

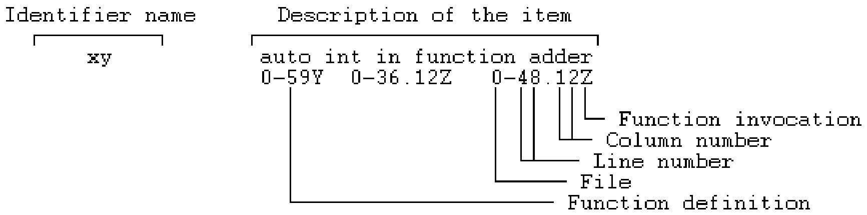
Any function defined with the **#pragma mc_func** *function_name* directive is listed as being defined on the line of the **#pragma** directive.

Example

To compile `myprogram.C` and produce a cross-reference listing of all identifiers whether they are used or not, enter:

```
xlc++ myprogram.C -qxref=full -qattr
```

A typical cross-reference listing has the form:



Related information

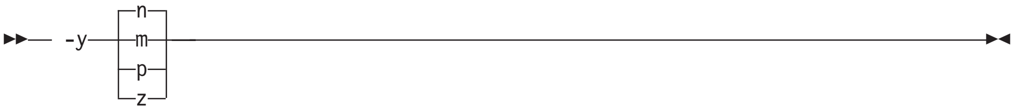
- “-qattr” on page 54
- “#pragma mc_func” on page 245
- Options that control listings and messages: Options for listing

-y

Description

Specifies the compile-time rounding mode of constant floating-point expressions.

Syntax



where suboptions are:

n Round to the nearest representable number. This is the default.
m Round toward minus infinity.
p Round toward plus infinity.
z Round toward zero.

Example

To compile myprogram.c so that constant floating-point expressions are rounded toward zero at compile time, enter:

```
xlc myprogram.c -yz
```

Related information

- Options that control integer and floating-point processing

Acceptable compiler mode and processor architecture combinations

You can use the **-q32**, **-q64**, **-qarch**, and **-qtune** compiler options to optimize the output of the compiler to suit:

- the broadest possible selection of target processors,
- a range of processors within a given processor architecture family,
- a single specific processor.

Generally speaking, the options do the following:

- **-q32** selects 32-bit execution mode.
- **-q64** selects 64-bit execution mode.
- **-qarch** selects the general family processor architecture for which instruction code should be generated. Certain **-qarch** settings produce code that will run *only* on systems that support *all* of the instructions generated by the compiler in response to a chosen **-qarch** setting.
- **-qtune** selects the specific processor for which compiler output is optimized. Some **-qtune** settings can also be specified as **-qarch** options, in which case they do not also need to be specified as a **-qtune** option. The **-qtune** option influences only the performance of the code when running on a particular system but does not determine where the code will run.

All PowerPC machines share a common set of instructions, but may also include additional instructions unique to a given processor or processor family.

The table below shows some selected processors, and the various features they may or may not support:

Architecture	graphics support	sqrt support	64-bit support	VMX support
rs64b	yes	yes	yes	no
rs64c	yes	yes	yes	no
pwr3	yes	yes	yes	no
pwr4	yes	yes	yes	no
pwr5	yes	yes	yes	no
pwr5x	yes	yes	yes	no
ppc	no	no	no	no
ppc64	no	no	yes	no
ppc64gr	yes	no	yes	no
ppc64grsq	yes	yes	yes	no
ppc64v	yes	yes	yes	yes
ppc970	yes	yes	yes	yes

If you want to generate code that will run across a variety of processors, use the following guidelines to select the appropriate **-qarch** and/or **-qtune** compiler options. Code compiled with:

- **-qarch=pwr3** will run on any POWER3, POWER4, POWER5, POWER5+, and PowerPC 970 machines.
- **-qarch=pwr4** will run on any POWER4, POWER5, POWER5+, and PowerPC 970 machines.
- **-qarch=pwr5** will run on POWER5, POWER5+, PowerPC 970 machines.
- **-qarch=pwr5x** will run on POWER5+ machines.
- **-qarch=ppc** will run on any PowerPC system.
- **-qarch=ppcgr** will run on any PowerPC system with graphics support.
- **-qarch=ppc64** will run on any 64-bit PowerPC system.
- **-qarch=ppc64gr** will run on any 64-bit PowerPC system with graphics support.
- **-qarch=ppc64grsq** will run on any 64-bit PowerPC system with graphics and square root support.
- **-qarch=ppc64v** will run on any 64-bit PowerPC system with VMX support.
- **-q64** will run only on PowerPC machines with 64-bit support
- Other **-qarch** options that refer to specific processors will run on any functionally equivalent PowerPC machine. For example, the table that follows shows that code compiled with **-qarch=pwr3** will also run on a **rs64c**.

If you want to generate code optimized specifically for a particular processor, acceptable combinations of **-q32**, **-q64**, **-qarch**, and **-qtune** compiler options are shown in the following table.

Table 40. Acceptable **-qarch** */***-qtune** *combinations*

-qarch option	Predefined macros	Default -qtune setting	Available -qtune settings
ppc	_ARCH_PPC	pwr4	auto pwr3 pwr4 pwr5 ppc970 rs64b rs64c
ppcgr	_ARCH_PPC _ARCH_PPCGR	pwr4	auto pwr3 pwr4 pwr5 ppc970 rs64b rs64c
ppc64	_ARCH_PPC _ARCH_PPC64	pwr4	auto pwr3 pwr4 pwr5 ppc970 rs64b rs64c
ppc64v	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PPC64GR _ARCH_PPC64GRSQ _ARCH_PPC64V	ppc970	auto ppc970
ppc64gr	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PPC64GR	pwr4	auto pwr3 pwr4 pwr5 ppc970 rs64b rs64c
ppc64grsq	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PPC64GR _ARCH_PPC64GRSQ	pwr4	auto pwr3 pwr4 pwr5 ppc970 rs64b rs64c
ppc970	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PWR3 _ARCH_PWR4 _ARCH_PPC970 _ARCH_PPC64GR _ARCH_PPC64GRSQ	ppc970	auto ppc970
rs64b	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_RS64B _ARCH_PPC64GR _ARCH_PPC64GRSQ	rs64b	auto rs64b
rs64c	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_RS64C _ARCH_PPC64GR _ARCH_PPC64GRSQ	rs64c	auto rs64c
pwr3	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PWR3 _ARCH_PPC64GR _ARCH_PPC64GRSQ	pwr3	auto pwr3 pwr4 pwr5 ppc970

Table 40. Acceptable **-qarch** */***-qtune** *combinations (continued)*

-qarch option	Predefined macros	Default -qtune setting	Available -qtune settings
pwr4	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PWR3 _ARCH_PWR4 _ARCH_PPC64GR _ARCH_PPC64GRSQ	pwr4	auto pwr4 pwr5 ppc970
pwr5	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PWR3 _ARCH_PWR4 _ARCH_PWR5 _ARCH_PPC64GR _ARCH_PPC64GRSQ	pwr5	auto pwr5
pwr5x	_ARCH_PPC _ARCH_PPCGR _ARCH_PPC64 _ARCH_PWR3 _ARCH_PWR4 _ARCH_PWR5 _ARCH_PWR5X _ARCH_PPC64GR _ARCH_PPC64GRSQ	pwr5	auto pwr5

Related information

- "Specifying compiler options for architecture-specific, 32-bit or 64-bit compilation" on page 20
- "-q32, -q64" on page 44
- "-qarch" on page 49
- "-qtune" on page 197

Chapter 4. Reusing GNU C/C++ compiler options with glxc and glxc++

This chapter describes how to reuse GNU compiler options with the XL C/C++ compiler through the use of the compiler invocation utility **gxlc** and **gxlc++**.

Each of the **gxlc** and **gxlc++** 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 **gxlc** and **gxlc++** are controlled by the configuration file `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. **gxlc** and **gxlc++** return warnings for input options that were not translated.

The **gxlc** and **gxlc++** option mappings are modifiable. For information on adding to or editing the **gxlc** and **gxlc++** configuration file, see "Configuring the option mapping" on page 212.

Example

To use the GCC `-ansi` option to compile the C version of the Hello World program, you can use:

```
gxlc -ansi hello.c
```

which translates into:

```
xlc -F:c89 hello.c
```

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

gxlc and gxlc++ return codes

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

40 A **gcc** or **g++** option error or unrecoverable error has been detected.

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

glxc and glxc++ syntax

The following diagram shows the **gxlc** and **gxlc++** syntax:

```
►►──┬─gxlc───┬──┬──────┬──┬─────────────────────────────┬──┬─────────────────────┬─filename─────────►◄
    └─gxlc++─┘  ├─-v───┤  └─-Wx,─xlc_or_xlc++_options─┘  └─gcc_or_g++_options─┘
                └─-vv──┘
```

where:

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++. **gxlc** or **gxlc++** 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. **gxlc** or **gxlc++** 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 or **xlc++** invocation command. **gxlc** or **gxlc++** adds the given options to the XL 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* use a comma delimiter.

gcc_or_g++_options
Are the **gxlc** or **gxlc++** options that are to be translated to **xlc** or **xlc++** options. The utility emits a warning for any option it cannot translate. The **gcc** and **g++** options that are currently recognized by **gxlc** or **gxlc++** are listed in the configuration file `gxlc.cfg`. Multiple *gcc_or_g++_options* are delimited by the space character.

Related information
- "Configuring the option mapping"

Configuring the option mapping

The **gxlc** and **gxlc++** utilities use the configuration file `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 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 **gxlc** 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 **gxlc** 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"
```

gxlc and **gxlc++** will then expect a value for these options.

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

- n, which tells the utility to process the option listed in the *gcc-option* field
- i, which tells the utility to ignore the option listed in the *gcc-option* field. **gxlc** and **gxlc++** will generate a message that this has been done, and continue processing the given options.
- e, which tells the utility to halt processing if the option listed in the *gcc-option* field is encountered. **gxlc** and **gxlc++** will also generate an error message.

For example, the **gcc** option -I- is not supported and must be ignored by **gxlc** and **gxlc++**. In this case, the flag is set to i, and the entry is:

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

If **gxlc** and **gxlc++** encounters this option as input, it will not process it and will generate a warning.

d
Lets **gxlc** and **gxlc++** include or ignore an option based on the type of compiler. The value can be:

- c, which tells **gxlc** and **gxlc++** to translate the option only for C.
- x, which tells **gxlc** and **gxlc++** to translate the option only for C++.
- *, which tells **gxlc** and **gxlc++** 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 **gcc** or **g++** option.

"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, **gxlc** and **gxlc++** 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 **gxlc** or **gxlc++** 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 or GNU C++ option to signify that the option has associated parameters. This is used to insure that **gxlc** or **gxlc++** 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 mapping, refer to:

http://www.ibm.com/support/search.wss?q=gxlcppoptionmaptabl&tc=SSJT9L&rs=2030&apar=include

Related information

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

Chapter 5. Compiler pragmas reference

The following sections describe the pragmas available in XL C/C++ for the Linux platform:

- "Summary of XL C/C++ pragmas"
- "Summary of OpenMP pragma directives" on page 216
- "Individual pragma descriptions" on page 217

Summary of XL C/C++ pragmas

The pragmas listed below are available for general programming use.

Pragma	Description
#pragma align	Aligns data items within structures.
▶ C #pragma alloca	Provides an inline version of the function `alloca(size_t size)`.
#pragma altivec_vrsave	Adds code to function prologs and epilogs to maintain the VRSAVE register.
#pragma block_loop	Instructs the compiler to create a blocking loop for a specific loop in a loop nest.
#pragma chars	Sets the sign type of character data.
#pragma comment	Places a comment into the object file.
#pragma complexgcc	Instructs the compiler how to pass and return parameters of complex type when calling functions.
#pragma STDC cx_limited_range	Instructs the compiler that within the scope it controls, complex division and absolute value are only invoked with values such that intermediate calculation will not overflow or lose significance.
▶ C++ #pragma define	Forces the definition of a template class without actually defining an object of the class.
#pragma disjoint	Lists the identifiers that are not aliased to each other within the scope of their use.
▶ C++ #pragma do_not_instantiate	Suppresses instantiation of a specified template declaration.
#pragma enum	Specifies the size of `enum` variables that follow.
#pragma execution_frequency	Lets you mark program source code that you expect will be either very frequently or very infrequently executed.
▶ C++ #pragma hashome	Informs the compiler that the specified class has a home module that will be specified by the **IsHome** pragma.
#pragma ibm snapshot	Allows the user to specify a location at which a breakpoint can be set and to define a list of variables that can be examined when program execution reaches that location.
▶ C++ #pragma implementation	Tells the compiler the name of the file containing the function-template definitions that correspond to the template declarations in the include file which contains the pragma.
#pragma info	Controls the diagnostic messages generated by the **info(...)** compiler options.

Pragma	Description
▶ C++ #pragma instantiate	Causes immediate instantiation of a specified template declaration.
▶ C++ #pragma ishome	Informs the compiler that the specified class's home module is the current compilation unit.
#pragma isolated_call	Marks a function that does not have or rely on side effects, other than those implied by its parameters.
#pragma langlvl	Selects the C or C++ language level for compilation.
#pragma leaves	Takes a function name and specifies that the function never returns to the instruction after the function call.
#pragma loop_id	Marks a block with a scope-unique identifier.
#pragma map	Tells the compiler that all references to an identifier are to be converted to a new name.
#pragma mc_func	Lets you define a function containing a short sequence of machine instructions.
#pragma nosimd	instructs the compiler to *not* generate VMX (Vector Multimedia Extension) instructions in the loop immediately following this directive.
#pragma novector	Instructs the compiler to *not* auto-vectorize the next loop.
#pragma options	Specifies options to the compiler in your source program.
#pragma option_override	Specifies alternate optimization options for specific functions.
#pragma pack	Modifies the current alignment rule for members of structures that follow this pragma.
▶ C++ #pragma priority	Specifies the order in which static objects are to be initialized.
#pragma reachable	Declares that the point after the call to a routine marked reachable can be the target of a branch from some unknown location.
#pragma reg_killed_by	Specifies those registers which value will be corrupted by the specified function. It must be used together with **#pragma mc_func**.
▶ C++ #pragma report	Controls the generation of specific messages.
#pragma stream_unroll	Breaks a stream contained in a loop into multiple streams.
#pragma strings	Sets storage type for strings.
#pragma unroll	Unrolls innermost and outermost loops in the program. This can help improve program performance.
#pragma unrollandfuse	Instructs the compiler to attempt an unroll and fuse operation on nested `for` loops. This can help improve program performance.
#pragma weak	Prevents the link editor from issuing error messages if it does not find a definition for a symbol, or if it encounters a symbol multiply-defined during linking.

Summary of OpenMP pragma directives

The pragma directives summarized on this page give you control over how the compiler handles parallel processing in your program.

Directives apply only to the statement or statement block immediately following the directive.

OpenMP pragma directives	Description
#pragma omp atomic	Identifies a specific memory location that must be updated atomically and not be exposed to multiple, simultaneous writing threads.
#pragma omp parallel	Defines a parallel region to be run by multiple threads in parallel. With specific exceptions, all other OpenMP directives work within parallelized regions defined by this directive.
#pragma omp for	Work-sharing construct identifying an iterative for-loop whose iterations should be run in parallel.
#pragma omp parallel for	Shortcut combination of **omp parallel** and **omp for** pragma directives, used to define a parallel region containing a single **for** directive.
#pragma omp ordered	Work-sharing construct identifying a structured block of code that must be executed in sequential order.
#pragma omp section, #pragma omp sections	Work-sharing construct identifying a non-iterative section of code containing one or more subsections of code that should be run in parallel.
#pragma omp parallel sections	Shortcut combination of **omp parallel** and **omp sections** pragma directives, used to define a parallel region containing a single **sections** directive.
#pragma omp single	Work-sharing construct identifying a section of code that must be run by a single available thread.
#pragma omp master	Synchronization construct identifying a section of code that must be run only by the master thread.
#pragma omp critical	Synchronization construct identifying a statement block that must be executed by a single thread at a time.
#pragma omp barrier	Synchronizes all the threads in a parallel region.
#pragma omp flush	Synchronization construct identifying a point at which the compiler ensures that all threads in a parallel region have the same view of specified objects in memory.
#pragma omp threadprivate	Defines the scope of selected file-scope data variables as being private to a thread, but file-scope visible within that thread.

Individual pragma descriptions

This section contains descriptions of individual pragmas available in XL C/C++.

#pragma align

Description

The **#pragma align** directive specifies how the compiler should align data items within structures.

Syntax

```
►►──#──pragma──align──(──┬─linuxppc───┬──)──────────────────────────────►◄
                         ├─bit_packed─┤
                         └─reset──────┘
```

See also “#pragma options” on page 248.

Notes

The **#pragma align(***suboption***)** directive overrides the **-qalign** compiler option setting for a specified section of program source code.

The compiler stacks alignment directives, so you can go back to using a previous alignment directive without knowing what it is by specifying the **#pragma align(reset)** directive.

For example, you can use this option if you have a class declaration within an include file and you do not want the alignment rule specified for the class to apply to the file in which the class is included. You can code **#pragma align(reset)** in a source file to change the alignment option to what it was before the last alignment option was specified. If no previous alignment rule appears in the file, the alignment rule specified in the invocation command is used.

Specifying **#pragma align** has the same effect as specifying **#pragma options align** in your source file. For more information and examples of **#pragma align** and **#pragma options align** usage, see “-qalign” on page 47.

Related information

- in *XL C/C++ Programming Guide*
- and "The packed variable attribute" in *XL C/C++ Language Reference*

#pragma alloca

▶ C

Description

The **#pragma alloca** directive specifies that the compiler should provide an inline version of the function `alloca(size_t`*`size`***)**. The function `alloca(size_t`*`size`***)** can be used to allocate space for an object. The amount of space allocated is determined by the value of *size*, which is measured in bytes. The allocated space is put on the stack.

Syntax

```
►►──#──pragma──alloca───────────────────────────────────────────────────►◄
```

Notes

You must specify the **#pragma alloca** directive or the **-qalloca** compiler option to have the compiler provide an inline version of `alloca`.

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

Related information

- “-qalloca” on page 48

#pragma altivec_vrsave

Descripton

When the **#pragma altivec_vrsave** directive is enabled, function prologs and epilogs include code to maintain the VRSAVE register.

Syntax

```
                                 ┌─on───┐
►►──#──pragma──altivec_vrsave────┼─off──┼────────────────────────────────────►◄
                                 └─allon┘
```

where pragma settings do the following:

on Function prologs and epilogs include code to maintain the VRSAVE register.

off Function prologs and epilogs do not include code to maintain the VRSAVE register.

allon The function containing the **altivec_vrsave** 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.

Notes

- **#pragma altivec_vrsave** is supported only when **-qaltivec** option is in effect.
- 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. The default behavior is to always maintain the vrsave register.
- This 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.

Related information
- “-qaltivec” on page 49
- “-qvrsave” on page 203

#pragma block_loop

Description

Marks a block with a scope-unique identifier.

Syntax

```
                                          ┌─,─────────┐
                                          ▼           │
►►──#──pragma──block_loop──(──n──,────────name_list───┴──)─────────────────────►◄
```

where:

n Is an integer expression the size of the iteration group.

name_list Is a unique identifier you can create using the **#pragma loopid** directive. If you do not specify *name_list*, blocking occurs on the first `for` loop or block_loop following the **#pragma block_loop** directive.

name is an identifier that is unique within the scoping unit.

Notes

For loop blocking to occur, a **#pragma block_loop** directive must precede a `for` loop.

If you specify **unroll**, **unroll_and_fuse** or **stream_unroll** directive for a blocking loop, the blocking loop is unrolled, unrolled and fused or steam unrolled respectively, if the blocking loop is actually created. Otherwise, this directive has no effect.

If you specify **unroll_and_fuse** or **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 **block_loop** directive was not specified.

You must not specify **#pragma block_loop** more than once, or combine the directive with the **nounroll**, **unroll**, **nounrollandfuse**, **unrollandfuse**, or **stream_unroll** pragma directives for the same `for` loop. Also, You should not apply more than one **unroll** directive to a single block loop directive.

Processing of all **block_loop** directives is always completed before performing any unrolling indicated by any of the unroll directives

Examples of accurate use of the directive

Example 1 - 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++)
      {
         ...
      }
    }
  }
```

Example 2 - Loop tiling

```
#pragma block_loop(50, mymainloop)
#pragma block_loop(20, myfirstloop, mysecondloop)
#pragma loopid(mymainloop)
 for (i=0; i < n; n++)
 {
#pragma loopid(myfirdstloop)
  for (j=0; j < m; j++)
  {
#pragma loopid(mysecondloop)
   for (k=0; k < m; k++)
   {
    ...
   }
  }
 }
```

Example 3 - 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++)
    {
     ...
    }
   }
  }
 }
```

Example 4 - 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++)
         {
           ...
         }
       }
     }
   }
```

Example 5 - Unroll-and-fuse of 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.

Example 6 -Unroll of 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, and after happens, the unroll directive is applied to the blocked loop.

Examples of inaccurate use of the directive

Example 1- Block_loop of 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.
```

Example 2- Block_loop of a loop identifer not within 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++)
   {
     ...
   }

 Referencing myloop is not allowed, since it is defined in a different
loop nest (nesting structure).
```

Example 3- Conflicting unroll directives specified for a blocking loop

```
 #pragma unrollandfuse(5)
 #pragma unroll(2)
   #pragma block_loop(10)
  for (i = 0; i < N; ++i) {
    }

This is not allowed since the unroll directives are conflicting
with each other.
```

Example 4- Conflicting unroll directives specified for a blocked loop

```
 #pragma block_loop(10)
 #pragma unroll(5)
 #pragma unroll(10)
   for (i = 0; i < N; ++i) {
   }

This is not allowed since there are two different unrolling factors
specified for the same loop, and therefore the diretives are conflicting.
```

Related information

- “#pragma loop_id” on page 241
- “-qunroll” on page 198
- “#pragma unroll” on page 261
- “#pragma unrollandfuse” on page 262
- “#pragma stream_unroll” on page 259

#pragma chars

Descripton

The **#pragma chars** directive sets the sign type of char objects to be either `signed` or `unsigned`.

Syntax

```
                          ┌─unsigned─┐
►►──#──pragma──chars──(───┴─signed───┴──)────────────────────────────────────►◄
```

Notes

In order to have effect, this pragma must appear before any source statements.

Once specified, the pragma applies to the entire file and cannot be turned off. If a source file contains any functions that you want to be compiled without **#pragma chars**, place these functions in a different file. If the pragma is specified more than once in the source file, the first one will take precedence.

Note: The default character type behaves like an unsigned char.

Related information

- "-qchars" on page 60

#pragma comment

Description

The **#pragma comment** directive places a comment string into the target or object file.

Syntax

```
                            ┌─compiler──────────────────────────────┐
►►──#──pragma──comment──(───┼─date──────────────────────────────────┼──)───────►◄
                            ├─timestamp─────────────────────────────┤
                            └─┬─copyright─┬──┬──────────────────────┬┘
                              └─user──────┘  └─,──"token_sequence"──┘
```

where suboptions do the following:

compiler — The name and version of the compiler is appended to the end of the generated object module.

date — The date and time of compilation is appended to the end of the generated object module.

timestamp — The date and time of the last modification of the source is appended to the end of the generated object module.

copyright — The text specified by the *token_sequence* is placed by the compiler into the generated object module and is loaded into memory when the program is run.

user — The text specified by the *token_sequence* is placed by the compiler into the generated object but is *not* loaded into memory when the program is run.

Example

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;
}
```

You can use the operating system **strings** command to look for these and other strings in an object or binary file. 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 10:28:09 2005
XL C/C++ for Linux Compiler Version 8.0
Mon Mar 1 10:28:13 2005
My copyright
```

Note:

> If the string literal specified in the *token_sequence* exceeds 32767 bytes, an information message is emitted and the pragma is ignored.

#pragma complexgcc

Description

The **#pragma complexgcc** directive instructs the compiler how to pass and return parameters of complex type.

Syntax

```
►►─#─pragma─complexgcc─(─┬─on──┬─)──────────────────────────────────────►◄
                         ├─off─┤
                         └─pop─┘
```

where suboptions do the following:

on Pushes **-qfloat=complexgcc** onto the stack. This instructs the compiler to use the GCC conventions for passing and returning parameters of complex type, by using general purpose registers.

off Pushes **-qfloat=nocomplexgcc** onto the stack. This instructs the compiler to use AIX conventions for passing and returning parameters of complex type, by using floating-point registers.

pop Removes the current setting from the stack, and restores the previous setting. If the stack is empty, the compiler will assume the **-qfloat=[no]complexgcc** setting specified on the command line, or if not specified, the compiler default for **-qfloat=[no]complexgcc**.

Notes

The current setting of this 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** compiler option. If this option is not explicitly set on the command line when invoking the compiler, the compiler default for this option is used. 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 */
}
```

Related information

- “-qcomplexgccincl” on page 64
- “-qfloat” on page 83

#pragma define

► C++

Description

The **#pragma define** directive forces the definition of a template class without actually defining an object of the class. This pragma is only provided for backward compatibility purposes.

Syntax

```
►►—#—pragma—define—(—template_classname—)——————————————————————►◄
```

where the *template_classname* is the name of the template to be defined.

Notes

A user can explicitly instantiate a class, function or member template specialization by using a construct of the form:

```
template declaration
```

For example:

```
#pragma define(Array<char>)
```

is equivalent to:

```
template class Array<char>;
```

This pragma must be defined in namespace scope (i.e. it cannot be enclosed inside a function/class body). It is used when organizing your program for the efficient or automatic generation of template functions.

Related information

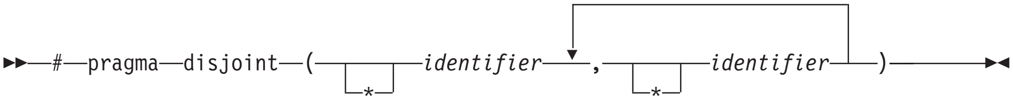
- “#pragma do_not_instantiate” on page 226
- “#pragma instantiate” on page 236

#pragma disjoint

Description

The **#pragma disjoint** directive lists the identifiers that are not aliased to each other within the scope of their use.

Syntax



Notes

The directive informs the compiler that none of the identifiers listed shares the same physical storage, which provides more opportunity for optimizations. If any identifiers actually share physical storage, the pragma may cause the program to give incorrect results.

An identifier in the directive must be visible at the point in the program where the pragma appears. The identifiers in the disjoint name list cannot refer to any of the following:

- a member of a structure, or union
- a structure, union, or enumeration tag
- an enumeration constant
- a typedef name
- a label

This pragma can be disabled with the **-qignprag** compiler option.

Example

```
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
void one_function()
{
     b = 6;
     *ptr_a = 7; // Assignment does not alter the value of b
     another_function(b); // Argument "b" has the value 6
}
```

Because external pointer `ptr_a` does not share storage with and never points to the external variable `b`, the assignment of 7 to the object that `ptr_a` points to 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 of `another_function` has the value 6 and will not reload the variable from memory.

Related information

- “-qignprag” on page 99
- “-qalias” on page 46

#pragma do_not_instantiate

C++

Description

The **#pragma do_not_instantiate** directive instructs the compiler to *not* instantiate the specified template declaration.

Syntax

```
►►──#──pragma──do_not_instantiate──template──────────────────────────────►◄
```

where *template* is a class template-id. For example:

```
#pragma do_not_instantiate Stack < int >
```

Notes

Use this pragma to suppress the implicit instantiation of a template for which a definition is supplied.

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 link-edit step.

Related information

- “#pragma define” on page 225
- “#pragma instantiate” on page 236
- “-qtempinc” on page 189
- “-qtemplateregistry” on page 190

#pragma enum

Description

The **#pragma enum** directive specifies the size of `enum` variables that follow. The size at the left brace of a declaration is the one that affects that declaration, regardless of whether further **enum** directives occur within the declaration. This pragma pushes a value on a stack each time it is used, with a reset option available to return to the previously pushed value.

Syntax

```
►►──#──pragma──enum──┬─(──suboption──)─┬──────────────────────────────────►◄
                     └─=──suboption────┘
```

where *suboption* is any of the following:

1 The enumeration type is one byte in length, of type `char` if the range of enumeration values falls within the limits of `signed char`, and `unsigned char` otherwise.

2 The enumeration type is two bytes in length, of type `short` if the range of enumeration values falls within the limits of `signed short`, and `unsigned short` otherwise.

4 The enumeration type is four bytes in length, of type `int` if the range of enumeration values falls within the limits of `signed int`, and `unsigned int` otherwise.

8 The enumeration type is eight bytes in length.
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, the enumeration is of type `long` if the range of enumeration values falls within the limits of `signed long` , and `unsigned long` otherwise.

int Same as **#pragma enum=4**.

intlong Specifies that enumeration will occupy 8 bytes of storage if the range of values in the enumeration exceeds the limit for `int`. See the description for "#pragma enum" on page 227.

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 The enumeration type is the smallest integral type that can contain all variables.

If an 8-byte enumeration results, the actual enumeration type used is dependent on compilation mode. See the description for "#pragma enum" on page 227.

pop This suboption resets the enumeration size setting to its previous **#pragma enum** setting. If there is no previous setting, the command line setting for **-qenum** is used.

reset Same as **pop**. This option is provided for backwards compatibility.

Notes

Popping on an empty stack generates a warning message and the `enum` value remains unchanged.

The **#pragma enum** directive overrides the **-qenum** compiler option.

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 is the only way to prevent one file from potentially changing the **enum** setting of another file that **#include**s it.

The **#pragma options enum** directive can be used instead of **#pragma enum**. The two pragmas are interchangeable.

A **-qenum=reset** option corresponding to the **#pragma enum=reset** directive does not exist. Attempting to use **-qenum=reset** generates a warning message and the option is ignored.

Examples

1. Usage of the **pop** and **reset** suboptions are shown in the following code segment.

```
#pragma enum(1)
#pragma enum(2)
#pragma enum(4)
#pragma enum(pop)    /* will reset enum size to 2       */
#pragma enum(reset)  /* will reset enum size to 1       */
#pragma enum(pop)    /* will reset enum size to the -qenum setting,
                        assuming -qenum was specified on the command
                        line.  If -qenum was not specified on the
                        command line, the compiler default is used. */
```

2. One typical use for the **reset** suboption is to reset the enumeration size set at the end of an include file that specifies an enumeration storage different from the default in the main file. For example, the following include file, `small_enum.h`, declares various minimum-sized enumerations, then resets the specification at the end of the include file to the last value on the option stack:

```
#ifndef small_enum_h
#define small_enum_h 1
/*
 * File small_enum.h
 * This enum must fit within an unsigned char type
 */
```

```
#pragma options enum=small
enum e_tag {a, b=255};
enum e_tag u_char_e_var; /* occupies 1 byte of storage */


/* Reset the enumeration size to whatever it was before */
#pragma options enum=reset
#endif
```

The following source file, int_file.c, includes small_enum.h:

```
/*
 * File int_file.c
 * Defines 4 byte enums
 */
#pragma options enum=int
enum testing {ONE, TWO, THREE};
enum testing test_enum;

/* various minimum-sized enums are declared */
#include "small_enum.h"

/* return to int-sized enums. small_enum.h has reset the
 * enum size
 */
enum sushi {CALIF_ROLL, SALMON_ROLL, TUNA, SQUID, UNI};
enum sushi first_order = UNI;
```

The enumerations test_enum and first_order both occupy 4 bytes of storage and are of type int. The variable u_char_e_var defined in small_enum.h occupies 1 byte of storage and is represented by an unsigned char data type.

3. If the following C 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.

4. If the following C code 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.

5. If you compile a file myprogram.C using the command:

   ```
   xlc++ myprogram.C -qenum=small
   ```

   assuming file myprogram.C does not contain **#pragma options=int** statements, all enum variables within your source file will occupy the minimum amount of storage.

6. If you compile a file yourfile.C that contains the following lines:

   ```
   enum testing {ONE, TWO, THREE};
   enum testing test_enum;

   #pragma options enum=small
   enum sushi {CALIF_ROLL, SALMON_ROLL, TUNA, SQUID, UNI};
   enum sushi first_order = UNI;

   #pragma options enum=int
   enum music {ROCK, JAZZ, NEW_WAVE, CLASSICAL};
   enum music listening_type;
   ```

   using the command:

```
xlc++ yourfile.C
```

only the enum variable first_order will be minimum-sized (that is, enum variable first_order will only occupy 1 byte of storage). The other two enum variables test_enum and listening_type will be of type int and occupy 4 bytes of storage.

The following examples show invalid enumerations or usage of **#pragma enum**:

- You cannot change the storage allocation of an enum using a **#pragma enum** within the declaration of an 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
```

- The enum constant range does not fit within the range of an unsigned int.

```
#pragma options enum=small
enum e_tag { a=0,
             b=4294967296 /* error: larger than maximum int */
           } e_var;
#pragma options enum=reset
```

Related information
- "-qenum" on page 78
- "#pragma options" on page 248

#pragma execution_frequency

Description

The **#pragma execution_frequency** directive lets you mark program source code that you expect will be either very frequently or very infrequently executed.

Syntax

```
►►──#──pragma──execution_frequency──(──┬─very_low──┬──)──────────────────────────►◄
                                       └─very_high─┘
```

Notes

Use this pragma to mark program source code that you expect will be executed very frequently or very infrequently. The pragma must be placed within block scope, and acts on the closest point of branching.

The pragma is used as a hint to the optimizer. If optimization is not selected, this pragma has no effect.

Examples

1. This 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();
   }
   ```

   The code block ″Block B″ would be 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();
   }
   ```

2. This 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.   */
   ```

3. This pragma cannot be used at file scope. It can be placed anywhere within a block scope and it 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)
```

The first and fourth pragmas are invalid, while the second and third are valid. However, only the third pragma has effect, and it affects whether program execution branches to Block A or Block B during the decision of `if (boo)`. The second pragma is ignored by the compiler.

#pragma hashome

▶ C++

Description

The **#pragma hashome** directive 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** was specified.

Syntax

```
►►─#─pragma─hashome─(─className──────────────)──────────────────────►◄
                                └─AllInlines─┘
```

where:

className specifies the name of a class that requires the above mentioned external referencing. *className* must be a class and it must be defined.

AllInlines specifies that all inline functions from within *className* should be referenced as being external. This argument is case insensitive.

Notes

A warning will be produced if there is a **#pragma ishome** without a matching **#pragma hashome**.

Example

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” on page 237

#pragma ibm snapshot

Description

The **#pragma ibm snapshot** allows the user to specify a location at which a breakpoint can be set and to define a list of variables that can be examined when program execution reaches that location.

Syntax

```
                                      ┌─,─────────────┐
                                      ▼               │
►►──#──pragma──ibm snapshot──(──────variable_name───┴──)────────────────────────►◄
```

where *variable_name* is a collection of variables. Class, structure, or union members cannot be specified.

Notes

This pragma is provided to facilitate debugging optimized code produced by the XL C/C++ compiler. During a debugging session, a breakpoint can be placed on this line to view the values of the named variables. When the program has been compiled with optimization and including the option **-g**, the named variables are guaranteed to be visible to the debugger.

Snapshot does not consistently preserve the contents of variables with a static storage class at high optimization levels.

Variables specified in **#pragma ibm snapshot** 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.

Example

```
#pragma ibm snapshot(a, b, c)
```

If a breakpoint is set through the debugger at this point in a program, the values of variables `a`, `b`, and `c` should be visible.

Related information

- “-g” on page 90
- “-O, -qoptimize” on page 148

#pragma implementation

▶ C++

Description

The **#pragma implementation** directive tells the compiler the name of the template instantiation file containing the function-template definitions. These definitions correspond to the template declarations in the include file containing the pragma.

Syntax

```
▶▶──#──pragma──implementation──(──string_literal──)──────────────────────────▶◀
```

Notes

This pragma can appear anywhere that a declaration is allowed. It is used when organizing your program for the efficient or automatic generation of template functions.

Related information

- "-qtempmax" on page 191

#pragma info

Description

The **#pragma info** directive instructs the compiler to produce or suppress specific groups of compiler messages.

Syntax

```
▶▶──#──pragma──info──(──┬─all────────┬──)────────────────────────────────────▶◀
                        ├─none───────┤
                        ├─restore────┤
                        │  ┌─,─────┐ │
                        └─▼─group──┴─┘
```

where:

all Turns on all diagnostic checking.
none Turns off all diagnostic suboptions for specific portions of your program.
restore Restores the option that was in effect before the previous **#pragma info** directive.

group Generates or suppresses all messages associated with the specified diagnostic *group*. More than one *group* name in the following list can be specified.

group	**Type of messages returned or suppressed**
c99 | noc99	C code that may behave differently between C89 and C99 language levels.
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.
inl | noinl	Functions not inlined.
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.
vft | novft	Generation of virtual function tables in C++ programs.
zea | nozea	Zero-extent arrays.

Notes

You can use the **#pragma info** directive to temporarily override the current **-qinfo** compiler option settings specified on the command line, in the configuration file, or by earlier invocations of the **#pragma info** directive.

Example

For example, in the code segments below, 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 invoked.

```
#pragma info(eff, nouni)
int MyFunction1()
{
  .
  .
  .

}

#pragma info(restore)
int MyFunction2()
{
  .
  .
  .

}
```

Related information

- "-qinfo" on page 100

#pragma instantiate

▶ C++

Description

The **#pragma instantiate** directive instructs the compiler to immediately instantiate the specified template declaration.

Syntax

```
►►—#—pragma—instantiate—template———————————————————————————————————►◄
```

where *template* is a class template-id. For example:

```
#pragma instantiate Stack < int >
```

Notes

Use this pragma if you are migrating existing code. New code should use standard C++ explicit instantiation.

If you are handling template instantiations manually (that is, **-qnotempinc** and **-qnotemplateregistry** are specified), using **#pragma instantiate** will ensure that the specified template instantiation will appear in the compilation unit.

Related information

- "#pragma define" on page 225

- “#pragma do_not_instantiate” on page 226
- “-qtempinc” on page 189
- “-qtemplateregistry” on page 190

#pragma ishome

C++

Description

The **#pragma ishome** directive 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

```
►►—#—pragma—ishome—(—className—)——————————————————————————►◄
```

where:

className Is the literal name of the class whose home will be the current compilation unit.

Notes

A warning will be produced if there is a **#pragma ishome** without a matching **#pragma hashome**.

Example

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 hashome" on page 232

#pragma isolated_call

Description

The **#pragma isolated_call** directive marks a function that does not have or rely on side effects, other than those implied by its parameters.

Syntax

```
►►──#──pragma──isolated_call──(──function──)───────────────────────────►◄
```

where *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. If the name refers to an overloaded function, all variants of that function are marked as isolated calls.

Notes

The **-qisolated_call** compiler option has the same effect as this pragma.

The pragma informs the compiler that the function listed does not have or rely on side effects, other than those implied by its parameters. Functions are considered to have or rely on side effects if they:
- Access a volatile object
- Modify an external object
- Modify a static object
- Modify a file
- Access a file that is modified by another process or thread
- Allocate a dynamic object, unless it is released before returning
- Release a dynamic object, unless it was allocated during the same invocation
- Change system state, such as rounding mode or exception handling
- Call a function that does any of the above

Essentially, any change in the state of the runtime environment is considered a side effect. Modifying function arguments passed by pointer or by reference is the only side effect that is allowed. Functions with other side effects can give incorrect results when listed in **#pragma isolated_call** directives.

Marking a function as **isolated_call** 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.

The function specified is permitted to examine non-volatile external objects and return a result that depends on the non-volatile state of the runtime environment. The function can also modify the storage pointed to by any pointer arguments passed to the function, that is, calls by reference. Do not specify a function that calls itself or relies on local static storage. Listing such functions in the **#pragma isolated_call** directive can give unpredictable results.

The **-qignprag** compiler option causes aliasing pragmas to be ignored. Use the **-qignprag** compiler option to debug applications containing the **#pragma isolated_call** directive.

Example

The following example shows the use of the **#pragma isolated_call** directive. Because the function `this_function` does not have side effects, a call to it will not change the value of the external variable `a`. The compiler can assume that the argument to `other_function` has the value 6 and will not reload the variable from memory.

```
int a;

// Assumed to have no side effects
int this_function(int);

#pragma isolated_call(this_function)
that_function()
{
   a = 6;
   // Call does not change the value of "a"
   this_function(7);

   // Argument "a" has the value 6
   other_function(a);
}
```

Related information

- "-qignprag" on page 99
- "-qisolated_call" on page 115

#pragma langlvl

Description

The **#pragma langlvl** directive selects the C language level for compilation.

Syntax

```
►►—#—pragma—langlvl—(——language——)——————————————————————————————————►◄
```

where values for *language* are described below.

C For C programs, you can specify one of the following values for *language*:

classic Allows the compilation of non-stdc89 programs, and conforms closely to the K&R level preprocessor.

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 to the ANSI C89 standard, also known as ISO C90.

stdc99 Compilation conforms to the ISO C99 standard.

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 Compilation is based on **strict98**, with some differences to accommodate extended language features.

strict98 Compilation conforms to the ISO C++ standard for C++ programs.

Default

The default language level varies according to the command you use to invoke the compiler:

Invocation	Default language level
xlc	extc89
cc	extended
c89	stdc89
c99	stdc99

Notes

This pragma can be specified only once in a source file, and it must appear before any noncommentary statements in a source file.

The compiler uses predefined macros in the header files to make declarations and definitions available that define the specified language level.

This directive can dynamically alter preprocessor behavior. As a result, compiling with the **-E** compiler option may produce results different from those produced when not compiling with the **-E** option.

Related information

- "-qlanglvl" on page 119
- "The IBM XL C language extensions" and "The IBM XL C++ language extensions" in *XL C/C++ Language Reference*

#pragma leaves

Description

The **#pragma leaves** directive takes a function name and specifies that the function never returns to the instruction after the call.

Syntax

```
                          ┌─,────────┐
                          ▼          │
►►─#─pragma─leaves─(────function───┴─)──────────────────────────────►◄
```

Notes

This pragma tells the compiler that *function* never returns to the caller.

The advantage of the pragma is that it allows the compiler to ignore any code that exists after *function*, in turn, the optimizer can generate more efficient code. This pragma is commonly used for custom error-handling functions, in which programs can be terminated if a certain error is encountered. Some functions which also behave similarily are **exit**, **longjmp**, and **terminate**.

Example

```
#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
 }
}
```

#pragma loop_id

Description

Marks a block with a scope-unique identifier.

Syntax

```
►►──#──pragma──loopid──(──name──)──────────────────────────────────────►◄
```

where *name* is an identifier that is unique within the scoping unit.

Notes

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.

Related information
- "-qunroll" on page 198
- "#pragma block_loop" on page 219
- "#pragma unroll" on page 261
- "#pragma unrollandfuse" on page 262

#pragma map

Description

The **#pragma map** directive tells the compiler that all references to an identifier are to be converted to *"name"*. *"name"* is then used in the object file and any assembly code.

Syntax

```
►►─#─pragma─map─(─┬─identifier─────────┬─,─"name"─)─────────────────────►◄
                  └─function_signature─┘
```

where:

identifier A name of a data object or a nonoverloaded function with external linkage.
C++ If the identifier is the name of an overloaded function or a member function, there is a risk that the pragma will override the compiler-generated names. This will create problems during linking.

function_signature A name of a function or operator with internal linkage. The name can be qualified.

name The external name that is to be bound to the given object, function, or operator.
C++ Specify the mangled name if linking into a C++ name (a name that will have C++ linkage signature, which is the default signature in C++). See Example 4, in the **Examples** section below.

Notes

The compiler emits a severe error message when the label name is the same as:

- an existing assembly label name that is specified on a different variable or function.
- an existing mapped name that is specified on a different variable or function by a **#pragma map**.

You should not use **#pragma map** to map the following:

- C++ member functions
- Overloaded functions
- Objects generated from templates
- Functions with built-in linkage

The directive can appear anywhere in the program. The identifiers appearing in the directive, including any type names used in the prototype argument list, are resolved as though the directive had appeared at file scope, independent of its actual point of occurrence.

If the name specified with pragma map exceeds 65535 bytes, an information message is emitted and the pragma is ignored.

Examples

Example 1 C

```
int funcname1()
{
    return 1;
}

#pragma map(func , "funcname1") //maps func to funcname1
```

```
int main()
{
   return func(); // no function prototype needed in C
}
```

Example 2 ▶ C++

```
extern "C" int funcname1()
{
  return 0;
}

extern "C" int func(); //function prototypes needed in C++

#pragma map(func , "funcname1") // maps ::func to funcname1

int main()
{
  return func();
}
```

Example 3 ▶ C++

```
#pragma map(foo, "bar")

int foo();  //function prototypes needed in C++

int main()
{
   return foo();
}

extern "C" int bar() {return 7;}
```

The following examples illustrate several cases which interaction between **#pragma map** and assembly labels may generate an error message.

Example 5

```
#pragma map(a, "abc")

// error, since the label name is the same as a map name to a
// different identifier
 int cba asm("abc");
```

Example 6

```
 int abc asm("myID");

//error, since the same label is used on two different variables
 int cba asm("myID");
```

When an asm label specification is applied to a declaration with a different label name than previously specified in a pragma map, the compiler generates an error message.

Example 7

```
#pragma map(a, "aaa")

// severe error, since "a" is already mapped by pragma map to a
// different name
 void a() asm("bbb");
```

Example 8

```
 #pragma map(a, "aaa")

// Valid declaration, Since "a" is mapped to the same name
 int a asm("aaa");
```

When a pragma map specifies a mapped name for an identifier, which conflicts with the mapped name from a previous assembly label on a different declaration, the **#pragma map** is ignored with a warning message.

Example 9

```
 int a asm("abc");

// Warning message,  since 'abc' is already used as a label name
 #pragma map(b, "abc")
```

When a **#pragma map** tries to map an identifier that already has an assembly label, the pragma map is ignored with a warning message.

Example 10

```
int a asm("abc");

 //Warning, since 'a' already has a label, pragma map is ignored
 #pragma map(a, "aaa")
```

Example 11

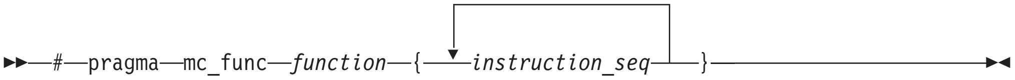
```
int a asm("abc");

// Valid declaration, Since "a" is mapped to the same name
 #pragma map(a, "abc")
```

#pragma mc_func

Description

The **#pragma mc_func** directive lets you define a function containing a short sequence of machine instructions.

Syntax



where:

function Should specify a previously-defined function in a C or C++ program. If the function is not previously-defined, the compiler will treat the pragma as a function definition.

instruction_seq Is a string containing a sequence of zero or more hexadecimal digits. The number of digits must comprise an integral multiple of 32 bits.

Notes

The **mc_func** pragma lets you 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 the `asm` keyword found in this and other compilers.

The **mc_func** pragma defines a function and should appear in your program source only where functions are ordinarily defined. The function name defined by **#pragma mc_func** should be previously declared or prototyped.

The compiler passes parameters to the function in the same way as 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. See "#pragma reg_killed_by" on page 256 for a list of volatile registers available on your system.

Code generated from *instruction_seq* 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.

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**.

If an string literal exceeding 65535 bytes is specified with pragma map, an information message is emitted and the pragma is ignored.

Example

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 ints with so-called *end-around carry*; that is, if a carry out results from the add then add the carry to the sum. This is frequently used in checksum computations.

The example also shows the use of **#pragma reg_killed_by** to list a specific set of volatile registers that can be altered 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 isolated_call" on page 238
- "#pragma reg_killed_by" on page 256
- "-qasm" on page 52

#pragma nosimd

Description

The **#pragma nosimd** directive instructs the compiler to *not* generate VMX (Vector Multimedia Extension) instructions in the loop immediately following this directive.

Syntax

```
►►──#──pragma──nosimd──────────────────────────────────────────────►◄
```

Notes

This directive has effect only for architectures that support VMX and when used with **-qhot=simd** option. With these compiler options in effect, the compiler will convert certain operations that are performed in a loop on successive elements of an array into a call to VMX (Vector Multimedia Extension) instruction. This call calculates several results at one time, which is faster than calculating each result sequentially.

The **#pragma nosimd** directive applies only to `while`, `do while`, and `for` loops.

The **#pragma nosimd** directive applies only to the loops immediately following it. The directive has no effect on other loops that may be nested within the specified loop.

The **#pragma nosimd** directive can be mixed with loop optimization and OpenMP directives without requiring any specific optimization level.

Related information
- "-qarch" on page 49
- "-qenablevmx" on page 77
- "-qhot" on page 94

#pragma novector

Description

The **#pragma novector** directive instructs the compiler to *not* auto-vectorize the loop immediately following this directive.

Syntax

```
►►──#──pragma──novector────────────────────────────────────────────►◄
```

Notes

This directive has effect only on architectures that support vectorization and when used with **-qhot=vector** option. With **-qhot=vector** in effect, the compiler will 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 vector library routine (MASS libraries). This call will calculate several results at one time, which is faster than calculating each result sequentially.

The **#pragma novector** directive applies only to `while`, `do while`, and `for` loops.

The **#pragma novector** directive applies only to the loops immediately following it. The directive has no effect on other loops that may be nested within the specified loop.

The **#pragma novector** directive can be mixed with loop optimization and OpenMP directives without requiring any specific optimization level.

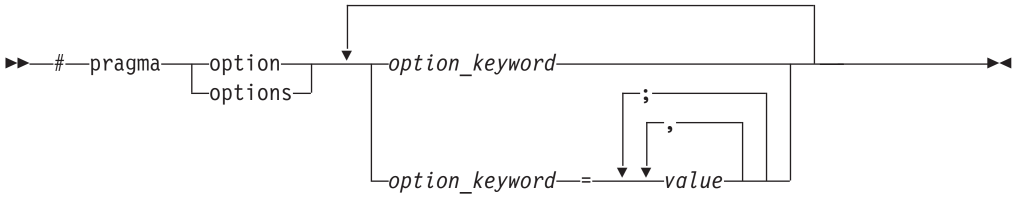
Related information
- "-qhot" on page 94

#pragma options

Description

The **#pragma options** directive specifies compiler options for your source program.

Syntax



Notes

By default, pragma options generally apply to the entire compilation unit.

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
```

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 ... */
```

Options specified before any code in your source program apply to your entire compilation unit. You can use other pragma directives throughout your program to turn an option on for a selected block of source code. For example, you can request that 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
```

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	Description
align=*option*	-qalign	Specifies what aggregate alignment rules the compiler uses for file compilation.
[no]attr attr=full	-qattr	Produces an attribute listing containing all names.
chars=*option*	-qchars See also #pragma chars	Instructs the compiler to treat all variables of type char as either `signed` or `unsigned`.
[no]check	-qcheck	Generates code which performs certain types of runtime checking.
[no]compact	-qcompact	When used with optimization, reduces code size where possible, at the expense of execution speed.
[no]dbcs	-qmbcs, -qdbcs	String literals and comments can contain DBCS characters.
▶ C [no]dbxextra	-qdbxextra	Generates symbol table information for unreferenced variables.
[no]digraph	-qdigraph	Allows special digraph and keyword operators.
[no]dollar	-qdollar	Allows the $ symbol to be used in the names of identifiers.
enum=*option*	-qenum See also #pragma enum	Specifies the amount of storage occupied by the enumerations.
flag=*option*	-qflag	Specifies the minimum severity level of diagnostic messages to be reported. Severity levels can also be specified with: #pragma options flag=i => #pragma report (level,I) #pragma options flag=w => #pragma report (level,W) #pragma options flag=e,s,u => #pragma report (level,E)
float=[no]*option*	-qfloat	Specifies various floating point options to speed up or improve the accuracy of floating point operations.
[no]flttrap=*option*	-qflttrap	Generates extra instructions to detect and trap floating point exceptions.
[no]fullpath	-qfullpath	Specifies the path information stored for files for dbx stabstrings.
[no]funcsect	-qfuncsect	Places intructions for each function in a separate csect.

Valid settings for #pragma options *option_keyword*	**Compiler option equivalent**	**Description**
halt	-qhalt	Stops compiler when errors of the specified severity detected.
[no]idirfirst	-qidirfirst	Specifies search order for user include files.
[no]ignerrno	-qignerrno	Allows the compiler to perform optimizations that assume `errno` is not modified by system calls.
ignprag=*option*	-qignprag	Instructs the compiler to ignore certain pragma statements.
[no]info=*option*	-qinfo See also #pragma info	Produces informational messages.
initauto=*value*	-qinitauto	Initializes automatic storage to a specified hexadecimal byte value.
[no]inlglue	-qinlglue	Generates fast external linkage by inlining the pointer glue code necessary to make a call to an external function or a call through a function pointer.
isolated_call=*names*	-qisolated_call See also #pragma isolated_call	Specifies functions in the source file that have no side effects.
▶ C langlvl	-qlanglvl	Specifies different language levels. This directive can dynamically alter preprocessor behavior. As a result, compiling with the **-E** compiler option may produce results different from those produced when not compiling with the **-E** option.
[no]libansi	-qlibansi	Assumes that all functions with the name of an ANSI C library function are in fact the system functions.
[no]list	-qlist	Produces a compiler listing that includes an object listing.
[no]longlong	-qlonglong	Allows `long long` types in your program.
[no]maxmem=*number*	-qmaxmem	Instructs the compiler to halt compilation when a specified number of errors of specified or greater severity is reached.
[no]mbcs	-qmbcs, -qdbcs	String literals and comments can contain DBCS characters.

Valid settings for #pragma options *option_keyword*	Compiler option equivalent	Description
[no]optimize optimize=*number*	-O, -qoptimize	Specifies the optimization level to apply to a section of program code. The compiler will accept the following values for *number*: • **0** - sets level 0 optimization • **2** - sets level 2 optimization • **3** - sets level 3 optimization If no value is specified for *number*, the compiler assumes level 2 optimization.
▶ C++ priority=*number*	-qpriority See also "#pragma priority" on page 255	Specifies the priority level for the initialization of static constructors
[no]proclocal, [no]procimported, [no]procunknown	-qproclocal, -qprocimported, -qprocunknown	Marks functions as local, imported, or unknown.
▶ C [no]proto	-qproto	If this option is set, the compiler assumes that all functions are prototyped.
[no]ro	-qro	Specifies the storage type for string literals.
[no]roconst	-qroconst	Specifies the storage location for constant values.
[no]showinc	-qshowinc	If used with **-q-qsource**, all include files are included in the source listing.
[no]source	-qsource	Produces a source listing.
spill=*number*	-qspill	Specifies the size of the register allocation spill area.
[no]stdinc	-qstdinc	Specifies which files are included with `#include <file_name>` and `#include "file_name"` directives.
[no]strict	-qstrict	Turns off aggressive optimizations of the **-O3** compiler option that have the potential to alter the semantics of your program.
tbtable=*option*	-qtbtable	Changes the length of tabs as perceived by the compiler.
tune=*option*	-qtune	Specifies the architecture for which the executable program is optimized.
[no]unroll unroll=*number*	-qunroll	Unrolls inner loops in the program by a specified factor.

Valid settings for #pragma options *option_keyword*	Compiler option equivalent	Description
C [no]upconv	-qupconv	Preserves the unsigned specification when performing integral promotions.
C++ [no]vftable	-qvftable	Controls the generation of virtual function tables.
[no]xref	-qxref	Produces a compiler listing that includes a cross-reference listing of all identifiers.

Related information

- "-E" on page 75

#pragma option_override

Description

The **#pragma option_override** directive lets you specify alternate optimization options to apply to specific functions.

Syntax

```
                                            ┌─,────────────┐
                                            ▼              │
►►──#──pragma──option_override──(──fname───"──option──"───┴──)──────────────►◄
```

Valid settings and syntax for *option*, and their corresponding command line options, are shown below:

Settings and syntax for #pragma option_override *option*	Command line option	Examples
opt(level,*number*)	-O, -O2, -O3, -O4, -O5	#pragma option_override (*fname*, "opt(level, 3)")
opt(registerSpillSize,*num*)	-qspill=*num*	#pragma option_override (*fname*, "opt(registerSpillSize,512)")
opt(size[,yes])	-qcompact	#pragma option_override (*fname*, "opt(size)") #pragma option_override (*fname*, "opt(size,yes)")
opt(size,no)	-qnocompact	#pragma option_override (*fname*, "opt(size,no)")
opt(strict)	-qstrict	#pragma option_override (*fname*, "opt(strict)")
opt(strict,no)	-qnostrict	#pragma option_override (*fname*, "opt(strict,no)")

Notes

By default, optimization options specified on the command line apply to the entire source program. However, certain types of runtime errors may occur only when optimization is turned on. This pragma lets you override command line optimization settings for specific functions (*fname*) in your program, which may be useful in identifying and correcting programming errors in those functions.

Per-function optimizations have effect only if optimization is already enabled by compilation option. You can request per-function optimizations at a level less than that applied to the rest of the program being compiled. Selecting options through this pragma affects only the specific optimization option selected, and does not affect the implied settings of related options.

Options are specified in double quotes, so they are not subject to macro expansion. The option specified within quotes must comply with the syntax of the build option.

This pragma cannot be used with overloaded member functions.

This pragma affects only functions defined in your compilation unit and can appear anywhere in the compilation unit, for example:

- before or after a compilation unit
- before or after the function definition
- before or after the function declaration
- before or after a function has been referenced
- inside or outside a function definition.

Related information

- "-O, -qoptimize" on page 148
- "-qcompact" on page 63
- "-qspill" on page 179
- "-qstrict" on page 183

#pragma pack

Description

The **#pragma pack** directive modifies the current alignment rule for members of structures following the directive.

Syntax

```
►►──#──pragma──pack──(──┬─────────┬──)───────────────────────────────────────►◄
                        ├─nopack──┤
                        ├─1───────┤
                        ├─2───────┤
                        ├─4───────┤
                        ├─8───────┤
                        ├─16──────┤
                        └─pop─────┘
```

where:

1 | 2 | 4 | 8 | 16   Members of structures are aligned on the specified byte-alignment, or on their natural alignment boundary, whichever is less, and the specified value is pushed on the stack.

nopack   No packing is applied, and **nopack** is pushed onto the pack stack

pop   The top element on the pragma pack stack is popped.

(*no argument specified*)   Specifying **#pragma pack()** has the same effect as specifying **#pragma pack(pop)**.

Notes

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 according to the alignment rule.

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 integer (int), a **#pragma pack(2)** directive would cause that member to be packed in the structure on a 2-byte boundary, while a **#pragma pack(4)** directive would have no effect.

The **#pragma pack** directive is stack based. All pack values are pushed onto a stack as the source code is parsed. The value at the top of the current pragma pack stack is the value used to pack members of all subsequent structures within the scope of the current alignment rule.

A **#pragma pack** stack is associated with the current element in the alignment rule stack. Alignment rules are specified with the **-qalign** compiler option or with the **#pragma options align** directive. If a new alignment rule is specified, a new **#pragma pack** stack is created. If the current alignment rule is popped off the alignment rule stack, the current **#pragma pack** stack is emptied and the previous **#pragma pack** stack is restored. Stack operations (pushing and popping pack settings) affect only the current **#pragma pack** stack.

The **#pragma pack** directive causes bit fields to cross bit field container boundaries.

Examples

1. In the code shown below, the structure s_t2 will have its members packed to 1-byte, but structure s_t1 will not be affected. This is because the declaration for s_t1 began before the pragma directive. However, s_t2 is affected because its declaration began after the pragma directive.

```
struct s_t1 {
    char a;
    int b;
    #pragma pack(1)
    struct s_t2 {
            char x;
            int y;
    } S2;
    char c;
    int d;
} S1;
```

2. 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):**
sizeof s_t = 16	sizeof s_t = 11
offsetof a = 0	offsetof a = 0
offsetof b = 4	offsetof b = 1
offsetof c = 8	offsetof c = 5
offsetof d = 12	offsetof d = 7
align of a = 1	align of a = 1
align of b = 4	align of b = 1
align of c = 2	align of c = 1

Default mapping:	**With #pragma pack(1):**
align of d = 4	align of d = 1

Related information

- “-qalign” on page 47
- “#pragma options” on page 248
- "Using alignment modifiers"in the *XL C/C++ Programming Guide*

#pragma priority

▶ C++

Description

The **#pragma priority** directive specifies the order in which static objects are to be initialized.

Syntax

```
►►─#─pragma─priority─(─n─)──────────────────────────────────────►◄
```

Notes

The value of *n* must be an integer literal in the range of 101 to 65535. The default value is 65535. A lower value indicates a higher priority; a higher value indicates a lower priority.

The priority value applies to all global and static objects following the **#pragma priority** directive, unless an explicit value is given by the variable attribute init_priority or another **#pragma priority** directive is encountered.

Objects with the same priority value are constructed in declaration order. Use **#pragma priority** to specify the construction order of objects across files. However, if you are creating an executable or shared library target from source files, the compiler will check dependency ordering, which may override **#pragma priority**.

For example, if a copy of object A is passed as a parameter to the object B constructor, then the compiler will arrange for A to be constructed first, even if this violates the top-to-bottom or **#pragma priority** ordering. This is essential for orderless programming, which the compiler permits. If the target is an `.obj/.lib`, this processing is not done, because there may not be enough information to detect the dependencies.

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.

Example

```
#pragma priority(1001)
```

Related information

- “-qinfo” on page 100
- "Initializing static objects in libraries"in the *XL C/C++ Programming Guide*

#pragma reachable

Description

The **#pragma reachable** directive declares that the point after the call to a routine, *function*, can be the target of a branch from some unknown location. This pragma should be used in conjunction with the `setjmp` macro.

Syntax

```
                                ┌─,────────┐
                                ▼          │
►►──#──pragma──reachable──(────function────┴──)────────────────────────────►◄
```

#pragma reg_killed_by

Description

The **#pragma reg_killed_by** directive specifies a set of volatile registers that may be altered (killed) by the specified function. This pragma can only be used on functions that are defined using **#pragma mc_func**.

Syntax

```
                                          ┌─,──────────────────────────┐
                                          ▼                            │
►►──#──pragma──reg_killed_by──function───┬────────────────────────────┬┴──────────►◄
                                         └─regid─┬───────────────┬────┘
                                                 └─-──regid──────┘
```

where:

function
The function previously defined using the **#pragma mc_func**.

regid
The symbolic name(s) of either a single register or a range of registers to be altered by the named *function*. A range of registers is identified by providing the symbolic names of both starting and ending registers, separated by a dash. If no registers are specified, no registers will be altered by the specified *function*.

The symbolic name is made up of two parts. The first part is the register class name, specified using a sequence of one or more characters in the range of ″a″ to ″z″ and/or ″A″ to ″Z″.

The second part is a integral number in the range of `unsigned int`. This number identifies a specific register number within a register class. Some register classes do not require that a register number be specified, and an error will result if you try to do so.

If *regid* is not specified, no volatile registers will be killed by the named *function*.

Registers	
Class and [register numbers]	**Description and usage**
ctr	Count register (CTR)

cr[0-7]	Condition register (CR) • Each register in this class is one of the 4-bit fields in the condition register. • Of the 8 CR fields, only **cr0**, **cr1**, and **cr5**-**cr7** can be specified by **#pragma reg_killed_by**.
fp[0-31]	Floating point registers (FPR) • Of the 32 machine registers, only **fp0**-**fp13** can be specified by **#pragma reg_killed_by**.
fs	Floating point status and control register (FPSCR)
lr	Link register (LR)
gr[0-31]	General purpose registers (GPR) • Of the 32 machine registers, only **gr0** and **gr3**-**gr12** can be specified by **#pragma reg_killed_by**.
vr[0–31]	Vector registers (VMX processors only)
xer	Fixed point exception (XER)

Notes

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.

Registers specified by *regid* must meet the following requirements:

- the class name part of the register name must be valid
- the register number is either required or prohibited
- when the register number is required, it must be in the valid range

If any of these requirements are not met, an error is issued and the pragma is ignored.

Example

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 245

#pragma report

C++

Description

The **#pragma report** directive controls the generation of specific messages. The pragma will take precedence over **#pragma info**. Specifying **#pragma report(pop)** will revert the report level to the previous level. If no previous report level was specified, then a warning will be issued and the report level will remain unchanged.

Syntax

```
►►──#──pragma──report──(──┬──level──,──┬─E─┬──────────────────┬──)──────────────────►◄
                          │            ├─W─┤                  │
                          │            └─I─┘                  │
                          ├─┬─enable──┬──,──message_number────┤
                          │ └─disable─┘                       │
                          └─pop───────────────────────────────┘
```

where:

level Indicates the minimum severity level of diagnostic messages to display.

E | W | I Used in conjunction with **level** to determine the type of diagnostic messages to display.

E Signifies a minimum message severity of ’error’. This is considered as the most severe type of diagnostic message. A report level of ’E’ will display only ’error’ messages. An alternative way of setting the report level to ’E’ is by specifying the **-qflag=e:e** compiler option.

W Signifies a minimum message severity of ’warning’. A report level of ’W’ will filter out all informational messages, and display only those messages classified as warning or error messages. An alternative way of setting the report level to ’W’ is by specifying the **-qflag=w:w** compiler option.

I Signifies a minimum message severity of ’information’. Information messages are considered as the least severe type of diagnostic message. A level of ’I’ would display messages of all types. The compiler sets this as the default option. An alternative way of setting the report level to ’I’ is by specifying the **-qflag=i:i** compiler option.

enable | disable Enables or disables the specified message number.

message_number Is an identifier containing the message number prefix, followed by the message number. An example of a message number is: CPPC1004

pop resets the report level back to the previous report level. If a pop operation is performed on an empty stack, the report level will remain unchanged and no message will be generated.

Examples

1. Specifying **#pragma info** instructs the compiler to print all informational diagnostics. The pragma report instructs the compiler to display only those messages with a severity of ’W’ or warning messages. In this case, none of the informational diagnostics will be displayed.

```
#pragma info(all)
#pragma report(level, W)
```

2. If CPPC1000 was an error message, it would be displayed. If it was any other type of diagnostic message, it would not be displayed.

   ```
   #pragma report(enable, CPPC1000)  // enables message number CPPC1000
   #pragma report(level, E)   // display only error messages.
   ```

   Changing the order of the code like so:

   ```
   #pragma report(level, E)
   #pragma report(enable, CPPC1000)
   ```

   would yield the same result. The order in which the two lines of code appear in, does not affect the outcome. However, if the message was ′disabled′, then regardless of what report level is set and order the lines of code appear in, the diagnostic message will not be displayed.
3. In line 1 of the example below, the initial report level is set to ′I′, causing message CPPC1000 to display regardless of the type of diagnostic message it is classified as. In line 3, a new report level of ′E′ is set, indicating only messages with a severity level of ′E′ will be displayed. Immediately following line 3, the current level ′E′ is ′popped′ and reset back to ′I′.

   ```
   1  #pragma report(level, I)
   2  #pragma report(enable, CPPC1000)
   3  #pragma report(level, E)
   4  #pragma report(pop)
   ```

Related information
- “-qflag” on page 82

#pragma STDC cx_limited_range

Descripton

The **STDC cx_limited_range** pragma instructs the compiler that within the scope it controls, complex division and absolute value are only invoked with values such that intermediate calculation will not overflow or lose significance. The default setting of the pragma is **off**.

Syntax

```
                                    ┌─off─────┐
►►──#──pragma──STDC cx_limited_range──┼─on──────┼──────────────────────────────►◄
                                    └─default─┘
```

Notes

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.

#pragma stream_unroll

Description

Breaks a stream contained in a `for` loop into multiple streams.

Syntax

```
►►──#──pragma──stream_unroll──(──┬───┬──)──────────────────────────────────►◄
                                 └─n─┘
```

where *n* is a loop unrolling factor. In C programs, the value of *n* is a positive integral constant expression. In C++ programs, the value of *n* is a positive scalar integer or compile-time constant initialization expression. An unroll factor of 1 disables unrolling. If *n* is not specified and if **-qhot**, **-qsmp**, or **-O4** or higher is specified, the optimizer determines an appropriate unrolling factor for each nested loop.

Notes

Neither **-O3** nor **-qipa=level=2** is sufficient to enable stream unrolling. You must additionally specify **-qhot** or **-qsmp**, or use optimization level **-O4** or higher.

For stream unrolling to occur, the **#pragma stream_unroll** directive must be the last pragma specified preceding a **for** loop. Specifying **#pragma stream_unroll** more than once for the same **for** loop or combining it with other loop unrolling pragmas (**unroll**, **nounroll**, **unrollandfuse**, **nounrollandfuse**) also results in a warning from XL C; XL C++ silently ignores all but the last of multiple loop unrolling pragmas specified on the same **for** loop.

Stream unrolling is also suppressed by compilation under certain optimization options. If option **-qstrict** is in effect, no stream unrolling takes place. Therefore, if you want to enable stream unrolling with the **-qhot** option alone, you must also specify **-qnostrict**.

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];
}
```

The increased number of read and store operations are distributed among a number of streams determined by the compiler, reducing computation time and boosting performance.

Related information

- "-qunroll" on page 198

- “#pragma unroll”
- “#pragma unrollandfuse” on page 262

#pragma strings

Description

The **#pragma strings** directive sets the storage type for string literals and specifies whether they can be placed in read-only or read-write memory.

Syntax

```
►►──#──pragma──strings──(──┬─writeable─┬──)──────────────────────────────►◄
                           └─readonly──┘
```

Notes

C Strings are read-only by default if any form of the compiler invocation **xlc** is used.

C++ Strings are read-only by default if any form of the compiler invocations **xlC** or **xlc++** is used.

This pragma must appear before any source statements in order to have effect.

Example

```
#pragma strings(writeable)
```

Related information

- “-qroconst” on page 169

#pragma unroll

Description

The **#pragma unroll** directive is used to unroll the innermost or outermost `for` loops in your program, which can help improve program performance.

Syntax

```
►►──#──pragma──┬─nounroll──────────────┬──────────────────────────────────►◄
               └─unroll──(─┬───┬─)─┘
                           └─n─┘
```

where *n* is the loop unrolling factor. In C programs, the value of *n* is a positive integral constant expression. In C++ programs, the value of *n* is a positive scalar integer or compile-time constant initialization expression. An unroll factor of 1 disables unrolling. If *n* is not specified and if **-qhot**, **-qsmp**, or **-O4** or higher is specified, the optimizer determines an appropriate unrolling factor for each nested loop.

Notes

The **#pragma unroll** and **#pragma nounroll** directives can only be used on `for` loops or a block_loop directive. It cannot be applied to `do while` and `while` loops.

The **#pragma unroll** and **#pragma nounroll** directives must appear immediately before the loop or the block_loop directive to be affected.

Only one of these directives can be specified for a given loop. 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.

Specifying **#pragma nounroll** for a loop instructs the compiler to not unroll that loop. Specifying **#pragma unroll(1)** has the same effect.

To see if the **unroll** option improves performance of a particular application, you should first compile the program with usual options, then run it with a representative workload. You should then recompile with command line **-qunroll** option and/or the **unroll** pragmas enabled, then rerun the program under the same conditions to see if performance improves.

Examples

- In this example, loop control *is* modified:

  ```
  #pragma unroll(3)
  for (i=0; i<n; i++) {
    a[i]=b[i] * c[i];
  }
  ```

  Unrolling by 3 gives:

  ```
  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

- "-qunroll" on page 198
- "#pragma unrollandfuse"

#pragma unrollandfuse

Description

This pragma instructs the compiler to attempt an unroll and fuse operation on nested for loops.

Syntax

```
►►──#──pragma──┬─nounrollandfuse──────────┬──────────────────────────────►◄
               └─unrollandfuse──(──┬───┬──)─┘
                                   └─n─┘
```

where *n* is a loop unrolling factor. In C programs, the value of *n* is a positive integral constant expression. In C++ programs, the value of *n* is a positive scalar integer or compile-time constant initialization expression. If *n* is not specified and if **-qhot**, **-qsmp**, or **-O4** or higher is specified, the optimizer determines an appropriate unrolling factor for each nested loop.

Notes

The **#pragma unrollandfuse** directive applies only to the outer loops of nested `for` loop structures 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 **nounrollandfuse**, **nounroll**, **unroll**, or **stream_unroll** directives for the same `for` loop.

Specifying **#pragma nounrollandfuse** instructs the compiler to not unroll that loop.

Examples

1. 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 structure 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];
    }
}
```

2. 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 198
- "#pragma unroll" on page 261

#pragma weak

Description

The **#pragma weak** directive prevents the link editor from issuing error messages if it does not find a definition for a symbol, or if it encounters a symbol multiply-defined during linking.

Syntax

```
►►──#──pragma──weak──identifier──┬──────────────────┬──────────────────────────►◄
                                 └─=──identifier2───┘
```

Notes

While this pragma is intended for use primarily with functions, it will also work for most data objects.

This pragma should not be used with uninitialized global data, or with shared library data objects that are exported to executables.

The dynamic linker will use the definition in whatever object appears first on the command line. Thus, the order in which the object files are presented to the linker is important.

Two forms of **#pragma weak** can be specified in your program source.

#pragma weak *identifier*

This form of the pragma defines *identifier* as a weak global symbol. References to *identifier* uses the identifier value if it is defined, otherwise *identifier* is assigned a value of 0.

If *Identifier* is defined in the same compilation unit as **#pragma weak** *identifier*, *identifier* is treated as a weak definition. If **#pragma weak** exists in a compilation unit that does not use or declare *identifier*, the pragma is accepted and ignored.

If *identifier* denotes a function with C++ linkage, *identifier* must be specified using the C++ mangled name of the function. Also, if the C++ function is a template function, you must explicitly instantiate the template function.

#pragma weak *identifier***=***identifier2*

This form of the pragma defines *identifier* as a weak global symbol. References to *identifier* will use the value of *identifier2*.

identifier2 must not be a member function.

identifier 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 *identifier* is declared in the compilation unit, *identifier*'s declaration must be compatible to that of *identifier2*. For example, if *identifier2* is a function, *identifier* must have the same return and argument types as *identifier2*.

identifier2 must be declared in the same compilation unit as **#pragma weak**.

If *identifier2* denotes a function with C++ linkage, the names of *identifier* and *identifier2* must be specified using the mangled names of the functions. If the C++ function is a template function, you must explicitly instantiate the template function.

The compiler will ignore **#pragma weak** and issue warning messages if:

- If *identifer2* (if specified) is not defined in the compilation unit.
- If *identifer2* (if specified) is a member function.
- If *identifer* is declared but its type is not compatible with that of *identifer2* (if specified).

The compiler will ignore **#pragma weak** and issue a severe error message if the weak *identifier* is defined.

Examples

1. The following is an example of the **#pragma weak** *identifier* form of the pragma:

```
// Begin Compilation Unit 1
#include <stdio.h>
extern int foo;
#pragma weak foo

int main()
{
   int *ptr;
   ptr = &foo;
   if (ptr == 0)
      printf("foo has been assigned a value of 0\n");
   else
      printf("foo was already defined\n");
}
//End Compilation Unit 1
```

```
// Begin Compilation Unit 2
int foo = 1;
// End Compilation Unit 2
```

If only Compilation Unit 1 is compiled to produce an executable, identifier `foo` will be defined and assigned the value `0`. The output from execution will be the string: ″`foo has been assigned a value of 0.`″

2. The following is an example of the **#pragma weak** *identifier***=***identifier2* form of the pragma:

```
//Begin Compilation Unit
extern "C" void printf(char *,...);

void foo1(void)
{
   printf("Just in function foo1()\n");
}


#pragma weak _Z3foov = _Z4foo1v

int main()
{
   foo();
}
//End Compilation Unit
```

Pragma directives for parallel processing

Parallel processing operations are controlled by pragma directives in your program source. The pragmas have effect only when parallelization is enabled with the **-qsmp** compiler option.

#pragma omp atomic

Description

The **omp atomic** directive identifies a specific memory location that must be updated atomically and not be exposed to multiple, simultaneous writing threads.

Syntax

```
►►──#──pragma──omp atomic──┬───────────┬──────────────────────────────►◄
                           └─statement─┘
```

where *statement* is an expression statement of scalar type that takes one of the forms that follow:

statement	**Conditions**
x bin_op = *expr*	where: *bin_op* is one of: + * - / & ^ | << >> *expr* is an expression of scalar type that does not reference *x*.
x++	
++x	

statement	**Conditions**
x--	
--x	

Notes

Load and store operations are atomic only for object *x*. Evaluation of *expr* is not atomic.

All atomic references to a given object in your program must have a compatible type.

Objects that can be updated in parallel and may be subject to race conditions should be protected with the **omp atomic** directive.

Examples

```
extern float x[], *p = x, y;

/* Protect against race conditions among multiple updates.  */
#pragma omp atomic
x[index[i]] += y;

/* Protect against races with updates through x.            */
#pragma omp atomic
p[i] -= 1.0f;
```

#pragma omp parallel

Description

The **omp parallel** directive explicitly instructs the compiler to parallelize the chosen block of code.

Syntax

```
                                  ┌─,──────┐
                                  ▼        │
►►──#──pragma──omp parallel───────clause───┴──────────────────────────────────►◄
```

where *clause* is any of the following:

if (*exp*) When the `if` argument is specified, the program code executes in parallel only if the scalar expression represented by *exp* evaluates to a non-zero value at run time. Only one `if` clause can be specified.

private (*list*) Declares the scope of the data variables in *list* to be private to each thread. Data variables in *list* are separated by commas.

firstprivate (*list*) Declares the scope of the data variables in *list* to be private to each thread. Each new private object is initialized with the value of the original variable as if there was an implied declaration within the statement block. Data variables in *list* are separated by commas.

num_threads (*int_exp*) The value of *int_exp* is an integer expression that specifies the number of threads to use for the parallel region. If dynamic adjustment of the number of threads is also enabled, then *int_exp* specifies the maximum number of threads to be used.

shared (*list*) Declares the scope of the comma-separated data variables in *list* to be shared across all threads.

default (shared | none)
Defines the default data scope of variables in each thread. Only one **default** clause can be specified on an **omp parallel** directive.

Specifying **default(shared)** is equivalent to stating each variable in a **shared(***list***)** clause.

Specifying **default(none)** requires that each data variable visible to the parallelized statement block must be explcitly listed in a data scope clause, with the exception of those variables that are:

- const-qualified,
- specified in an enclosed data scope attribute clause, or,
- used as a loop control variable referenced only by a corresponding **omp for** or **omp parallel for** directive.

copyin (*list*)
For each data variable specified in *list*, the value of the data variable in the master thread is copied to the thread-private copies at the beginning of the parallel region. Data variables in *list* are separated by commas.

Each data variable specified in the **copyin** clause must be a **threadprivate** variable.

reduction (*operator*: *list*)
Performs a reduction on all scalar variables in *list* using the specified *operator*. Reduction variables in *list* are separated by commas.

A private copy of each variable in *list* is created for each thread. At the end of the statement block, the final values of all private copies of the reduction variable are combined in a manner appropriate to the operator, and the result is placed back into the original value of the shared reduction variable.

Variables specified in the **reduction** clause:

- must be of a type appropriate to the operator.
- must be shared in the enclosing context.
- must not be const-qualified.
- must not have pointer type.

Notes

When a parallel region is encountered, a logical team of threads is formed. Each thread in the team executes all statements within a parallel region except for work-sharing constructs. Work within work-sharing constructs is distributed among the threads in a team.

Loop iterations must be independent before the loop can be parallelized. An implied barrier exists at the end of a parallelized statement block.

Nested parallel regions are always serialized.

#pragma omp for

Description

The **omp for** directive instructs the compiler to distribute loop iterations within the team of threads that encounters this work-sharing construct.

Syntax

```
                          ┌─,──────────────────┐
                          ↓                    │
►►─#─pragma─omp for───────┬────────────────────┴──────────────────────────►◄
                          └─clause─for-loop─┘
```

where *clause* is any of the following:

private (*list*)
Declares the scope of the data variables in *list* to be private to each thread. Data variables in *list* are separated by commas.

firstprivate (*list*)
Declares the scope of the data variables in *list* to be private to each thread. Each new private object is initialized as if there was an implied declaration within the statement block. Data variables in *list* are separated by commas.

lastprivate (*list*)
Declares the scope of the data variables in *list* to be private to each thread. The final value of each variable in *list*, if assigned, will be the value assigned to that variable in the last iteration. Variables not assigned a value will have an indeterminate value. Data variables in *list* are separated by commas.

reduction (*operator*:*list*)
Performs a reduction on all scalar variables in *list* using the specified *operator*. Reduction variables in *list* are separated by commas.

A private copy of each variable in *list* is created for each thread. At the end of the statement block, the final values of all private copies of the reduction variable are combined in a manner appropriate to the operator, and the result is placed back into the original value of the shared reduction variable.

Variables specified in the **reduction** clause:

- must be of a type appropriate to the operator.
- must be shared in the enclosing context.
- must not be const-qualified.
- must not have pointer type.

ordered
Specify this clause if an ordered construct is present within the dynamic extent of the **omp for** directive.

schedule (*type*)

Specifies how iterations of the **for** loop are divided among available threads. Acceptable values for *type* are:

dynamic

Iterations of a loop are divided into chunks of size **ceiling**(*number_of_iterations*/*number_of_threads*).

Chunks are dynamically assigned to threads on a first-come, first-serve basis as threads become available. This continues until all work is completed.

dynamic,*n*

As above, except chunks are set to size *n*. *n* must be an integral assignment expression of value 1 or greater.

guided

Chunks are made progressively smaller until the default minimum chunk size is reached. The first chunk is of size **ceiling**(*number_of_iterations*/*number_of_threads*). Remaining chunks are of size **ceiling**(*number_of_iterations_left*/*number_of_threads*).

The minimum chunk size is 1.

Chunks are assigned to threads on a first-come, first-serve basis as threads become available. This continues until all work is completed.

guided,*n*

As above, except the minimum chunk size is set to *n*. *n* must be an integral assignment expression of value 1 or greater.

runtime

Scheduling policy is determined at run time. Use the OMP_SCHEDULE environment variable to set the scheduling type and chunk size.

static

Iterations of a loop are divided into chunks of size **ceiling**(*number_of_iterations*/*number_of_threads*). Each thread is assigned a separate chunk.

This scheduling policy is also known as *block scheduling*.

static,*n*

Iterations of a loop are divided into chunks of size *n*. Each chunk is assigned to a thread in *round-robin* fashion.

n must be an integral assignment expression of value 1 or greater.

This scheduling policy is also known as *block cyclic scheduling*.
Note: if *n*=1, iterations of a loop are divided into chunks of size 1 and each chunk is assigned to a thread in *round-robin* fashion. This scheduling policy is also known as *block cyclic scheduling*

nowait

Use this clause to avoid the implied **barrier** at the end of the **for** directive. This is useful if you have multiple independent work-sharing sections or iterative loops within a given parallel region. Only one **nowait** clause can appear on a given **for** directive.

and where *for_loop* is a `for` loop construct with the following canonical shape:

```
for (init_expr; exit_cond; incr_expr)
 statement
```

where:

init_expr	takes form:	`iv = b`
		`integer-type iv = b`

exit_cond	takes form:	`iv <= ub`
		`iv <  ub`
		`iv >= ub`
		`iv >  ub`

incr_expr	takes form:	`++iv`
		`iv++`
		`--iv`
		`iv--`
		`iv += incr`
		`iv -= incr`
		`iv = iv + incr`
		`iv = incr + iv`
		`iv = iv - incr`

and where:

iv Iteration variable. The iteration variable must be a `signed integer` not modified anywhere within the `for` loop. It is implicitly made private for the duration of the `for` operation. If not specified as **lastprivate**, the iteration variable will have an indeterminate value after the operation completes.

b, ub, incr Loop invariant signed integer expressions. No synchronization is performed when evaluating these expressions and evaluated side effects may result in indeterminate values.

Notes

This pragma must appear immediately before the loop or loop block directive to be affected.

Program sections using the **omp for** pragma must be able to produce a correct result regardless of which thread executes a particular iteration. Similarly, program correctness must not rely on using a particular scheduling algorithm.

The `for` loop iteration variable is implicitly made private in scope for the duration of loop execution. This variable must not be modified within the body of the `for` loop. The value of the increment variable is indeterminate unless the variable is specified as having a data scope of **lastprivate**.

An implicit barrier exists at the end of the `for` loop unless the **nowait** clause is specified.

Restrictions are:

- The `for` loop must be a structured block, and must not be terminated by a `break` statement.
- Values of the loop control expressions must be the same for all iterations of the loop.
- An **omp for** directive can accept only one **schedule** clauses.
- The value of *n* (chunk size) must be the same for all threads of a parallel region.

#pragma omp ordered

Description

The **omp ordered** directive identifies a structured block of code that must be executed in sequential order.

Syntax

```
►►─#─pragma─omp ordered─────────────────────────────────────────►◄
```

Notes

The **omp ordered** directive must be used as follows:

- It must appear within the extent of a **omp for** or **omp parallel for** construct containing an **ordered** clause.
- It applies to the statement block immediately following it. Statements in that block are executed in the same order in which iterations are executed in a sequential loop.
- An iteration of a loop must not execute the same **omp ordered** directive more than once.
- An iteration of a loop must not execute more than one distinct **omp ordered** directive.

#pragma omp parallel for

Description

The **omp parallel for** directive effectively combines the **omp parallel** and **omp for** directives. This directive lets you define a parallel region containing a single **for** directive in one step.

Syntax

```
                        ┌─────────────────┐
                        │ └─,─┘           │
                        ▼                 │
►►─#─pragma─omp for─────┬─────────────────┴─────────────────────►◄
                        └─clause─for-loop─┘
```

Notes

With the exception of the **nowait** clause, clauses and restrictions described in the **omp parallel** and **omp for** directives also apply to the **omp parallel for** directive.

#pragma omp section, #pragma omp sections

Description

The **omp sections** directive distributes work among threads bound to a defined parallel region.

Syntax

```
                          ┌─,────┐
                          ▼      │
►►─#─pragma─omp sections────clause─┴─────────────────────────────►◄
```

where *clause* is any of the following:

private (*list*)
Declares the scope of the data variables in *list* to be private to each thread. Data variables in *list* are separated by commas.

firstprivate (*list*)
Declares the scope of the data variables in *list* to be private to each thread. Each new private object is initialized as if there was an implied declaration within the statement block. Data variables in *list* are separated by commas.

lastprivate (*list*)
Declares the scope of the data variables in *list* to be private to each thread. The final value of each variable in *list*, if assigned, will be the value assigned to that variable in the last **section**. Variables not assigned a value will have an indeterminate value. Data variables in *list* are separated by commas.

reduction (*operator*: *list*)
Performs a reduction on all scalar variables in *list* using the specified *operator*. Reduction variables in *list* are separated by commas.

A private copy of each variable in *list* is created for each thread. At the end of the statement block, the final values of all private copies of the reduction variable are combined in a manner appropriate to the operator, and the result is placed back into the original value of the shared reduction variable.

Variables specified in the **reduction** clause:

- must be of a type appropriate to the operator.
- must be shared in the enclosing context.
- must not be const-qualified.
- must not have pointer type.

nowait
Use this clause to avoid the implied **barrier** at the end of the **sections** directive. This is useful if you have multiple independent work-sharing sections within a given parallel region. Only one **nowait** clause can appear on a given **sections** directive.

Notes

The **omp section** directive is optional for the first program code segment inside the **omp sections** directive. Following segments must be preceded by an **omp section** directive. All **omp section** directives must appear within the lexical construct of the program source code segment associated with the **omp sections** directive.

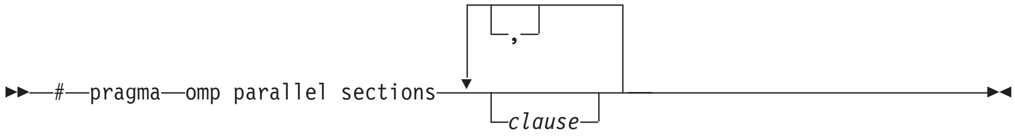
When program execution reaches a **omp sections** directive, program segments defined by the following **omp section** directive are distributed for parallel execution among available threads. A barrier is implicitly defined at the end of the larger program region associated with the **omp sections** directive unless the **nowait** clause is specified.

#pragma omp parallel sections

Description

The **omp parallel sections** directive effectively combines the **omp parallel** and **omp sections** directives. This directive lets you define a parallel region containing a single **sections** directive in one step.

Syntax



Notes

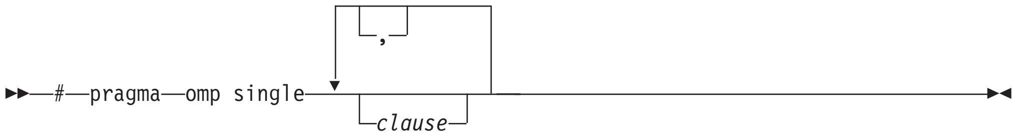
All clauses and restrictions described in the **omp parallel** and **omp sections** directives apply to the **omp parallel sections** directive.

#pragma omp single

Description

The **omp single** directive identifies a section of code that must be run by a single available thread.

Syntax



where *clause* is any of the following:

private (*list*)
Declares the scope of the data variables in *list* to be private to each thread. Data variables in *list* are separated by commas.

A variable in the **private** clause must not also appear in a **copyprivate** clause for the same **omp single** directive.

copyprivate (*list*)
Broadcasts the values of variables specified in *list* from one member of the team to other members. This occurs after the execution of the structured block associated with the **omp single** directive, and before any of the threads leave the barrier at the end of the construct. For all other threads in the team, each variable in the *list* becomes defined with the value of the corresponding variable in the thread that executed the structured block. Data variables in *list* are separated by commas. Usage restrictions for this clause are:

- A variable in the **copyprivate** clause must not also appear in a **private** or **firstprivate** clause for the same **omp single** directive.
- If an **omp single** directive with a **copyprivate** clause is encountered in the dynamic extent of a parallel region, all variables specified in the **copyprivate** clause must be private in the enclosing context.
- Variables specified in **copyprivate** clause within dynamic extent of a parallel region must be private in the enclosing context.
- A variable that is specified in the **copyprivate** clause must have an accessible and unambiguous copy assignment operator.
- The **copyprivate** clause must not be used together with the **nowait** clause.

firstprivate (*list*) Declares the scope of the data variables in *list* to be private to each thread. Each new private object is initialized as if there was an implied declaration within the statement block. Data variables in *list* are separated by commas.

A variable in the **firstprivate** clause must not also appear in a **copyprivate** clause for the same **omp single** directive.

nowait Use this clause to avoid the implied **barrier** at the end of the **single** directive. Only one **nowait** clause can appear on a given **single** directive. The **nowait** clause must not be used together with the **copyprivate** clause.

Notes

An implied barrier exists at the end of a parallelized statement block unless the **nowait** clause is specified.

#pragma omp master

Description

The **omp master** directive identifies a section of code that must be run only by the master thread.

Syntax

```
►►──#──pragma──omp master────────────────────────────────────────────►◄
```

Notes

Threads other than the master thread will not execute the statement block associated with this construct.

No implied barrier exists on either entry to or exit from the master section.

#pragma omp critical

Description

The **omp critical** directive identifies a section of code that must be executed by a single thread at a time.

Syntax

```
                           ┌,─────┐
                           ▼      │
►►──#──pragma──omp critical───(name)┴─────────────────────────────────►◄
```

where *name* can optionally be used to identify the critical region. Identifiers naming a critical region have external linkage and occupy a namespace distinct from that used by ordinary identifiers.

Notes

A thread waits at the start of a critical region identified by a given name until no other thread in the program is executing a critical region with that same name. Critical sections not specifically named by **omp critical** directive invocation are mapped to the same unspecified name.

#pragma omp barrier

Description

The **omp barrier** directive identifies a synchronization point at which threads in a parallel region will wait until all other threads in that section reach the same point. Statement execution past the **omp barrier** point then continues in parallel.

Syntax

```
►►──#──pragma──omp barrier──────────────────────────────────────────────►◄
```

Notes

The **omp barrier** directive must appear within a block or compound statement. For example:

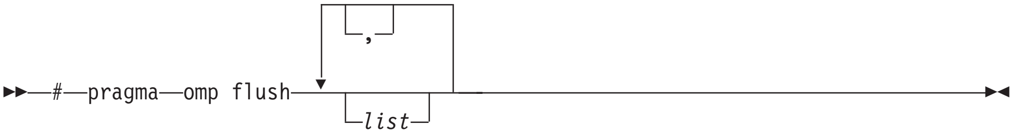
```
if (x!=0) {
   #pragma omp barrier    /* valid usage    */
}
if (x!=0)
   #pragma omp barrier    /* invalid usage  */
```

#pragma omp flush

Description

The **omp flush** directive identifies a point at which the compiler ensures that all threads in a parallel region have the same view of specified objects in memory.

Syntax



where *list* is a comma-separated list of variables that will be synchronized.

Notes

If *list* includes a pointer, the pointer is flushed, not the object being referred to by the pointer. If *list* is not specified, all shared objects are synchronized except those inaccessible with automatic storage duration.

An implied **flush** directive appears in conjunction with the following directives:

- **omp barrier**
- Entry to and exit from **omp critical**.
- Exit from **omp parallel**.
- Exit from **omp for**.
- Exit from **omp sections**.
- Exit from **omp single**.

The **omp flush** directive must appear within a block or compound statement. For example:

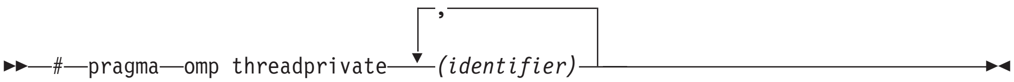
```
if (x!=0) {
   #pragma omp flush    /* valid usage    */
}
if (x!=0)
   #pragma omp flush    /* invalid usage  */
```

#pragma omp threadprivate

Description

The **omp threadprivate** directive makes the named file-scope, namespace-scope, or static block-scope variables private to a thread.

Syntax



where *identifier* is a file-scope, name space-scope or static block-scope variable.

Notes

Each copy of an **omp threadprivate** data variable is initialized once prior to first use of that copy. If an object is changed before being used to initialize a **threadprivate** data variable, behavior is unspecified.

A thread must not reference another thread's copy of an **omp threadprivate** data variable. References will always be to the master thread's copy of the data variable when executing serial and master regions of the program.

Use of the **omp threadprivate** directive is governed by the following points:

- An **omp threadprivate** directive must appear at file scope outside of any definition or declaration.
- The **omp threadprivate** directive is applicable to static-block scope variables and may appear in lexical blocks to reference those block-scope variables. The directive must appear in the scope of the variable and not in a nested scope, and must precede all references to variables in its list.
- A data variable must be declared with file scope prior to inclusion in an **omp threadprivate** directive *list*.
- An **omp threadprivate** directive and its *list* must lexically precede any reference to a data variable found in that *list*.
- A data variable specified in an **omp threadprivate** directive in one translation unit must also be specified as such in all other translation units in which it is declared.
- Data variables specified in an **omp threadprivate** *list* must not appear in any clause other than the **copyin**, **copyprivate**, **if**, **num_threads**, and **schedule** clauses.
- The address of a data variable in an **omp threadprivate** *list* is not an address constant.
- A data variable specified in an **omp threadprivate** *list* must not have an incomplete or reference type.

Chapter 6. Predefined macros

Predefined macros fall into several categories:

- Macros related to language features
- Macros indicating the XL C/C++ compiler
- Macros related to the Linux platform

Macros related to language features

The following macros can be tested for enabled C99 features, features related to GNU C or C++, and other IBM language extensions. A macro is defined to the value of 1 if the listed feature is supported under the specified compiler option. If the feature is not supported, then the macro is undefined. All predefined macros are protected.

Table 41. Predefined macros for language features

Predefined macro name	Description	Compiler option:
__ALTIVEC__	Support for vector data types	-qaltivec
__C99_BOOL	Support for the `_Bool` data type	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_COMPLEX	Support for complex data types	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_COMPLEX_HEADERS__	Support for C99-style complex headers	C++ -qlanglvl=extended
__C99_CPLUSCMT	Support for C++ style comments	C -qlanglvl=stdc99 | extc99-qcpluscmt
__C99_COMPOUND_LITERAL	Support for compound literals	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_DESIGNATED_INITIALIZER	Support for designated initialization	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_DUP_TYPE_QUALIFIER	Support for duplicated type qualifiers	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_EMPTY_MACRO_ARGUMENTS	Support for empty macro arguments	C -qlanglvl=stdc99 | extc99 | extc89 | extended C++ -qlanglvl=extended
__C99_FLEXIBLE_ARRAY_MEMBER	Support for flexible array members	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99__FUNC__	Support for the `__func__` keyword	C -qlanglvl=stdc99 | extc99 | extc89 | extended C++ -qlanglvl=extended
__C99_HEX_FLOAT_CONST	Support for hexadecimal floating constants	C -qlanglvl=stdc99 | extc99 | extc89 | extended C++ -qlanglvl=extended
__C99_INLINE	Support for the `inline` function specifier	C -qlanglvl=stdc99 | extc99 -qkeyword=inline
__C99_LLONG	Support for `long long` data types	C -qlanglvl=stdc99 | extc99
__C99_MACRO_WITH_VA_ARGS	Support for function-like macros with variable arguments	C -qlanglvl=stdc99 | extc99 | extc89 | extended C++ -qlanglvl=extended
__C99_MAX_LINE_NUMBER	New limit for `#line` directive	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_MIXED_DECL_AND_CODE	Support for mixed declaration and code	C -qlanglvl=stdc99 | extc99 | extc89 | extended
__C99_MIXED_STRING_CONCAT	Support for concatenation of wide string and non-wide string literals	C -qlanglvl=stdc99 | extc99 | extc89 | extended

Table 41. Predefined macros for language features (continued)

Predefined macro name	Description	Compiler option:
__C99_NON_LVALUE_ARRAY_SUB	Support for non-lvalue subscripts for arrays	C -qlanglvl=stdc99|extc99|extc89|extended
__C99_NON_CONST_AGGR_INITIALIZER	Support for non-constant aggregate initializers	C -qlanglvl=stdc99|extc99|extc89|extended
__C99_PRAGMA_OPERATOR	Support for the `_Pragma` operator	C -qlanglvl=stdc99|extc99|extc89|extended C++ -qlanglvl=extended
__C99_REQUIRE_FUNC_DECL	Implicit function declaration not supported	C -qlanglvl=stdc99
__C99_RESTRICT	Support for the `restrict` qualifier	C -qlanglvl=stdc99|extc99 -qkeyword=restrict C++ -qlanglvl=extended -qkeyword=restrict
__C99_STATIC_ARRAY_SIZE	Support for the `static` keyword in array parameters to functions	C -qlanglvl=stdc99|extc99|extc89|extended
__C99_STD_PRAGMAS	Support for standard pragmas	C -qlanglvl=stdc99|extc99|extc89|extended
__C99_TGMATH	Support for type-generic macros in tgmath.h	C -qlanglvl=stdc99|extc99|extc89|extended
__C99_UCN	Support for universal character names	C -qlanglvl=stdc99|extc99|ucs C++ -qlanglvl=ucs
__C99_VAR_LEN_ARRAY	Support for variable length arrays	C -qlanglvl=stdc99|extc99|extc89|extended
__C99_VARIABLE_LENGTH_ARRAY		C++ extended
__IBM__ALIGNOF__	Support for the `__alignof__` operator	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_ALTERNATE_KEYWORDS	Support for alternate keywords	C -qlanglvl=extc99|extc89|extended
__IBM_ATTRIBUTES	Support for type, variable, and function attributes	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_COMPUTED_GOTO	Support for computed `goto` statements	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_EXTENSION_KEYWORD	Support for the `__extension__` keyword	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_GCC_ASM	Support for GNU C inline `asm` statements	C -qlanglvl=extc99|extc89|extended, -qkeyword=asm, -qasm=gcc C++ -qlanglvl=extended, -qasm=gcc
__IBM_GCC__INLINE__	Support for the GNU C `__inline__` specifier	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_DOLLAR_IN_ID	Support for dollar signs in identifiers	C -qlanglvl=extc99|extc89|extended
__IBM_GENERALIZED_LVALUE	Support for generalized lvalues	C -qlanglvl=extc99|extc89|extended
__IBM_INCLUDE_NEXT	Support for the `#include_next` preprocessing directive	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_LABEL_VALUE	Support for labels as values	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
__IBM_LOCAL_LABEL	Support for local labels	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended

Table 41. Predefined macros for language features (continued)

Predefined macro name	Description	Compiler option:
__IBM_MACRO_WITH_VA_ARGS	Support for variadic macro extensions	C -qlanglvl=extc99|extc89|extended C++ -qlanglvl=extended
_IBM_NESTED_FUNCTION	Support for nested functions	C -qlanglvl=extc99|extc89|extended
__IBM_PP_PREDICATE	Support for `#assert`, `#unassert`, **#cpu**, `#machine`, and `#system` preprocessing directives	C -qlanglvl=extc99|extc89|extended
__IBM_PP_WARNING	Support for the `#warning` preprocessing directive	C -qlanglvl=extc99|extc89|extended
__IBM_REGISTER_VARS	Support for variables in specified registers	C
__IBM_STDCPP_ASM	Support for `asm` statements. If assembler code is generated, the macro has the value 1; otherwise, 0	C++
__IBM__TYPEOF__	Support for the `__typeof__` keyword	C -qlanglvl=extc99|extc89|extended, -qkeyword=typeof C++ -qlanglvl=extended, -qkeyword=typeof
__IBM_UTF_LITERAL	Support for UTF-16 and UTF-32 string literals	-qutf

Macros indicating the XL C/C++ compiler

Predefined macros related to the XL C/C++ compiler are always defined.

Predefined macro name	Description
C __IBMC__	Indicates the level of the XL C compiler as an integer constant representing version, release, and modification number.
C++ __IBMCPP__	Indicates the level of the XL C++ compiler as an integer constant representing version, release, and modification number.
C __xlc__	Indicates the level of the XL C compiler as a string displaying the version, release, modification, and fix level.
__xlC__	Indicates the level of the XL C++ compiler as a three-digit hexadecimal constant, representing version, release, and modification number. Using the XL C compiler also automatically defines this macro.

Macros related to the Linux platform

The following predefined macros are provided to facilitate porting applications between platforms.

Predefined macro name	Description
__BASE_FILE__	Defined to the fully qualified file name of the primary source file.
_BIG_ENDIAN	Defined to 1.
__BIG_ENDIAN__	Defined to 1.
_CALL_SYSV	Defined to 1.
__CHAR_UNSIGNED__	Defined to 1 if the option **-qchars=unsigned** or **#pragma chars(unsigned)** is in effect. This macro is undefined if the option **-qchars=signed** or **#pragma chars(signed)** is in effect.
__ELF__	Defined to 1 on this platform to indicate the ELF object model is in effect.
C++ __EXCEPTIONS	Defined to 1 if the **-qeh** option is in effect. Otherwise it is not defined.
__GXX_WEAK__	Undefined for C. For C++, this macro is defined to 0 for gcc V3.3 or 1 for g++ V3.5.

Predefined macro name	Description
__HOS_LINUX__	Defined to 1 if the host operating system is Linux. Otherwise it is not defined.
__linux	Defined to 1.
__linux__	Defined to 1.
__OPTIMIZE__	Defined to 2 for optimization level **-O** or **-O2**, or to 3 for optimization level **-O3** or higher.
__OPTIMIZE_SIZE__	Defined to 1 if the options **-qcompact** and **-O** are set. Otherwise it is not defined.
__powerpc	Defined to 1.
__powerpc__	Defined to 1.
__powerpc64__	Defined to 1 when compiling in 64-bit mode. Otherwise it is not defined.
__PPC	Defined to 1.
__PPC__	Defined to 1.
__PPC64__	Defined to 1 when compiling in 64-bit mode. Otherwise it is not defined.
__SIZE_TYPE__	Defined to the underlying type of `size_t` on this platform. On Linux, in 32-bit mode, the macro is defined as `unsigned int`. In 64-bit mode, the macro is defined as `unsigned long`.
__TOS_LINUX__	Defined to 1 if the target operating system is Linux. Otherwise it is not defined.
__unix	Defined to 1 on all UNIX-like platforms. Otherwise it is not defined.
__unix__	Defined to 1 on all UNIX-like platforms. Otherwise it is not defined.

Chapter 7. Built-in functions for POWER and PowerPC architectures

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 POWER and PowerPC architectures have special instructions that enable the development of highly optimized applications. Access to some POWER or 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 POWER or 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 for the Linux platform.

- "Fixed-point built-in functions"
- "Floating-point built-in functions" on page 285
- "Synchronization and atomic built-in functions" on page 289
- "Cache-related built-in functions" on page 295
- "Block-related built-in functions" on page 296
- "Miscellaneous built-in functions" on page 297
- "Built-in functions for parallel processing" on page 298

Fixed-point built-in functions

Prototype	**Description**
int __assert1(int, int, int);	Generates trap instructions for kernel debugging.
void __assert2(int);	Generates trap instructions for kernel debugging.
unsigned int __cntlz4(unsigned int);	Count Leading Zeros, 4-byte integer
unsigned int __cntlz8(unsigned long long);	Count Leading Zeros, 8-byte integer
unsigned int __cnttz4(unsigned int);	Count Trailing Zeros, 4-byte integer
unsigned int __cnttz8(unsigned long long);	Count Trailing Zeros, 8-byte integer
signed long long __llabs (signed long long);	Returns the absolute value of the argument.
unsigned short __load2r(unsigned short*);	Load Halfword Byte Reversed
unsigned int __load4r(unsigned int*);	Load Word Byte Reversed
long long int __mulhd(long long int *ra*, long long int *rb*);	Multiply High Doubleword Signed Returns the highorder 64 bits of the 128bit product of the operands *ra* and *rb*. Supported only in 64-bit mode.

Prototype	Description
unsigned long long int __mulhdu(unsigned long long int *ra*, unsigned long long int *rb*);	Multiply High Doubleword Unsigned Returns the highorder 64 bits of the 128bit product of the operands *ra* and *rb*. Supported only in 64-bit mode.
int __mulhw(int *ra*, int *rb*);	Multiply High Word Signed Returns the highorder 32 bits of the 64bit product of the operands *ra* and *rb*.
unsigned int __mulhwu(unsigned int *ra*, unsigned int *rb*);	Multiply High Word Unsigned Returns the highorder 32 bits of the 64bit product of the operands *ra* and *rb*.
int __popcnt4(unsigned int);	Returns the number of bits set for a 32-bit integer.
int __popcnt8(unsigned long long);	Returns the number of bits set for a 64-bit integer.
unsigned long __popcntb(unsigned long);	Counts the 1 bits in each byte of the source operand and places that count into the corresponding byte of the result.
int __poppar4(unsigned int);	Returns 1 if there is an odd number of bits set in a 32-bit integer. Returns 0 otherwise.
int __poppar8(unsigned long long);	Returns 1 if there is an odd number of bits set in a 64-bit integer. Returns 0 otherwise.
unsigned long long __rdlam(unsigned long long *rs*, unsigned int *shift*, unsigned long long *mask*);	Rotate Double Left and AND with Mask Rotates the contents of *rs* left *shift* bits, ANDs the rotated data with the mask. *mask* must be a constant and represent a contiguous bit field.
unsigned long long __rldimi(unsigned long long *rs*, unsigned long long *is*, unsigned int *shift*, unsigned long long *mask*);	Rotate Left Doubleword Immediate then Mask Insert Rotates *rs* left *shift* bits then inserts *rs* into *is* under bit mask *mask*. *shift* must be a constant and 0<=*shift*<=63. *mask* must be a constant and represent a contiguous bit field.
unsigned int __rlwimi(unsigned int *rs*, unsigned int *is*, unsigned int *shift*, unsigned int *mask*);	Rotate Left Word Immediate then Mask Insert Rotates *rs* left *shift* bits then inserts *rs* into *is* under bit mask *mask*. *shift* must be a constant and 0<=*shift*<=31. *mask* must be a constant and represent a contiguous bit field.
unsigned int __rlwnm(unsigned int *rs*, unsigned int *shift*, unsigned int *mask*);	Rotate Left Word then AND with Mask Rotates *rs* left *shift* bits, then ANDs *rs* with bit mask *mask*. *mask* must be a constant and represent a contiguous bit field.
unsigned int __rotatel4(unsigned int *rs*, unsigned int *shift*);	Rotate Left Word Rotates *rs* left *shift* bits.
unsigned long long __rotatel8(unsigned long long *rs*, unsigned long long *shift*);	Rotate Left Doubleword Rotates *rs* left *shift* bits.
void __store2r(unsigned short, unsigned short *);	Store 2-byte Register
void __store4r(unsigned int, unsigned int *);	Store 4-byte Register

Prototype	Description
void __tdw(long long *a*, long long *b*, unsigned int *TO*);	Trap Doubleword Compares operand *a* with operand *b*. This comparison results in five conditions which are ANDed with a 5-bit constant *TO* containing a value of **0** to **31** inclusive. If the result is not 0 the system trap handler is invoked. Each bit position, if set, indicates one or more of the following possible conditions: **0 (high-order bit)** *a* Less than *b*, using signed comparison. **1** *a* Greater than *b*, using signed comparison. **2** *a* Equal *b* **3** *a* Less than *b*, using unsigned comparison. **4 (low-order bit)** *a* Greater than *b*, using unsigned comparison. Supported only in 64-bit mode.
void __trap(int);	Trap if the Parameter is not Zero
void __trapd (long long);	Trap if the Parameter is not Zero Supported only in 64-bit mode.
void __tw(int *a*, int *b*, unsigned int *TO*);	Trap Word Compares operand *a* with operand *b*. This comparison results in five conditions which are ANDed with a 5-bit constant *TO* containing a value of **0** to **31** inclusive. If the result is not 0 the system trap handler is invoked. Each bit position, if set, indicates one or more of the following possible conditions: **0 (high-order bit)** *a* Less than *b*, using signed comparison. **1** *a* Greater than *b*, using signed comparison. **2** *a* Equal *b* **3** *a* Less than *b*, using unsigned comparison. **4 (low-order bit)** *a* Greater than *b*, using unsigned comparison.

Floating-point built-in functions

Prototype	Description
double __exp(double);	Returns the exponential value.
double __fabs(double);	Returns the absolute value of a double-precision floating-point.
float __fabss(float);	Returns the absolute value of a single-precision floating-point.

Prototype	Description
double __fcfid (double);	Floating Convert from Integer Doubleword Converts a 64bit signed fixedpoint operand to a double-precision floating-point.
double __fctid (double);	Floating Convert to Integer Doubleword Converts a floating-point operand to a 64-bit signed fixed-point integer, using the rounding mode specified by $FPSCR_{RN}$ (Floating-Point Rounding Control field in the Floating-Point Status and Control Register).
double __fctidz (double);	Floating Convert to Integer Doubleword with Rounding towards Zero Converts a floating-point operand to a 64-bit signed fixed-point integer, using the rounding mode round-toward-zero.
double __fctiw (double);	Floating Convert to Integer Word Converts a floating-point operand to a 32-bit signed fixed-point integer, using the rounding mode specified by $FPSCR_{RN}$ (Floating-Point Rounding Control field in the Floating-Point Status and Control Register).
double __fctiwz (double);	Floating Convert to Integer Word with Rounding towards Zero Converts a floating-point operand to a 32-bit signed fixed-point integer, using the rounding mode round-toward-zero.
double __fmadd(double, double, double);	Floating Point Multiply-Add
float __fmadds(float, float, float);	Floating Point Multiply-Add Short
double __fmsub(double, double, double);	Floating Point Multiply-Subtract
float __fmsubs(float, float, float);	Floating Point Multiply-Subtract
double __fmul (double, double);	Floating Point Multiply
float __fmuls (float, float);	Floating Point Multiply
double __fnabs(double);	Floating Point Negative Absolute
float __fnabss(float);	Floating Point Negative Absolute
double __fnmadd(double, double, double);	Floating Point Negative Multiply-Add
float __fnmadds (float, float, float);	Floating Point Negative Multiply-Add
double __fnmsub(double, double, double);	Floating Point Negative Multiply-Subtract __fnmsubs (*a*, *x*, *y*) = [- (*a* * *x* - *y*)]
float __fnmsubs (float, float, float);	Floating Point Negative Multiply-Subtract
float __fre (double);	Floating Point Reciprocal __fre (*x*) = [(estimate of) 1.0/*x*] Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).
float __fres (float);	Floating Point Reciprocal __fres (*x*) = [(estimate of) 1.0/*x*]

Prototype	Description
double __frim (double);	Rounds the double argument to an integer using round-to-minus-infinity mode, and returns the value as a double. Supported only when the target architecture is specified for POWER5+ processors (**-qarch** is set to **pwr5x**).
double __frin (double);	Rounds the double argument to an integer using round-to-nearest mode, and returns the value as a double. Supported only when the target architecture is specified for POWER5+ processors (**-qarch** is set to **pwr5x**).
double __frip (double);	Rounds the double argument to an integer using round-to-plus-infinity mode, and returns the value as a double. Supported only when the target architecture is specified for POWER5+ processors (**-qarch** is set to **pwr5x**).
double __friz (double);	Rounds the double argument to an integer using round-to-zero mode, and returns the value as a double. Supported only when the target architecture is specified for POWER5+ processors (**-qarch** is set to **pwr5x**).
double __frsqrte (double);	Floating Point Reciprocal Square Root __frsqrte (*x*) = [(estimate of) 1.0/sqrt(*x*)]
float __frsqrtes (float);	Floating Point Reciprocal Square Root __frsqrtes (*x*) = [(estimate of) 1.0/sqrt(*x*)]. Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).

double __fsel (double, double, double);	Floating Point Select
	if (*a* >= 0.0) then __fsel (*a*, *x*, *y*) = *x*;
	else __fsel (*a*, *x*, *y*) = *y*

float __fsels (float, float, float);	Floating point select
	if (*a* >= 0.0) then __fsels (*a*, *x*, *y*) = *x*;
	else __fsels (*a*, *x*, *y*) = *y*

double __fsqrt (double);	Floating Point Square Root __fsqrt (*x*) = square root of *x*
float __fsqrts (float);	Floating Point Square Root __fsqrts (*x*) = square root of *x*
signed long __labs (signed long);	Calculates the absolute value of a long integer.
void __mtfsb0(unsigned int *bt*);	Move to Floating Point Status/Control Register (FPSCR) Bit 0 Sets bit *bt* of the FPSCR to 0. *bt* must be a constant and 0<=*bt*<=31.
void __mtfsb1(unsigned int *bt*);	Moves to FPSCR Bit 1 Sets bit *bt* of the FPSCR to 1. *bt* must be a constant and 0<=*bt*<=31.

Prototype	**Description**
void __mtfsf(unsigned int *flm*, unsigned int *frb*);	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. *flm* must be a constant 8-bit mask.
void __mtfsfi(unsigned int *bf*, unsigned int *u*);	Move to FPSCR Field Immediate Places the value of *u* into the FPSCR field specified by *bf*. *bf* and *u* must be constants, with 0<=*bf*<=7 and 0<=*u*<=15.
double __pow(double, double);	Calculates the value of the first argument raised to the power of the second argument.
double __readflm();	Reads the FPSCR.
double __setflm(double);	Sets the FPSCR.
double __setrnd(int);	Sets the rounding mode. The allowable values for the argument are: • 0 — round to zero • 1 — round to nearest • 2 — round to +infinity • 3 — round to -infinity
void __stfiw(const int* *addr*, double *value*);	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*.
double __swdiv_nochk(double, double);	Floating-point division of `double` types; no range checking. 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. Argument restrictions: numerators equal to infinity are not allowed; denominators equal to infinity, zero, or denormalized are not allowed; the quotient of numerator and denominator may not be equal to positive or negative infinity. With **-qstrict** in effect, the result is identical bitwise to IEEE division. For correct operation in this scenario, the arguments must satisfy the following additional restrictions. Numerators must have an absolute value greater than 2 ^ (-970) and less than infinity. Denominators must have an absolute value greater than 2 ^ (-1022) and less than 2 ^ 1021. The quotient of numerator and denominator must have an absolute value greater than 2 ^ (-1021) and less than 2 ^ 1023.
double __swdiv(double, double);	Floating-point division of `double` types. No argument restrictions.

Prototype	Description
float __swdivs_nochk(float, float);	Floating-point division of `float` types; no range checking. Argument restrictions: numerators equal to infinity are not allowed; denominators equal to infinity, zero, or denormalized are not allowed; the quotient of numerator and denominator may not be equal to positive or negative infinity.
float __swdivs(float, float);	Floating-point division of `double` types. No argument restrictions.

Synchronization and atomic built-in functions

Prototype	Description
unsigned int __check_lock_mp (const int* *addr*, int *old_value*, int *new_value*);	Check Lock on Multiprocessor Systems Conditionally updates a single word variable atomically. *addr* specifies the address of the single word variable. *old_value* specifies the old value to be checked against the value of the single word variable. *new_value* specifies the new value to be conditionally assigned to the single word variable. The word variable must be aligned on a full word boundary. Return values: 1. A return value of false indicates that the single word variable was equal to the old value and has been set to the new value. 2. A return value of true indicates that the single word variable was not equal to the old value and has been left unchanged.
unsigned int __check_lockd_mp (const long long int* *addr*, long long int *old_value*, long long int *new_value*);	Check Lock Doubleword on Multiprocessor Systems Conditionally updates a doubleword variable atomically. *addr* specifies the address of the doubleword variable. *old_value* specifies the old value to be checked against the value of the doubleword variable. *new_value* specifies the new value to be conditionally assigned to the doubleword variable. The doubleword variable must be aligned on a doubleword boundary. Return values: 1. A return value of false indicates that the doubleword variable was equal to the old value and has been set to the new value. 2. A return value of true indicates that the doubleword variable was not equal to the old value and has been left unchanged. Supported only in 64-bit mode.

Prototype	Description
unsigned int __check_lock_up (const int* *addr*, int *old_value*, int *new_value*);	Check Lock on Uniprocessor Systems Conditionally updates a single word variable atomically. *addr* specifies the address of the single word variable. *old_value* specifies the old value to be checked against the value of the single word variable. *new_value* specifies the new value to be conditionally assigned to the single word variable. The word variable must be aligned on a full word boundary. Return values: • A return value of false indicates that the single word variable was equal to the old value, and has been set to the new value. • A return value of true indicates that the single word variable was not equal to the old value and has been left unchanged.
unsigned int __check_lockd_up (const long long int* *addr*, long long int *old_value*, int long long *new_value*);	Check Lock Doubleword on Uniprocessor systems Conditionally updates a doubleword variable atomically. *addr* specifies the address of the doubleword variable. *old_value* specifies the old value to be checked against the value of the doubleword variable. *new_value* specifies the new value to be conditionally assigned to the doubleword variable. The doubleword variable must be aligned on a doubleword boundary. Return values: • A return value of false indicates that the doubleword variable was equal to the old value, and has been set to the new value. • A return value of true indicates that the doubleword variable was not equal to the old value and has been left unchanged. Supported only in 64-bit mode.
void __clear_lock_mp (const int* *addr*, int *value*);	Clear Lock on Multiprocessor Systems Atomic store of the *value* into the single word variable at the address *addr*. The word variable must be aligned on a full word boundary.
void __clear_lockd_mp (const long long int* *addr*, long long int *value*);	Clear Lock Doubleword on Multiprocessor Systems Atomic store of the *value* into the doubleword variable at the address *addr*. The doubleword variable must be aligned on a doubleword boundary. Supported only in 64-bit mode.
void __clear_lock_up (const int* *addr*, int *value*);	Clear Lock on Uniprocessor Systems Atomic store of the *value* into the single word variable at the address *addr*. The word variable must be aligned on a full word boundary.

Prototype	Description
void __clear_lockd_up (const long long int* *addr*, long long int *value*);	Clear Lock Doubleword on Uniprocessor Systems Atomic store of the *value* into the doubleword variable at the address *addr*. The doubleword variable must be aligned on a doubleword boundary. Supported only in 64-bit mode.
int __compare_and_swap(volatile int* *addr*, int* *old_val_addr*, int *new_val*);	Performs an atomic operation which compares the contents of a single word variable with a stored old value. If the values are equal, a new value is stored in the single word variable and 1 is returned; otherwise, the single word variable is not updated and 0 is returned. In either case, the contents of the memory location specified by *addr* are copied into the memory location specified by *old_val_addr*. 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. The memory location that is taken as the input parameter*addr* must be 4-byte aligned. If `__compare_and_swap` is used as a locking primitive, insert a call to the `__isync` built-in function at the start of any critical sections.
int __compare_and_swaplp(volatile long* *addr*, long* *old_val_addr*, long *new_val*);	Performs an atomic operation which compares the contents of a doubleword variable with a stored old value. If the values are equal, a new value is stored in the doubleword variable and 1 is returned; otherwise, the doubleword variable is not updated and 0 is returned. In either case, the contents of the memory location specified by*addr* are copied into the memory location specified by *old_val_addr*. The memory location that is taken as the input parameter*addr* must be 8-byte aligned. This function is useful when a doubleword value must be updated only if it has not been changed since it was last read. If `__compare_and_swaplp` is used as a locking primitive, insert a call to the `__isync` built-in function at the start of any critical sections. Supported only in 64-bit mode.
void __eieio(void);	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. This built-in function is useful to manage 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.

Prototype	Description
int __fetch_and_add(volatile int* *addr*, int *val*);	Increments the single word specified by *addr* by the amount specified by *val* in a single atomic operation. The return value is equal to the original contents of the memory location. The address specified by *addr* must be 4-byte aligned. This operation is useful when a counter variable is shared between several threads or processes.
long __fetch_and_addlp(volatile long* *addr*, long *val*);	Increments the doubleword specified by *addr* by the amount specified by *val* in a single atomic operation. The return value is equal to the original contents of the memory location. The address specified by *addr* must be 8-byte aligned. This operation is useful when a counter variable is shared between several threads or processes. Supported only in 64-bit mode.
unsigned int __fetch_and_and(volatile unsigned int* *addr*, unsigned int *val*);	Clears bits in the single word specified by*addr* by AND-ing that value with the input *val* parameter, in a single atomic operation. The return value is equal to the original contents of the memory location. The address specified by *addr* must be 4-byte aligned. This operation is useful when a variable containing bit flags is shared between several threads or processes.
unsigned long __fetch_and_andlp(volatile unsigned long* *addr*, unsigned long *val*);	Clears bits in the doubleword specified by *addr* by AND-ing that value with the input *val* parameter, in a single atomic operation. The return value is equal to the original contents of the memory location. The address specified by *addr* must be 8-byte aligned. This operation is useful when a variable containing bit flags is shared between several threads or processes. Supported only in 64-bit mode.
unsigned int __fetch_and_or(volatile unsigned int* *addr*, unsigned int*val*);	Sets bits in the single word specified by *addr* by OR-ing that value with the input *val* parameter, in a single atomic operation. The return value is equal to the original contents of the memory location. The address specified by *addr* must be 4-byte aligned. This operation is useful when a variable containing bit flags is shared between several threads or processes.

Prototype	**Description**
unsigned long __fetch_and_orlp(volatile unsigned long* *addr*, unsigned long *val*;	Sets bits in the doubleword specified by *addr* by OR-ing that value with the input *val* parameter, in a single atomic operation. The return value is equal to the original contents of the memory location. The address specified by *addr* must be 8-byte aligned. This operation is useful when a variable containing bit flags is shared between several threads or processes. Supported only in 64-bit mode.
unsigned int __fetch_and_swap(volatile unsigned int* *addr*, unsigned int*val*);	Sets the single word specified by *addr* to the value or the input *val* parameter and returns the original contents of the memory location, in a single atomic operation.The address specified by *addr* must be 4-byte aligned. 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.
unsigned long __fetch_and_swaplp(volatile unsigned long* *addr*, unsigned long *val*);	Sets the doubleword specified by *addr* to the value or the input *val* parameter and returns the original contents of the memory location, in a single atomic operation. The address specified by *addr* must be 8-byte aligned. 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. Supported only in 64-bit mode.
void __iospace_eieio(void);	Alternate name for the `__eieio` built-in function (described above).
void __iospace_lwsync(void);	Alternate name for the `__lwsync` built-in function (described below).
void __iospace_sync(void);)	Alternate name for the `__sync` built-in function (described below).
void __isync(void);	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	Description
long __ldarx(volatile long* addr);	Load Doubleword and Reserve Indexed Loads the value from the memory location specified by *addr* and returns the result. *addr* must be 8-byte aligned. Can be used with a subsequent `__stdcx` 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 297 for a description of the `__fence` built-in function. Supported only in 64-bit mode.
int __lwarx(volatile int* addr);	Load Word and Reserve Indexed Loads the value from the memory location specified by *addr* and returns the result. In 64-bit mode, the compiler returns the sign-extended result. *addr* must be 4-byte aligned. Can be used with a subsequent `__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 `__lwarx` function is executed and the time the `__stwcx` function completes. This has the same effect as inserting `__fence` built-in functions before and after the `__lwarx` built-in function and can inhibit compiler optimization of surrounding code.
void __lwsync(void);	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	Description
int __stdcx(volatile long* addr, long val);	Store Doubleword Conditional Indexed Stores the value specified by *val* into the memory location specified by *addr*, and returns 1 if the update of the specified memory location is successful and 0 if it is unsuccessful. *addr* must be 8-byte aligned. Can be used with a preceding `__ldarx` 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. Supported only in 64-bit mode.
int __stwcx(volatile int* addr, int val);	Store Word Conditional Indexed Stores the value specified by *val* into the memory location specified by *addr*, and returns 1 if the update of the specified memory location is successful and 0 if it is unsuccessful. *addr* must be 4-byte aligned. Can be used with a preceding `__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 `__lwarx` function is executed and the time the `__stwcx` function completes. This has the same effect as inserting `__fence` built-in functions before and after the `__stwcx` built-in function and can inhibit compiler optimization of surrounding code.
void __sync(void);	Ensures that all instructions preceding the function the call to `__sync` complete before any instructions following the function call can execute.

Cache-related built-in functions

Prototype	Description
void __dcbt (void *);	Data Cache Block Touch Loads the block of memory containing the specified address into the data cache.
void __dcbz (void *);	Data Cache Block set to Zero Sets a cache line containing the specified address in the data cache to zero (0).
void __prefetch_by_load(const void*);	Touches a memory location by using an explicit load.

Prototype	**Description**
void __prefetch_by_stream(const int, const void*);	Touches a memory location by using an explicit stream.
void __protected_stream_count(unsigned int *unit_cnt*, unsigned int *ID*);	Sets *unit_cnt* number of cache lines for the limited length protected stream with identifier *ID*. *unit_cnt* must be an integer with value of 0 to 1023. Stream *ID* must have integer value 0 to 15. Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).
void __protected_stream_go();	Starts prefetching all limited-length protected streams. Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).
void __protected_stream_set(unsigned int *direction*, const void* *addr*, unsigned int *ID*);	Establishes a limited length protected stream using identifier *ID*, which begins with the cache line at *addr* and then depending on the value of *direction*, fetches from either incremental (forward) or decremental (backward) memory addresses. The stream is protected from being replaced by any hardware detected streams. *direction* must have value of 1 (forward) or 3 (backward). Stream *ID* must have integer value 0 to 15. Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).
void __protected_unlimited_stream_set_go (unsigned int *direction*, const void* *addr*, unsigned int *ID*);	Establishes an unlimited length protected stream using identifier *ID*, which begins with the cache line at *addr* and then depending on the value of *direction*, fetches from either incremental (forward) or decremental (backward) memory addresses. The stream is protected from being replaced by any hardware detected streams. *Direction* must have value of 1 (forward) or 3 (backward). Stream *ID* must have integer value 0 to 15. Supported only when the target architecture is specified for POWER5 or PowerPC 970 processors (**-qarch** is set to **pwr5**, **pwr5x**, or **ppc970**).
void __protected_stream_stop(unsigned int *ID*);	Stops prefetching the protected steam with identifier *ID*. Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).
void __protected_stream_stop_all();	Stops prefetching all protected steams. Supported only when the target architecture is specified for POWER5 processors (**-qarch** is set to **pwr5** or **pwr5x**).

Block-related built-in functions

Prototype	**Description**
void __bcopy(char *, char *, size_t);	Block copy for 64-bit systems
void __bzero(void *, size_t);	Block zero

Miscellaneous built-in functions

Prototype	Description
void __alignx(int *alignment*, const void **address*);	Informs the compiler that the specified *address* is aligned at a known compile-time offset. *alignment* must be a positive constant integer with a value greater than zero and of a power of two.
void __builtin_return_address (unsigned int *level*);	Returns the return address of the current function, or of one of its callers. Where *level* argument is 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 yields the return address of the current function, a value of 1 yields the return address of the caller of the current function and so on. **Notes:** 1. When the top of the stack is reached, the function will return 0. 2. The *level* must range from 0 to 63, otherwise a warning message will be issued and the compilation will halt. 3. When functions are inlined, the return address corresponds to that of the function that is returned to. 4. Compiler optimization may affect expected return value due to introducing extra stack frames or fewer stack frames than expected due to optimizations such as inlining.
void __builtin_frame_address (unsigned int *level*);	Returns the address of the function frame of the current function, or of one of its callers. Where *level* argument is 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 yields the return the frame address of the current function, a value of 1 yields the return the frame address of the caller of the current function and so on. **Notes:** 1. When the top of the stack is reached, the function will return 0. 2. The *level* must range from 0 to 63, otherwise a warning message will be issued and the compilation will halt. 3. When functions are inlined, the frame address corresponds to that of the function that is returned to. 4. Compiler optimization may affect expected return value due to introducing extra stack frames or fewer stack frames than expected due to optimizations such as inlining.
void __fence(void);	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. This construct is useful to guarantee the ordering of instructions in the object code generated by the compiler when optimization is enabled.

Prototype	Description
unsigned long __mftb();	Move from Time Base In 32-bit compilation mode, returns the lower word of the time base register, and can be used in conjunction with the__mftbu built-in function to read the entire time base register. In 64-bit mode, returns the entire doubleword time base register. **Note:** It is recommended that you insert the __fence built-in function before and after the __mftb built-in function.
unsigned int __mftbu();	Move from Time Base Upper In 32-bit compilation mode, returns the upper word of the time base register, and can be used in conjunction with the __mftb built-in function to read the entire time base register. In 64-bit mode, returns the entire doubleword time base register; therefore, separate use of __mftbu is unnecessary. **Note:** It is recommended that you insert the __fence built-in function before and after the __mftbu built-in function.
unsigned long __mfmsr (void);	Moves the contents of the MSR into bits 32 to 63 of the designated GPR. Execution of this instruction is privileged and restricted to supervisor mode only.
unsigned __mfspr(const int *registerNumber*);	Returns the value of given special purpose register *registerNumber*. The *registerNumber* must be known at compile time.
void __mtmsr (unsigned long);	Moves the contents of bits 32 to 63 of the designated GPR into the MSR. Execution of this instruction is privileged and restricted to supervisor mode only.
void __mtspr(const int *registerNumber*, unsigned long *value*);	Sets the value of special purpose register *registerNumber* with unsigned long *value*. Both values must be known at compile time.

Built-in functions for parallel processing

Use these built-in functions to obtain information about the parallel environment. Function definitions for the **omp_** functions can be found in the omp.h header file.

Prototype	Description
int omp_get_num_threads(void);	Returns the number of threads currently in the team executing the parallel region from which it is called.
void omp_set_num_threads(int *num_threads*);	Overrides the setting of the OMP_NUM_THREADS environment variable, and specifies the number of threads to use in parallel regions following this directive. The value *num_threads* must be a positive integer. If the num_threads clause is present, then for the parallel region it is applied to, it supersedes the number of threads requested by the omp_set_num_threads library function or the OMP_NUM_THREADS environment variable. Subsequent parallel regions are not affected by it.

Prototype	Description
int omp_get_max_threads(void);	Returns the maximum value that can be returned by calls to `omp_get_num_threads`.
int omp_get_thread_num(void);	Returns the thread number, within its team, of the thread executing the function. The thread number lies between 0 and `omp_get_num_threads()`-1, inclusive. The master thread of the team is thread 0.
int omp_get_num_procs(void);	Returns the maximum number of processors that could be assigned to the program.
int omp_in_parallel(void);	Returns non-zero if it is called within the dynamic extent of a parallel region executing in parallel; otherwise, it returns 0.
void omp_set_dynamic(int dynamic_threads);	Enables or disables dynamic adjustment of the number of threads available for execution of parallel regions.
int omp_get_dynamic(void);	Returns non-zero if dynamic thread adjustments enabled and returns 0 otherwise.
void omp_set_nested(int nested);	Enables or disables nested parallelism.
int omp_get_nested(void);	Returns non-zero if nested parallelism is enabled and 0 if it is disabled.

void omp_init_lock(omp_lock_t **lock*);
void omp_init_nest_lock(omp_nest_lock_t **lock*);
	These functions provide the only means of initializing a lock. Each function initializes the lock associated with the parameter *lock* for use in subsequent calls.

void omp_destroy_lock(omp_lock_t **lock*);
void omp_destroy_nest_lock(omp_nest_lock_t **lock*);
	These functions ensure that the specified lock variable *lock* is uninitialized.

void omp_set_lock(omp_lock_t *lock);
void omp_set_nest_lock(omp_nest_lock_t *lock);
	Each of these functions blocks the thread executing the function until the specified lock is available and then sets the lock. A simple lock is available if it is unlocked. A nestable lock is available if it is unlocked or if it is already owned by the thread executing the function.

void omp_unset_lock(omp_lock_t *lock);
void omp_unset_nest_lock(omp_nest_lock_t *lock);
	These functions provide the means of releasing ownership of a lock.

int omp_test_lock(omp_lock_t *lock);
int omp_test_nest_lock(omp_nest_lock_t *lock);
	These functions attempt to set a lock but do not block execution of the thread.

double omp_get_wtime(void);	Returns the time elapsed from a fixed starting time. The value of the fixed starting time is determined at the start of the current program, and remains constant throughout program execution.
double omp_get_wtick(void);	Returns the number of seconds between clock ticks.

Note: In the current implementation, nested parallel regions are always serialized. As a result, `omp_set_nested` does not have any effect, and `omp_get_nested` always returns 0.

For complete information about OpenMP runtime library functions, refer to the OpenMP C/C++ Application Program Interface specification in www.openmp.org.

Related information

- Chapter 7, "Built-in functions for POWER and PowerPC architectures," on page 283

Appendix A. 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 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 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 42. Redistributable libraries

Package name	Libraries (and default installation path)	Description
vacpp.rte	/opt/ibmcmp/lib/libibmc++.so.1 /opt/ibmcmp/lib64/libibmc++.so.1	C++ runtime libraries
xlsmp.rte	/opt/ibmcmp/lib/libxlomp_ser.so.1 /opt/ibmcmp/lib/libxlsmp.so.1 /opt/ibmcmp/lib64/libxlomp_ser.so.1 /opt/ibmcmp/lib64/libxlsmp.so.1	SMP (OMP) runtime libraries
xlsmp.msg.rte	/opt/ibmcmp/msg/en_US/smprt.cat /opt/ibmcmp/msg/en_US.utf8/smprt.cat	SMP message catalogs (English)
	/opt/ibmcmp/msg/ja_JP/smprt.cat /opt/ibmcmp/msg/ja_JP.eucjp/smprt.cat /opt/ibmcmp/msg/ja_JP.utf8/smprt.cat	SMP message catalogs (Japanese)
	/opt/ibmcmp/msg/zh_CN/smprt.cat /opt/ibmcmp/msg/zh_CN.gb18030/smprt.cat /opt/ibmcmp/msg/zh_CN.gb2312/smprt.cat /opt/ibmcmp/msg/zh_CN.gbk/smprt.cat /opt/ibmcmp/msg/zh_CN.utf8/smprt.cat	SMP message catalogs (Chinese)

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Appendix B. ASCII character set

XL C/C++ uses the American National Standard Code for Information Interchange (ASCII) character set.

The following table lists the standard ASCII characters in ascending numerical order, with their corresponding decimal, octal, and hexadecimal values. It also shows the control characters with **Ctrl-** notation. For example, the carriage return (ASCII symbol **CR**) appears as **Ctrl-M**, which you enter by simultaneously pressing the **Ctrl** key and the **M** key.

Decimal value	Octal value	Hex value	Control character	ASCII symbol	Meaning
0	0	00	Ctrl-@	NUL	null
1	1	01	Ctrl-A	SOH	start of heading
2	2	02	Ctrl-B	STX	start of text
3	3	03	Ctrl-C	ETX	end of text
4	4	04	Ctrl-D	EOT	end of transmission
5	5	05	Ctrl-E	ENQ	enquiry
6	6	06	Ctrl-F	ACK	acknowledge
7	7	07	Ctrl-G	BEL	bell
8	10	08	Ctrl-H	BS	backspace
9	11	09	Ctrl-I	HT	horizontal tab
10	12	0A	Ctrl-J	LF	new line
11	13	0B	Ctrl-K	VT	vertical tab
12	14	OC	Ctrl-L	FF	form feed
13	15	0D	Ctrl-M	CR	carriage return
14	16	0E	Ctrl-N	SO	shift out
15	17	0F	Ctrl-O	SI	shift in
16	20	10	Ctrl-P	DLE	data link escape
17	21	11	Ctrl-Q	DC1	device control 1
18	22	12	Ctrl-R	DC2	device control 2
19	23	13	Ctrl-S	DC3	device control 3
20	24	14	Ctrl-T	DC4	device control 4
21	25	15	Ctrl-U	NAK	negative acknowledge
22	26	16	Ctrl-V	SYN	synchronous idle
23	27	17	Ctrl-W	ETB	end of transmission block
24	30	18	Ctrl-X	CAN	cancel
25	31	19	Ctrl-Y	EM	end of medium
26	32	1A	Ctrl-Z	SUB	substitute
27	33	1B	Ctrl-[	ESC	escape
28	34	1C	Ctrl-\	FS	file separator

Decimal value	Octal value	Hex value	Control character	ASCII symbol	Meaning
29	35	1D	Ctrl-]	GS	group separator
30	36	1E	Ctrl-^	RS	record separator
31	37	1F	Ctrl-_	US	unit separator
32	40	20		SP	digit select
33	41	21		!	exclamation point
34	42	22		"	double quotation mark
35	43	23		#	pound sign, number sign
36	44	24		$	dollar sign
37	45	25		%	percent sign
38	46	26		&	ampersand
39	47	27		'	apostrophe
40	50	28		(	left parenthesis
41	51	29		)	right parenthesis
42	52	2A		*	asterisk
43	53	2B		+	addition sign
44	54	2C		,	comma
45	55	2D		-	subtraction sign
46	56	2E		.	period
47	57	2F		/	right slash
48	60	30		0	
49	61	31		1	
50	62	32		2	
51	63	33		3	
52	64	34		4	
53	65	35		5	
54	66	36		6	
55	67	37		7	
56	70	38		8	
57	71	39		9	
58	72	3A		:	colon
59	73	3B		;	semicolon
60	74	3C		<	less than
61	75	3D		=	equal
62	76	3E		>	greater than
63	77	3F		?	question mark
64	100	40		@	at sign
65	101	41		A	
66	102	42		B	
67	103	43		C	

Decimal value	Octal value	Hex value	Control character	ASCII symbol	Meaning
68	104	44		D	
69	105	45		E	
70	106	46		F	
71	107	47		G	
72	110	48		H	
73	111	49		I	
74	112	4A		J	
75	113	4B		K	
76	114	4C		L	
77	115	4D		M	
78	116	4E		N	
79	117	4F		O	
80	120	50		P	
81	121	51		Q	
82	122	52		R	
83	123	53		S	
84	124	54		T	
85	125	55		U	
86	126	56		V	
87	127	57		W	
88	130	58		X	
89	131	59		Y	
90	132	5A		Z	
91	133	5B		[	left bracket
92	134	5C		\	left slash, backslash
93	135	5D		]	right bracket
94	136	5E		^	hat, circumflex, caret
95	137	5F		_	underscore
96	140	60		`	grave accent
97	141	61		a	
98	142	62		b	
99	143	63		c	
100	144	64		d	
101	145	65		e	
102	146	66		f	
103	147	67		g	
104	150	68		h	
105	151	69		i	
106	152	6A		j	
107	153	6B		k	

Decimal value	Octal value	Hex value	Control character	ASCII symbol	Meaning
108	154	6C		l	
109	155	6D		m	
110	156	6E		n	
111	157	6F		o	
112	160	70		p	
113	161	71		q	
114	162	72		r	
115	163	73		s	
116	164	74		t	
117	165	75		u	
118	166	76		v	
119	167	77		w	
120	170	78		x	
121	171	79		y	
122	172	7A		z	
123	173	7B		{	left brace
124	174	7C		|	logical or, vertical bar
125	175	7D		}	right brace
126	176	7E		~	similar, tilde
127	177	7F		DEL	delete

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The following standards are supported:

- The C language is consistent with the International Standard for Information Systems-Programming Language C (ISO/IEC 9899-1999 (E)).
- The C++ language is consistent with the International Standard for Information Systems-Programming Language C++ (ISO/IEC 14882:1998).
- The C and C++ languages are consistent with the OpenMP C and C++ application programming interface, Version 1.0.

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