IBM XL Fortran Advanced Edition V10.1 for Linux

Compiler Reference

SC09-8019-00

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Note!
Before using this information and the product it supports, be sure to read the general information under "Notices" on page 267.

First Edition (November 2005)

This edition applies to Version 10.1 of IBM XL Fortran Advanced Edition V10.1 for Linux (Program 5724-M17) and to all subsequent releases and modifications until otherwise indicated in new editions. Make sure you are using the correct edition for the level of the product.

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Contents

About this document

This document describes the IBM® XL Fortran Advanced Edition V10.1 for Linux® compiler and explains how to set up the compilation environment and how to compile, link, and run programs written in the in the Fortran language. This guide also contains cross-references to relevant topics of other reference guides in the XL Fortran documentation suite.

Who should read this document

This document is for anyone who wants to work with the XL Fortran compiler, is familiar with the Linux operating system, and who has some previous Fortran programming experience. Users new to XL Fortran can use this document to find information on the capabilities and features unique to XL Fortran. This document 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

While this document covers information about configuring the compiler, and compiling, linking and running XL Fortran programs, it does not include information on the following topics, which are covered in other documents:

- Installation, system requirements, last-minute updates: see the *XL Fortran Installation Guide* and product README.
- Overview of XL Fortran features: see the *Getting Started with XL Fortran Advanced Edition V10.1 for Linux* .
- Syntax, semantics, and implementation of the XL Fortran programming language: see the *XL Fortran Language Reference*.
- Optimizing, porting, OpenMP/ SMP programming: see the *XL Fortran Optimization and Programming Guide*.
- Operating system commands related to the use of the compiler: consult your Linux-specific distribution's man page help and documentation.

How this document is organized

This document starts with an overview of the compiler and provides information on the tasks you need to do before invoking the compiler. It then continues with reference information about the compiler options and debugging problems.

This reference includes the following topics:

- Chapter 1, "Introduction" through Chapter 4, "Editing, compiling, linking, and running XL Fortran programs" discuss setting up the compilation environment and the environment variables that you need for different compilation modes, customizing the configuration file, the types of input and output files, compiler listings and messages and information specific to invoking the preprocessor and linkage editor.
- Chapter 5, "XL Fortran compiler option reference" contains a table summarizing the compiler options by their functional category. You can search for options by their name, or alternatively use the links in the functional category tables and look up options according to their functionality. This section also includes

individual descriptions of the compiler options sorted alphabetically. Descriptions provide examples and list related topics.

- Chapter 6, "Using XL Fortran in a 64-Bit Environment" discusses application development for the 64-bit environment.
- Chapter 7, "Problem determination and debugging" addresses debugging and understanding compiler listings.
- Appendix A, "XL Fortran technical information" and Appendix B, "XL Fortran internal limits" provide information that advanced programmers may need to diagnose unusual problems and run the compiler in a specialized environment.

Conventions and terminology used in this document

Typographical conventions

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

Table 1. Typographical conventions

Typeface	Indicates	Example
bold	Commands, executable names, and compiler options.	By default, if you use the **-qsmp** compiler option in conjunction with one of these invocation commands, the option **-qdirective=IBM*:SMP$:$OMP:IBMP:IBMT** will be on.
italics	Parameters or variables whose actual names or values are to be supplied by the user. Italics are also used to introduce new terms.	The maximum length of the *trigger_constant* in fixed source form is 4 for directives that are continued on one or more lines.
UPPERCASE bold	Fortran programming keywords, statements, directives, and intrinsic procedures.	The **ASSERT** directive applies only to the **DO** loop immediately following the directive, and not to any nested **DO** loops.
lowercase bold	Lowercase programming keywords and library functions, compiler intrinsic procedures, file and directory names, examples of program code, command strings, or user-defined names.	If you call **omp_destroy_lock** with an uninitialized lock variable, the result of the call is undefined.

How to read syntax diagrams

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

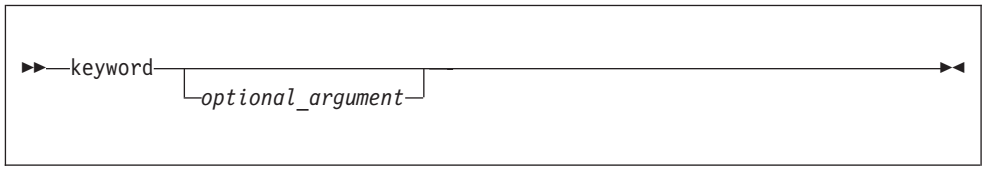
If a variable or user-specified name ends in *_list*, you can provide a list of these terms separated by commas.

You must enter punctuation marks, parentheses, arithmetic operators, and other special characters as part of the syntax.

- Read syntax diagrams from left to right and from top to bottom, following the path of the line:
  - The ►►── symbol indicates the beginning of a statement.

  - The ⟶ symbol indicates that the statement syntax continues on the next line.
  - The ►— symbol indicates that a statement continues from the previous line.
  - The ⟶◄ symbol indicates the end of a statement.
  - Program units, procedures, constructs, interface blocks and derived-type definitions consist of several individual statements. For such items, a box encloses the syntax representation, and individual syntax diagrams show the required order for the equivalent Fortran statements.
  - IBM XL Fortran extensions to and implementations of language standards are marked by a number in the syntax diagram with an explanatory note immediately following the diagram.
- Required items are shown on the horizontal line (the main path):

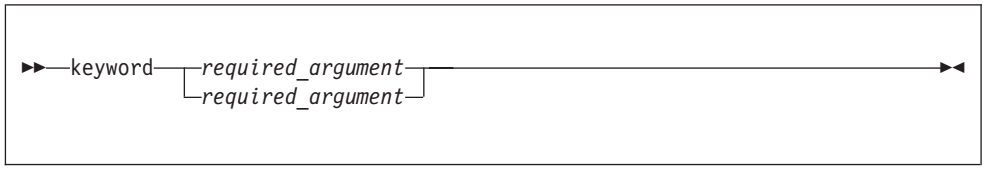
- Optional items are shown below the main path:



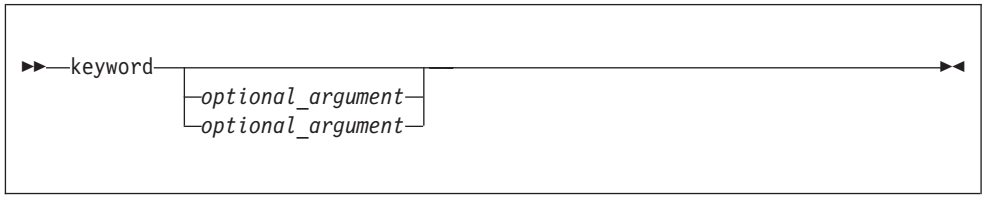
Note: Optional items (not in syntax diagrams) are enclosed by square brackets ([and]). For example, `[UNIT=]u`

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

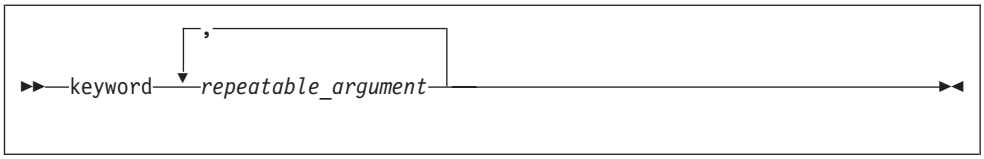
  If you *must* choose one of the items, one item of the stack is shown on the main path:



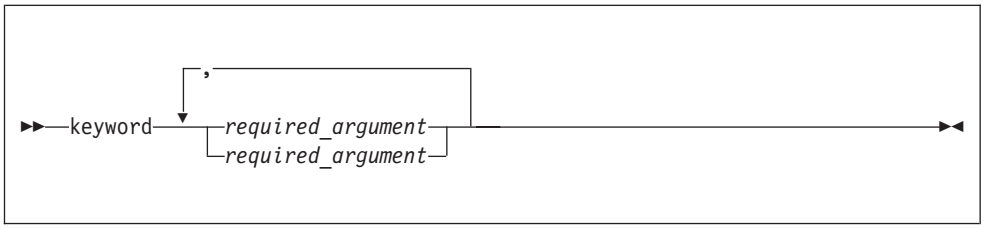
  If choosing one of the items is optional, the entire stack is shown below the main path:



- An arrow returning to the left above the main line (a repeat arrow) indicates that you can repeat an item, and the separator character if it is other than a blank:

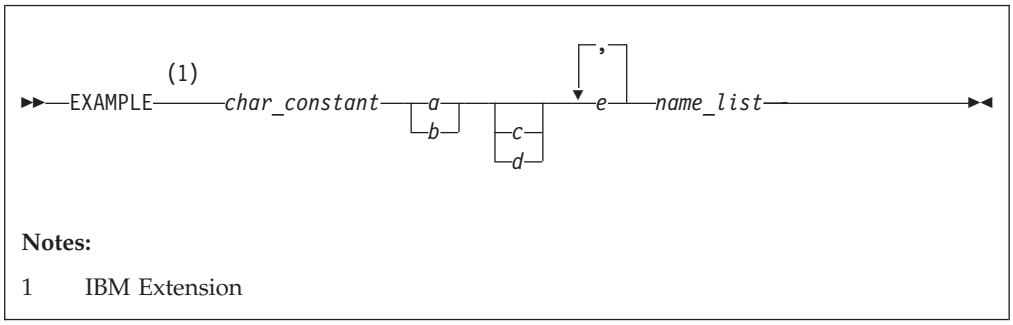


A repeat arrow above a stack indicates that you can make more than one choice from the items in the stack.



Sample syntax diagram

The following is an example of a syntax diagram with an interpretation:



Interpret the diagram as follows:

- Enter the keyword EXAMPLE.
- EXAMPLE is an IBM extension.
- Enter a value for *char_constant*.
- Enter a value for *a* or *b*, but not for both.
- Optionally, enter a value for *c* or *d*.
- Enter at least one value for *e*. If you enter more than one value, you must put a comma between each.
- Enter the value of at least one *name* for *name_list*. If you enter more than one value, you must put a comma between each. (The *_list* syntax is equivalent to the previous syntax for *e*.)

How to read syntax statements

Syntax statements are read from left to right:

- Individual required arguments are shown with no special notation.
- When you must make a choice between a set of alternatives, they are enclosed by { and } symbols.
- Optional arguments are enclosed by [and] symbols.
- When you can select from a group of choices, they are separated by | characters.
- Arguments that you can repeat are followed by ellipses (...).

Example of a syntax statement

```
EXAMPLE char_constant {a|b}[c|d]e[,e]... name_list{name_list}...
```

The following list explains the syntax statement:

- Enter the keyword **EXAMPLE**.
- Enter a value for *char_constant*.
- Enter a value for *a* or *b*, but not for both.
- Optionally, enter a value for *c* or *d*.
- Enter at least one value for *e*. If you enter more than one value, you must put a comma between each.
- Optionally, enter the value of at least one *name* for *name_list*. If you enter more than one value, you must put a comma between each *name*.

Note: The same example is used in both the syntax-statement and syntax-diagram representations.

Examples

The examples in this document are coded in a simple style that does not try to conserve storage, check for errors, achieve fast performance, or demonstrate recommended practice.

The examples in this document use the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **xlf**, **xlf_r**, **f77**, **fort77**, **f90**, and **f95** compiler invocation commands interchangeably. For more substantial source files, one of these commands may be more suitable than the others, as explained in "Compiling XL Fortran programs" on page 15.

Some sample programs from this document and some other programs that illustrate ideas presented in this document are in the directory **/opt/ibmcmp/xlf/10.1/samples**.

Notes on path names

The path names shown in this document assume the default installation path for the XL Fortran compiler. By default, XL Fortran will be installed in the following directory on the selected disk:

```
/opt/ibmcmp/xlf/10.1
```

You can select a different destination (*relocation-path*) for the compiler. If you choose a different path, the compiler will be installed in the following directory:

```
relocation-path/opt/ibmcmp/xlf/10.1
```

Notes on the terminology used

Some of the terminology in this document is shortened, as follows:

- The term *free source form format* will often appear as *free source form*.
- The term *fixed source form format* will often appear as *fixed source form*.
- The term *XL Fortran* will often appear as *XLF*.

Related information

IBM XL Fortran documentation

XL Fortran 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/xlf/10.1` 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 *IBM XL Fortran Advanced Edition V10.1 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 Fortran 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/xlf/10.1/doc/`*`language`*`/pdf` directory, where *language* can be one of the following supported languages:
  - en_US (U.S. English)
  - ja_JP (Japanese)

  PDF documents are also available on the Web at:
  http://www.ibm.com/software/awdtools/fortran/xlfortran/library

  In addition to this document, the following files comprise the full set of XL Fortran product manuals:

Table 2. XL Fortran PDF files

Document title	PDF file name	Description
IBM XL Fortran Advanced Edition V10.1 for Linux Installation Guide	install.pdf	Contains information for installing XL Fortran and configuring your environment for basic compilation and program execution.
Getting Started with XL Fortran Advanced Edition V10.1 for Linux	getstart.pdf	Contains an introduction to the XL Fortran product, with overview information on setting up and configuring your environment, compiling and linking programs, and troubleshooting compilation errors.
IBM XL Fortran Advanced Edition V10.1 for Linux Compiler Reference	cr.pdf	Contains information on setting up and configuring your compilation environment, compiling, linking and running programs, troubleshooting compilation errors, and descriptions of the various compiler options.
IBM XL Fortran Advanced Edition V10.1 for Linux Language Reference	lr.pdf	Contains information about the Fortran programming language as supported by IBM, including language extensions for portability and conformance to non-proprietary standards, compiler directives, and intrinsic procedures.
IBM XL Fortran Advanced Edition V10.1 for Linux Optimization and Programming Guide	opg.pdf	Contains information on advanced programming topics, such as application porting, interlanguage calls, floating-point operations, input/output, application optimization and parallelization, and the XL Fortran 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 http://www.adobe.com

Additional documentation

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

http://www.ibm.com/software/awdtools/fortran/xlfortran/library

Operating system and other documentation is available as follows:

- The ***RPM home page*** at URL `http://www.rpm.org/` covers all aspects of the standard Linux installation procedure using the RPM Package Manager (RPM).
- For general information and documentation on Linux, visit ***The Linux Documentation Project*** at URL `http://www.tldp.org/`. Consult your Linux-specific distribution's man page help and documentation for information on using your operating system and its features.
- Visit the ***Linux at IBM*** home page at URL `http://www.ibm.com/linux/` for information on IBM-related offerings for Linux.
- *System V Application Binary Interface: PowerPC Processor Supplement* is a supplement to the generic System V ABI and contains information specific to System V implementations built on the PowerPC Architecture™ operating in 32-bit mode.
- *64–bit PowerPC ELF Application Binary Interface Supplement* is a supplement to the generic System V ABI and contains information specific to System V implementations built on the PowerPC Architecture operating in 64-bit mode.

Related documentation

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
- *ESSL for Linux on POWER V4.2 Guide and Reference*

Standards documents

XL Fortran is designed according to the following standards. You can refer to these standards for precise definitions of some of the features found in this document.

- *American National Standard Programming Language FORTRAN*, ANSI X3.9-1978.
- *American National Standard Programming Language Fortran 90*, ANSI X3.198-1992. (This document uses its informal name, Fortran 90.)
- *ANSI/IEEE Standard for Binary Floating-Point Arithmetic*, ANSI/IEEE Std 754-1985.
- *Federal (USA) Information Processing Standards Publication Fortran*, FIPS PUB 69-1.
- *Information technology - Programming languages - Fortran*, ISO/IEC 1539-1:1991 (E).
- *Information technology - Programming languages - Fortran - Part 1: Base language*, ISO/IEC 1539-1:1997. (This document uses its informal name, Fortran 95.)
- *Information technology - Programming languages - Fortran - Floating-Point Exception Handling*, ISO/IEC JTC1/SC22/WG5 N1379.
- *Information technology - Programming languages - Fortran - Enhance Data Type Facilities*, ISO/IEC JTC1/SC22/WG5 N1378.
- *Military Standard Fortran DOD Supplement to ANSI X3.9-1978*, MIL-STD-1753 (United States of America, Department of Defense standard). Note that XL

Fortran supports only those extensions documented in this standard that have also been subsequently incorporated into the Fortran 90 standard.

- *OpenMP Application Program Interface, Version 2.5, (May 2005)* specification.

Technical support

Additional technical support is available from the XL Fortran 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 Fortran Support page on the Web at:

http://www.ibm.com/software/awdtools/fortran/xlfortran/support

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

compinfo@ca.ibm.com

For the latest information about XL Fortran, visit the product information site at:

http://www.ibm.com/software/awdtools/fortran/xlfortran

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 Fortran 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 Fortran, and, if applicable, the specific location of the text you are commenting on (for example, a page number or table number).

Chapter 1. Introduction

IBM XL Fortran Advanced Edition V10.1 for Linux is an optimizing, standards-based, command-line compiler for the Linux operating system, running on PowerPC® hardware with the PowerPC architecture. The XL Fortran compiler enables application developers to create and maintain optimized 32-bit and 64-bit applications for the Linux operating system. The compiler also offers a diversified portfolio of optimization techniques that allow an application developer to exploit the multi-layered architecture of the PowerPC processor.

The implementation of the Fortran programming language is intended to promote portability among different environments by enforcing conformance to language standards. A program that conforms strictly to its language specification will have maximum portability among different environments. In theory, a program that compiles correctly with one standards-conforming compiler will compile and execute correctly under all other conforming compilers, insofar as hardware differences permit. A program that correctly exploits the extensions to the programming language in which it is written can improve the efficiency of its object code.

XL Fortran Advanced Edition V10.1 for Linux can be used for large, complex, and computationally intensive programs. It also supports interlanguage calls with C/C++. For applications that require SIMD (single-instruction, multiple data) parallel processing, performance improvements can be achieved through optimization techniques, which may be less labor-intensive than vector programming. Many of the optimizations developed by IBM are controlled by compiler options and directives.

Chapter 2. Overview of XL Fortran features

This section discusses the features of the XL Fortran compiler, language, and development environment at a high level. It is intended for people who are evaluating XL Fortran and for new users who want to find out more about the product.

Hardware and operating-system support

The XL Fortran Advanced Edition Version 10.1 compiler is supported on several Linux distributions. See the *IBM XL Fortran Advanced Edition V10.1 for Linux Installation Guide* and README file for a list of supported distributions and requirements.

The compiler, its generated object programs, and run-time library will run on all POWER3™, POWER4™, POWER5™, PowerPC 970, and PowerPC systems with the required software, disk space, and virtual storage.

The POWER3, POWER4, POWER5, or POWER5+™ processor is a type of PowerPC. In this document, any statement or reference to the PowerPC also applies to the POWER3, POWER4, POWER5, or POWER5+ processor.

To take maximum advantage of different hardware configurations, the compiler provides a number of options for performance tuning based on the configuration of the machine used for executing an application.

Language support

The XL Fortran language consists of the following:

- The full American National Standard Fortran 90 language (referred to as Fortran 90 or F90), defined in the documents *American National Standard Programming Language Fortran 90*, ANSI X3.198-1992 and *Information technology - Programming languages - Fortran*, ISO/IEC 1539-1:1991(E). This language has a superset of the features found in the FORTRAN 77 standard. It adds many more features that are intended to shift more of the tasks of error checking, array processing, memory allocation, and so on from the programmer to the compiler.
- The full ISO Fortran 95 language standard (referred to as Fortran 95 or F95), defined in the document *Information technology - Programming languages - Fortran - Part 1: Base language*, ISO/IEC 1539-1:1997.
- Extensions to the Fortran 95 standard:
  - Industry extensions that are found in Fortran products from various compiler vendors
  - Extensions specified in SAA Fortran
- Partial support of the Fortran 2003 standard

In the *XL Fortran Language Reference*, extensions to the Fortran 95 language are marked as described in the *Typographical Conventions* topic.

Migration support

The XL Fortran compiler helps you to port or to migrate source code among Fortran compilers by providing full Fortran 90 and Fortran 95 language support and selected language extensions (intrinsic functions, data types, and so on) from many different compiler vendors. Throughout this document, we will refer to these extensions as "industry extensions".

To protect your investment in FORTRAN 77 source code, you can easily invoke the compiler with a set of defaults that provide backward compatibility with earlier versions of XL Fortran. The **xlf**, **xlf_r**, **f77**, and **fort77** commands provide maximum compatibility with existing FORTRAN 77 programs. The default options provided with the **f90**, **xlf90** and **xlf90_r** commands give access to the full range of Fortran 90 language features. The default options provided with the **f95**, **xlf95** and **xlf95_r** commands give access to the full range of Fortran 95 language features.

Additionally, you can name your source files with extensions such as **.f77**, **.f90**, or **.f95** and use the generic compiler invocations such as **xlf** or **xlf_r** to automatically select language-level appropriate defaults.

Source-code conformance checking

To help you find anything in your programs that might cause problems when you port to or from different Fortran 2003, FORTRAN 77, Fortran 90, or Fortran 95 compilers, the XL Fortran compiler provides options that warn you about features that do not conform to certain Fortran definitions.

If you specify the appropriate compiler options, the XL Fortran compiler checks source statements for conformance to the following Fortran language definitions:

- Full Fortran 2003 Standard (**-qlanglvl=2003std** option), full American National Standard FORTRAN 77 (**-qlanglvl=77std** option), full American National Standard Fortran 90 (**-qlanglvl=90std** option), and full Fortran 95 standard (**-qlanglvl=95std** option)
- Fortran 90, less any obsolescent features (**-qlanglvl=90pure** option)
- Fortran 95, less any obsolescent features (**-qlanglvl=95pure** option)
- Fortran 2003, less any obsolescent features (**-qlanglvl=2003pure** option)
- IBM SAA® FORTRAN (**-qsaa** option)

You can also use the **langlvl** environment variable for conformance checking.

Note: Fortran 2003 conformance checking is based on XL Fortran's current, subset implementation of this standard.

Highly configurable compiler

You can invoke the compiler by using the **xlf**, **xlf_r**, **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f77**, or **fort77** command. The **xlf**, **xlf_r**, and **f77** commands maintain maximum compatibility with the behavior and I/O formats of XL Fortran Version 2. The **f90**, **xlf90** and **xlf90_r** commands provide more Fortran 90 conformance and some implementation choices for efficiency and usability. The **f95**, **xlf95** and **xlf95_r** commands provide more Fortran 95 conformance and some implementation choices for efficiency and usability. The **f77** or **fort77** command provides maximum compatibility with the XPG4 behavior.

The main difference between the set of **xlf_r**, **xlf90_r**, and **xlf95_r** commands and the set of **xlf**, **xlf90**, **xlf95**, **f77**, **fort77**, **f90**, and **f95** commands is that the first set links and binds the object files to the thread-safe components (libraries, and so on). You can have this behavior with the second set of commands by using the **-F** compiler option to specify the configuration file stanza to use. For example:

```
xlf -F/etc/opt/ibmcmp/xlf/10.1/xlf.cfg:xlf_r
```

You can control the actions of the compiler through a set of options. The different categories of options help you to debug, to optimize and tune program performance, to select extensions for compatibility with programs from other platforms, and to do other common tasks that would otherwise require changing the source code.

To simplify the task of managing many different sets of compiler options, you can customize the single file **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg** instead of creating many separate aliases or shell scripts.

Related information:
- "Customizing the configuration file" on page 10
- "Compiling XL Fortran programs" on page 15
- "Summary of the XL Fortran compiler options" on page 39 and "Detailed descriptions of the XL Fortran compiler options" on page 63
- "Understanding XL Fortran messages" on page 244

Diagnostic listings

The compiler output listing has optional sections that you can include or omit. For information about the applicable compiler options and the listing itself, refer to "Options that control listings and messages" on page 49 and Chapter 8, "Understanding XL Fortran compiler listings," on page 251.

The **-S** option gives you a true assembler source file.

Symbolic debugger support

You can use **gdb** and other symbolic debuggers for your programs.

Program optimization

The XL Fortran compiler helps you control the optimization of your programs:
- You can select different levels of compiler optimizations.
- You can turn on separate optimizations for loops, floating point, and other categories.
- You can optimize a program for a particular class of machines or for a very specific machine configuration, depending on where the program will run.

The *XL Fortran Optimization and Programming Guide* provides a road map and optimization strategies for these features.

Chapter 3. Setting up and customizing XL Fortran

This section explains how to customize XL Fortran settings for yourself or all users. The full installation procedure is beyond the scope of this section, which refers you to the documents that cover the procedure in detail.

This section can also help you to diagnose problems that relate to installing or configuring the compiler.

Some of the instructions require you to be a superuser, and so they are only applicable if you are a system administrator.

Where to find installation instructions

To install the compiler, refer to these documents (preferably in this order):

1. Read the file called **/opt/ibmcmp/xlf/10.1/doc/en_US/README**, and follow any directions it gives. It contains information that you should know and possibly distribute to other people who use XL Fortran.
2. Read the *XL Fortran Installation Guide* to see if there are any important notices you should be aware of or any updates you might need to apply to your system before doing the installation.
3. You should be familiar with the RPM Package Manager (RPM) for installing this product. For information on using RPM, visit the RPM Web page at URL **http://www.rpm.org/**, or type **rpm --help** at the command line.

   If you are already experienced with Linux software installation, you can use the **rpm** command to install all the images from the distribution medium.

Using the compiler on a network file System

If you want to use the XL Fortran compiler on a Network File System server for a networked cluster of machines, use the Network Install Manager.

The following directories contain XL Fortran components:

- **/opt/ibmcmp/xlf/10.1/bin** contains the compiler invocation commands.
- **/opt/ibmcmp/xlf/10.1/exe** contains executables and files that the compiler needs.
- **/opt/ibmcmp/xlf/10.1/lib** and **/opt/ibmcmp/xlf/10.1/lib64** contain the non-redistributable libraries.
- **/opt/ibmcmp/lib/** and **/opt/ibmcmp/lib64/** contain the redistributable libraries.
- **/opt/ibmcmp/xlf/10.1/include** contains the include files and supplied **.mod** files.
- **/opt/ibmcmp/msg** contains the message catalogues for the redistribtable run-time libraries.
- **/opt/ibmcmp/xlf/10.1/doc/en_US/pdf** contains the PDF format of the English XL Fortran publications.

  /opt/ibmcmp/xlf/10.1/doc/ja_JP/pdf contains the PDF format of the Japanese XL Fortran publications.
- **/opt/ibmcmp/xlf/10.1/doc/en_US/html** contains the HTML format of the English XL Fortran publications.

  /opt/ibmcmp/xlf/10.1/doc/ja_JP/html contains the HTML format of the Japanese XL Fortran publications.

You must copy the **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg** file from the server to the client. The **/etc/opt/ibmcmp/xlf/10.1** directory contains the configuration files specific to a machine, and it should not be mounted from the server.

Correct settings for environment variables

You can set and export a number of environment variables for use with the operating system. The following sections deal with the environment variables that have special significance to the XL Fortran compiler, application programs, or both.

Environment variable basics

You can set the environment variables from shell command lines or from within shell scripts. (For more information about setting environment variables, see the man page help for the shell you are using.) If you are not sure which shell is in use, a quick way to find out is to issue **echo $SHELL** to show the name of the current shell.

To display the contents of an environment variable, enter the command **echo $***var_name*.

Note: For the remainder of this document, most examples of shell commands use **Bash** notation instead of repeating the syntax for all shells.

Environment variables for national language support

Diagnostic messages and the listings from the compiler appear in the default language that was specified at installation of the operating system. If you want the messages and listings to appear in another language, you can set and export the following environment variables before executing the compiler:

LANG Specifies the *locale*. A locale is divided into categories. Each category contains a specific aspect of the locale data. Setting **LANG** may change the national language for all the categories.

NLSPATH Refers to a list of directory names where the message catalogs may be found.

For example, to specify the Japanese locale, set the **LANG** environment variable to **ja_JP**.

Substitute any valid national language code for **ja_JP**, provided the associated message catalogs are installed.

These environment variables are initialized when the operating system is installed and may be different from the ones that you want to use with the compiler.

Each category has an environment variable associated with it. If you want to change the national language for a specific category but not for other categories, you can set and export the corresponding environment variable.

For example:

LC_MESSAGES
Specifies the national language for the messages that are issued. It affects messages from the compiler and XLF-compiled programs, which may be displayed on the screen or stored in a listing, module, or other compiler output file.

LC_TIME
Specifies the national language for the time format category. It primarily affects the compiler listings.

LC_CTYPE
Defines character classification, case conversion, and other character attributes. For XL Fortran, it primarily affects the processing of multibyte characters.

LC_NUMERIC
Specifies the format to use for input and output of numeric values. Setting this variable in the shell *does not* affect either the compiler or XLF-compiled programs. The first I/O statement in a program sets the **LC_NUMERIC** category to **POSIX**. Therefore, programs that require a different setting must reset it after this point and should restore the setting to **POSIX** for all I/O statements.

Notes:

1. Specifying the **LC_ALL** environment variable overrides the value of the **LANG** and other **LC_** environment variables.
2. If the XL Fortran compiler or application programs cannot access the message catalogs or retrieve a specific message, the message appears in U.S. English.
3. The backslash character, ****, has the same hexadecimal code, X'5C', as the Yen symbol and can appear as the Yen symbol on the display if the locale is Japanese.

Related information: "Selecting the language for run-time messages" on page 29.

See the Linux-specific documentation and man page help for more information about National Language Support environment variables and locale concepts.

Setting library search paths

If your executable program is linked with shared libraries, you need to set the run-time library search paths. There are two ways to set run-time library search paths. You can use:

- The **-R** (or **-rpath**) compile/link option, or
- The **LD_LIBRARY_PATH** and **LD_RUN_PATH** environment variables

Specifying search paths with the compile/link **-R** (or **-rpath**) option has the effect of writing the specified run-time library search paths into the executable program. If you use the **-L** option, library search paths are searched at link time, but are not written into the executable as run-time library search paths. For example:

```
# Compile and link
xlf95 -L/usr/lib/mydir1 -R/usr/lib/mydir1 -L/usr/lib/mydir2 -R/usr/lib/mydir2
  -lmylib1 -lmylib2 test.f

# -L directories are searched at link time.
# -R directories are searched at run time.
```

You can also use the **LD_LIBRARY_PATH** and **LD_RUN_PATH** environment variables to specify library search paths. Use **LD_RUN_PATH** to specify the directories that are to be searched for libraries at run time. Use **LD_LIBRARY_PATH** to specify the directories that are to be searched for libraries at both link and run time.

For more information on linker options and environment variables, see the man pages for the **ld** command.

PDFDIR: Specifying the directory for PDF profile information

When you compile a Fortran program with the **-qpdf** compiler option, you can specify the directory where profiling information is stored by setting the **PDFDIR** environment variable to the name of the directory. The compiler creates the files to hold the profile information. XL Fortran updates the files when you run an application that is compiled with the **-qpdf1** option.

Because problems can occur if the profiling information is stored in the wrong place or is updated by more than one application, you should follow these guidelines:

- Always set the **PDFDIR** variable when using the **-qpdf** option.
- Store the profiling information for each application in a different directory, or use the **-qipa=pdfname=[filename]** option to explicitly name the temporary profiling files according to the template provided.
- Leave the value of the **PDFDIR** variable the same until you have completed the PDF process (compiling, running, and compiling again) for the application.

TMPDIR: Specifying a directory for temporary files

The XL Fortran compiler creates a number of temporary files for use during compilation. An XL Fortran application program creates a temporary file at run time for a file opened with **STATUS='SCRATCH'**. By default, these files are placed in the directory **/tmp**.

If you want to change the directory where these files are placed, perhaps because **/tmp** is not large enough to hold all the temporary files, set and export the **TMPDIR** environment variable before running the compiler or the application program.

If you explicitly name a scratch file by using the **XLFSCRATCH**_*unit* method described below, the **TMPDIR** environment variable has no effect on that file.

XLFSCRATCH_unit: Specifying names for scratch files

To give a specific name to a scratch file, you can set the run-time option **scratch_vars=yes**; then set one or more environment variables with names of the form **XLFSCRATCH**_*unit* to file names to use when those units are opened as scratch files. See *Naming scratch files* in the *XL Fortran Optimization and Programming Guide* for examples.

XLFUNIT_unit: Specifying names for implicitly connected files

To give a specific name to an implicitly connected file or a file opened with no **FILE=** specifier, you can set the run-time option **unit_vars=yes**; then set one or more environment variables with names of the form **XLFUNIT**_*unit* to file names. See *Naming files that are connected with no explicit name* in the *XL Fortran Optimization and Programming Guide* for examples.

Customizing the configuration file

The configuration file specifies information that the compiler uses when you invoke it. XL Fortran provides the default configuration file **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg** at installation time.

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 add new named stanzas to the configuration file and to create new commands that are links to existing commands. For example, you could specify something similar to the following to create a link to the **xlf95** command:

```
ln -s /opt/ibmcmp/xlf/10.1/bin/xlf95 /home/username/bin/my_xlf95
```

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

Notes:

1. The configuration file contains other named stanzas to which you may want to link.
2. If you make any changes to the default configuration file and then move or copy your makefiles to another system, you will also need to copy the changed configuration file.
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.

Attributes

The configuration file contains the following attributes:

use The named and local stanzas provide the values for attributes. For single-valued attributes, values in the **use** attribute apply if there is no value in the local, or default, stanza. For comma-separated lists, the values from the **use** attribute are added to the values from the local stanza. You can only use a single level of the **use** attribute. Do not specify a **use** attribute that names a stanza with another **use** attribute.

crt When invoked in 32-bit mode, the default (which is the path name of the object file that contains the startup code), passed as the first parameter to the linkage editor.

crt_64 When invoked in 64-bit mode, using **-q64** for example, the path name of the object file that contains the startup code, passed as the first parameter to the linkage editor.

mcrt Same as for **crt**, but the object file contains profiling code for the **-p** option.

mcrt_64 Same as for **crt_64**, but the object file contains profiling code for the **-p** option.

gcrt Same as **crt**, but the object file contains profiling code for the **-pg** option.

gcrt_64 Same as **crt_64**, but the object file contains profiling code for the **-pg** option.

gcc_libs When invoked in 32–bit mode, the linker options to specify the path to the GCC libraries and to link the GCC library.

gcc_libs_64 When invoked in 64–bit mode, the linker options to specify the path to the GCC libraries and to link the GCC library.

gcc_path Specifies the path to the 32–bit tool chain.

gcc_path_64 Specifies the path to the 64–bit tool chain.

cpp The absolute path name of the C preprocessor, which is automatically called for files ending with a specific suffix (usually **.F**).

xlf The absolute path name of the main compiler executable file. The compiler commands are driver programs that execute this file.

code The absolute path name of the optimizing code generator.

xlfopt Lists names of options that are assumed to be compiler options, for cases where, for example, a compiler option and a linker option use the same letter. The list is a concatenated set of single-letter flags. Any flag that takes an argument is followed by a colon, and the whole list is enclosed by double quotation marks.

as The absolute path name of the assembler.

asopt Lists names of options that are assumed to be assembler options for cases where, for example, a compiler option and an assembler option use the same letter. The list is a concatenated set of single-letter flags. Any flag that takes an argument is followed by a colon, and the whole list is enclosed by double quotation marks. You may find it more convenient to set up this attribute than to pass options to the assembler through the **-W** compiler option.

ld The absolute path name of the linker.

ldopt Lists names of options that are assumed to be linker options for cases where, for example, a compiler option and a linker option use the same letter. The list is a concatenated set of single-letter flags. Any flag that takes an argument is followed by a colon, and the whole list is enclosed by double quotation marks.

You may find it more convenient to set up this attribute than to pass options to the linker through the **-W** compiler option. However, most unrecognized options are passed to the linker anyway.

options A string of options that are separated by commas. The compiler processes these options as if you entered them on the command line before any other option. This attribute lets you shorten the command line by including commonly used options in one central place.

cppoptions A string of options that are separated by commas, to be processed by **cpp** (the C preprocessor) as if you entered them on the command line before any other option. This attribute is needed because some **cpp** options are usually required to produce output that can be compiled by XL Fortran. The default option is **-C**, which preserves any C-style comments in the output.

fsuffix The allowed suffix for Fortran source files. The default is **f**. The compiler requires that all source files in a single compilation have the same suffix. Therefore, to compile files with other suffixes, such as **f95**, you must change this attribute in the configuration file or use the **-qsuffix** compiler option. For more information on **-qsuffix**, see “-qsuffix option” on page 207.

cppsuffix The suffix that indicates a file must be preprocessed by the C preprocessor (**cpp**) before being compiled by XL Fortran. The default is **F**.

osuffix The suffix used to recognize object files that are specified as input files. The default is **o**.

ssuffix The suffix used to recognize assembler files that are specified as input files. The default is **s**.

libraries **-l** options, which are separated by commas, that specify the libraries used to link all programs.

smplibraries Specifies the libraries that are used to link programs that you compiled with the **-qsmp** compiler option.

hot Absolute path name of the program that does array language transformations.

ipa Absolute path name of the program that performs interprocedural optimizations, loop optimizations, and program parallelization.

bolt Absolute path name of the binder.

defaultmsg Absolute path name of the default message files.

include Indicates the search path that is used for compilation include files and module files.

include_32 Indicates the search path that is used for 32-bit compilation include files.

include_64 Indicates the search path that is used for 64-bit compilation include files.

Note: To specify multiple search paths for compilation include files, separate each path location with a comma as follows:

```
include = -I/path1, -I/path2, ...
```

Related information: You can use the "-F option" on page 71 to select a different configuration file, a specific stanza in the configuration file, or both.

Determining which level of XL Fortran is installed

Sometimes, you may not be sure which level of XL Fortran is installed on a particular machine. You would need to know this information before contacting software support.

To check whether the latest level of the product has been installed through the system installation procedure, issue the command:

```
rpm -qa | grep xlf.cmp-10.1 | xargs rpm -qi
```

The result includes the version, release, modification, and fix level of the compiler image installed on the system.

You can also use the **-qversion** compiler option to see the version and release for the compiler.

Running two levels of XL Fortran

It is possible for two different levels of the XL Fortran compiler to coexist on one system. This allows you to invoke one level by default and to invoke the other one whenever you explicitly choose to.

To do this, consult the *XL Fortran Installation Guide* for details.

Chapter 4. Editing, compiling, linking, and running XL Fortran programs

Most Fortran program development consists of a repeating cycle of editing, compiling and linking (which is by default a single step), and running. If you encounter problems at some part of this cycle, you may need to refer to the sections that follow this one for help with optimizing, debugging, and so on.

Prerequisite information:

1. Before you can use the compiler, all the required Linux settings (for example, certain environment variables and storage limits) must be correct for your user ID; for details, see "Correct settings for environment variables" on page 8.
2. To learn more about writing and optimizing XL Fortran programs, refer to the *XL Fortran Language Reference* and *XL Fortran Optimization and Programming Guide*.

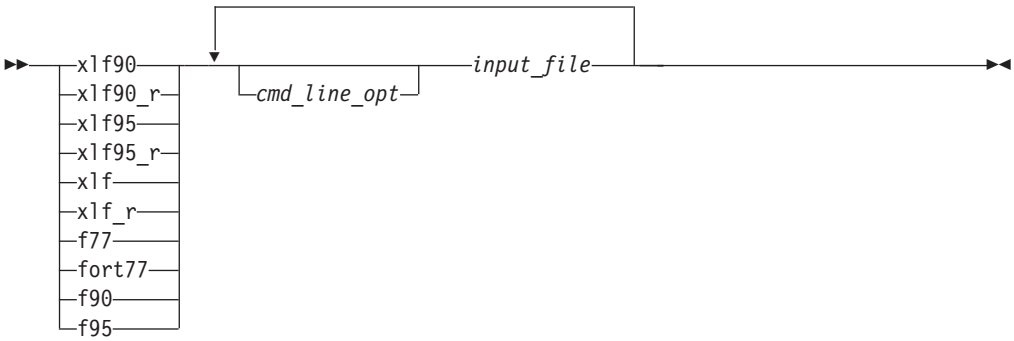
Editing XL Fortran source files

To create Fortran source programs, you can use any of the available text editors, such as **vi** or **emacs**. Source programs must have a suffix of **.f** unless the **fsuffix** attribute in the configuration file specifies a different suffix or the **-qsuffix** compiler option is used. You can also use a suffix of **.F** if the program contains C preprocessor (**cpp**) directives that must be processed before compilation begins. Source files with the **.f77**, **.f90**, or **.f95** suffix are also valid.

For the Fortran source program to be a valid program, it must conform to the language definition that is specified in the *XL Fortran Language Reference*.

Compiling XL Fortran programs

To compile a source program, use one of the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **xlf**, **xlf_r**, **f77**, **fort77**, **f90**, or **f95** commands, which have the form:



These commands all accept essentially the same Fortran language. The main difference is that they use different default options (which you can see by reading the file **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**).

The invocation command performs the necessary steps to compile the Fortran source files, assemble any **.s** files, and link the object files and libraries into an

executable program. In particular, the **xlf_r**, **xlf90_r**, and **xlf95_r** commands use the thread-safe components (libraries, and so on) to link and bind object files.

The following table summarizes the invocation commands that you can use:

Table 3. XL Fortran Invocation commands

Driver Invocation	Path or Location	Chief Functionality	Linked Libraries
xlf90	/opt/ibmcmp/xlf/10.1/bin	Fortran 90	libxlf90.so
xlf90_r	/opt/ibmcmp/xlf/10.1/bin	Threadsafe Fortran 90	libxlf90_r.so
xlf95	/opt/ibmcmp/xlf/10.1/bin	Fortran 95	libxlf90.so
xlf95_r	/opt/ibmcmp/xlf/10.1/bin	Threadsafe Fortran 95	libxlf90_r.so
xlf	/opt/ibmcmp/xlf/10.1/bin	FORTRAN 77	libxlf90.so
xlf_r	/opt/ibmcmp/xlf/10.1/bin	Threadsafe FORTRAN 77	libxlf90_r.so
f77 or **fort77**	/opt/ibmcmp/xlf/10.1/bin	FORTRAN 77	libxlf90.so
f90	/opt/ibmcmp/xlf/10.1/bin	Fortran 90	libxlf90.so
f95	/opt/ibmcmp/xlf/10.1/bin	Fortran 95	libxlf90.so

The invocation commands have the following implications for directive triggers:

- For **f77**, **fort77**, **f90**, **f95**, **xlf**, **xlf90**, and **xlf95**, the directive trigger is **IBM*** by default.
- For all other commands, the directive triggers are **IBM*** and **IBMT** by default. If you specify **-qsmp**, the compiler also recognizes the **IBMP**, **SMP$**, and **$OMP** trigger constants. If you specify the **-qsmp=omp** option, the compiler only recognizes the **$OMP** trigger constant.

If you specify the **-qsmp** compiler option, the following occurs:
- The compiler turns on automatic parallelization.
- The compiler recognizes the **IBMP**, **IBMT**, **IBM***, **SMP$**, and **$OMP** directive triggers.

XL Fortran provides the library **libxlf90_t.so**, in addition to **libxlf90_r.so**. The library **libxlf90_r.so** is a superset of **libxlf90_t.so**. The file **xlf.cfg** is set up to link to **libxlf90_r.so** automatically when you use the **xlf90_r**, **xlf95_r**, and **xlf_r** commands.

libxlf90_t.so is a partial thread-support run-time library. It will be installed as **/opt/ibmcmp/lib/libxlf90_t.so** with one restriction on its use: because routines in the library are not thread-reentrant, only one Fortran thread at a time can perform I/O operations or invoke Fortran intrinsics in a multithreaded application that uses the library. To avoid the thread synchronization overhead in **libxlf90_r.so** when an application is threaded, you can use **libxlf90_t.so** in multithreaded applications where there is only one Fortran thread.

When you bind a multithreaded executable with multiple Fortran threads, libxlf90_r.so should be used. Note that using the **xlf_r** ,**xlf90_r**, or **xlf95_r** invocation command ensures the proper linking.

Compiling Fortran 90 or Fortran 95 programs

The **f90**, **xlf90**, and **xlf90_r** commands make your programs conform more closely to the Fortran 90 standard than do the **xlf**, **xlf_r**, and **f77**/**fort77** commands. The **f95**, **xlf95**, and **xlf95_r** commands make your programs conform more closely to

the Fortran 95 standard than do the **xlf**, **xlf_r**, and **f77**/**fort77** commands. **f90**, **xlf90**, **xlf90_r**, **f95**, **xlf95**, and **xlf95_r** are the preferred commands for compiling any new programs. They all accept Fortran 90 free source form by default; to use them for fixed source form, you must use the **-qfixed** option. I/O formats are slightly different between these commands and the other commands. I/O formats also differ between the set of **f90**, **xlf90** and **xlf90_r** commands and the set of **f95**, **xlf95** and **xlf95_r** commands. We recommend that you switch to the Fortran 95 formats for data files whenever possible.

By default, the **f90**, **xlf90** and **xlf90_r** commands do not conform completely to the Fortran 90 standard. Also, by default, the **f95**, **xlf95** and **xlf95_r** commands do not conform completely to the Fortran 95 standard. If you need full Fortran 90 or Fortran 95 compliance, compile with any of the following additional compiler options (and suboptions):

```
-qnodirective -qnoescape -qextname -qfloat=nomaf:nofold -qnoswapomp
-qlanglvl=90std
-qlanglvl=95std
```

Also, specify the following run-time options before running the program, with a command similar to one of the following:

```
export XLFRTEOPTS="err_recovery=no:langlvl=90std"
export XLFRTEOPTS="err_recovery=no:langlvl=95std"
```

The default settings are intended to provide the best combination of performance and usability. Therefore, it is usually a good idea to change them only when required. Some of the options above are only required for compliance in very specific situations. For example, you only need to specify **-qextname** when an external symbol, such as a common block or subprogram, is named **main**.

Compiling XL Fortran SMP programs

You can use the **xlf_r**, **xlf90_r**, or **xlf95_r** command to compile XL Fortran SMP programs. The **xlf_r** command is similar to the **xlf** command; the **xlf90_r** command is similar to the **xlf90** command; the **xlf95_r** command is similar to the **xlf95** command. The main difference is that the thread-safe components are used to link and bind the object files if you specify the **xlf_r**, , **xlf90_r**, or **xlf95_r** command.

Note that using any of these commands alone does not imply parallelization. For the compiler to recognize the SMP directives and activate parallelization, you must also specify **-qsmp**. In turn, you can only specify the **-qsmp** option in conjunction with one of these six invocation commands. When you specify **-qsmp**, the driver links in the libraries specified on the **smplibraries** line in the active stanza of the configuration file.

POSIX pthreads API support

XL Fortran supports thread programming with the IEEE 1003.1-2001 (POSIX) standard pthreads API.

To compile and then link your program with the standard interface libraries, use the **xlf_r**, **xlf90_r**, or **xlf95_r** command. For example, you could specify:

```
xlf95_r test.f
```

Compilation order for Fortran programs

If you have a program unit, subprogram, or interface body that uses a module, you must first compile the module. If the module and the code that uses the module are in separate files, you must first compile the file that contains the

module. If they are in the same file, the module must come before the code that uses it in the file. If you change any entity in a module, you must recompile any files that use that module.

Canceling a compilation

To stop the compiler before it finishes compiling, press **Ctrl+C** in interactive mode, or use the **kill** command.

XL Fortran input files

The input files to the compiler are:

Source Files (.f or .F suffix)

All **.f**, **.f77**, **.f90**, **.f95** and **.F** files are source files for compilation. The compiler compiles source files in the order you specify on the command line. If it cannot find a specified source file, the compiler produces an error message and proceeds to the next file, if one exists. Files with a suffix of **.F** are passed through the C preprocessor (**cpp**) before being compiled.

Include files also contain source and often have different suffixes from **.f**.

Related information: See "Passing Fortran files through the C preprocessor" on page 24.

The **fsuffix** and **cppsuffix** attributes in "Customizing the configuration file" on page 10 and the "-qsuffix option" on page 207 let you select a different suffix.

Object Files (.o suffix)

All **.o** files are object files. After the compiler compiles the source files, it uses the **ld** command to link-edit the resulting **.o** files, any **.o** files that you specify as input files, and some of the **.o** and **.a** files in the product and system library directories. It then produces a single executable output file.

Related information: See "Options that control linking" on page 60 and "Linking XL Fortran programs" on page 26.

The **osuffix** attribute, which is described in "Customizing the configuration file" on page 10 and the "-qsuffix option" on page 207, lets you select a different suffix.

Assembler Source Files (.s suffix)

The compiler sends any specified **.s** files to the assembler (**as**). The assembler output consists of object files that are sent to the linker at link time.

Related information: The **ssuffix** attribute, which is described in "Customizing the configuration file" on page 10 and the "-qsuffix option" on page 207, lets you select a different suffix.

Shared Object or Library Files (.so suffix)

These are object files that can be loaded and shared by multiple processes at run time. When a shared object is specified during linking, information about the object is recorded in the output file, but no code from the shared object is actually included in the output file.

Configuration Files (.cfg suffix)

The contents of the configuration file determine many aspects of the compilation process, most commonly the default options for the compiler.

You can use it to centralize different sets of default compiler options or to keep multiple levels of the XL Fortran compiler present on a system.

The default configuration file is **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**.

Related information: See "Customizing the configuration file" on page 10 and "-F option" on page 71 for information about selecting the configuration file.

Module Symbol Files: *modulename*.**mod**

A module symbol file is an output file from compiling a module and is an input file for subsequent compilations of files that **USE** that module. One **.mod** file is produced for each module, so compiling a single source file may produce multiple **.mod** files.

Related information: See "-I option" on page 73 and "-qmoddir option" on page 163.

Profile Data Files

The **-qpdf1** option produces run-time profile information for use in subsequent compilations. This information is stored in one or more hidden files with names that match the pattern "**.*pdf***".

Related information: See "-qpdf option" on page 172.

XL Fortran Output files

The output files that XL Fortran produces are:

Executable Files: a.out

By default, XL Fortran produces an executable file that is named **a.out** in the current directory.

Related information: See "-o option" on page 80 for information on selecting a different name and "-c option" on page 68 for information on generating only an object file.

Object Files: *filename*.**o**

If you specify the **-c** compiler option, instead of producing an executable file, the compiler produces an object file for each specified **.f** source file, and the assembler produces an object file for each specified **.s** source file. By default, the object files have the same file name prefixes as the source files and appear in the current directory.

Related information: See "-c option" on page 68 and "Linking XL Fortran programs" on page 26. For information on renaming the object file, see "-o option" on page 80.

Assembler Source Files: *filename*.**s**

If you specify the **-S** compiler option, instead of producing an executable file, the XL Fortran compiler produces an equivalent assembler source file for each specified **.f** source file. By default, the assembler source files have the same file name prefixes as the source files and appear in the current directory.

Related information: See "-S option" on page 231 and "Linking XL Fortran programs" on page 26. For information on renaming the assembler source file, see "-o option" on page 80.

Compiler Listing Files: *filename*.**lst**

By default, no listing is produced unless you specify one or more listing-related compiler options. The listing file is placed in the current directory, with the same file name prefix as the source file and an extension of **.lst**.

Related information: See "Options that control listings and messages" on page 49.

Module Symbol Files: *modulename*.**mod**

Each module has an associated symbol file that holds information needed by program units, subprograms, and interface bodies that **USE** that module. By default, these symbol files must exist in the current directory.

Related information: For information on putting **.mod** files in a different directory, see "-qmoddir option" on page 163.

cpp-Preprocessed Source Files: F*filename*.**f**

If you specify the **-d** option when compiling a file with a **.F** suffix, the intermediate file created by the C preprocessor (cpp) is saved rather than deleted.

Related information: See "Passing Fortran files through the C preprocessor" on page 24 and "-d option" on page 70.

Profile Data Files (.*pdf*)

These are the files that the **-qpdf1** option produces. They are used in subsequent compilations to tune optimizations that are based on actual execution results.

Related information: See "-qpdf option" on page 172.

Scope and precedence of option settings

You can specify compiler options in any of three locations. Their scope and precedence are defined by the location you use. (XL Fortran also has comment directives, such as **SOURCEFORM**, that can specify option settings. There is no general rule about the scope and precedence of such directives.)

Location	Scope	Precedence
In a stanza of the configuration file.	All compilation units in all files compiled with that stanza in effect.	Lowest
On the command line.	All compilation units in all files compiled with that command.	Medium
In an **@PROCESS** directive. (XL Fortran also has comment directives, such as **SOURCEFORM**, that can specify option settings. There is no general rule about the scope and precedence of such directives.)	The following compilation unit.	Highest

If you specify an option more than once with different settings, the last setting generally takes effect. Any exceptions are noted in the individual descriptions in the "Detailed descriptions of the XL Fortran compiler options" on page 63 and are indexed under "conflicting options".

Specifying options on the command line

XL Fortran supports the traditional UNIX® method of specifying command-line options, with one or more letters (known as flags) following a minus sign:

```
xlf95 -c file.f
```

You can often concatenate multiple flags or specify them individually:

```
xlf95 -cv file.f     # These forms
xlf95 -c -v file.f   # are equivalent
```

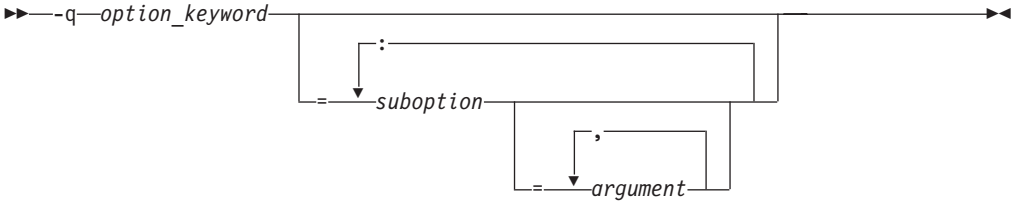
(There are some exceptions, such as **-pg**, which is a single option and not the same as **-p -g**.)

Some of the flags require additional argument strings. Again, XL Fortran is flexible in interpreting them; you can concatenate multiple flags as long as the flag with an argument appears at the end. The following example shows how you can specify flags:

```
# All of these commands are equivalent.
  xlf95 -g -v -o montecarlo -p montecarlo.f
  xlf95 montecarlo.f -g -v -o montecarlo -p
  xlf95 -g -v montecarlo.f -o montecarlo -p
  xlf95 -g -v -omontecarlo -p montecarlo.f
# Because -o takes a blank-delimited argument,
# the -p cannot be concatenated.
  xlf95 -gvomontecarlo -p montecarlo.f
# Unless we switch the order.
  xlf95 -gvpomontecarlo montecarlo.f
```

If you are familiar with other compilers, particularly those in the XL family of compilers, you may already be familiar with many of these flags.

You can also specify many command-line options in a form that is intended to be easy to remember and make compilation scripts and makefiles relatively self-explanatory:



This format is more restrictive about the placement of blanks; you must separate individual **-q** options by blanks, and there must be no blank between a **-q** option and a following argument string. Unlike the names of flag options, **-q** option names are not case-sensitive except that the **q** must be lowercase. Use an equal sign to separate a **-q** option from any arguments it requires, and use colons to separate suboptions within the argument string.

For example:

```
xlf95 -qddim -qXREF=full -qfloat=nomaf:rsqrt -O3 -qcache=type=c:level=1 file.f
```

Specifying options in the source file

By putting the **@PROCESS** compiler directive in the source file, you can specify compiler options to affect an individual compilation unit. The **@PROCESS** compiler directive can override options specified in the configuration file, in the default settings, or on the command line.

option is the name of a compiler option without the **-q**.

suboption
is a suboption of a compiler option.

In fixed source form, **@PROCESS** can start in column 1 or after column 6. In free source form, the **@PROCESS** compiler directive can start in any column.

You cannot place a statement label or inline comment on the same line as an **@PROCESS** compiler directive.

By default, option settings you designate with the **@PROCESS** compiler directive are effective only for the compilation unit in which the statement appears. If the file has more than one compilation unit, the option setting is reset to its original state before the next unit is compiled. Trigger constants specified by the **DIRECTIVE** option are in effect until the end of the file (or until **NODIRECTIVE** is processed).

The **@PROCESS** compiler directive must usually appear before the first statement of a compilation unit. The only exceptions are when specifying **SOURCE** and **NOSOURCE**; you can put them in **@PROCESS** directives anywhere in the compilation unit.

Passing command-line options to the ″ld″ or ″as″ commands

Because the compiler automatically executes other commands, such as **ld** and **as**, as needed during compilation, you usually do not need to concern yourself with the options of those commands. If you want to choose options for these individual commands, you can do one of the following:

- Include linker options on the compiler command line. When the compiler does not recognize a command-line option other than a **-q** option, it passes the option on to the linker:

  ```
  xlf95 --print-map file.f # --print-map is passed to ld
  ```

- Use the **-W** compiler option to construct an argument list for the command:

  ```
  xlf95 -Wl,--print-map file.f # --print-map is passed to ld
  ```

  In this example, the **ld** option **--print-map** is passed to the linker (which is denoted by the **l** in the **-Wl** option) when the linker is executed.

  This form is more general than the previous one because it works for the **as** command and any other commands called during compilation, by using different letters after the **-W** option.

- Edit the configuration file **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**, or construct your own configuration file. You can customize particular stanzas to allow specific command-line options to be passed through to the assembler or linker.

  For example, if you include these lines in the **xlf95** stanza of **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**:

  ```
  asopt = "W"
  ldopt = "M"
  ```

  and issue this command:

  ```
  xlf95 -Wa,-Z -Wl,-s -w produces_warnings.s uses_many_symbols.f
  ```

  the file **produces_warnings.s** is assembled with the options **-W** and **-Z** (issue warnings and produce an object file even if there are compilation errors), and the linker is invoked with the options **-s** and **-M** (strip final executable file and produce a load map). .

Related information: See "-W option" on page 237 and "Customizing the configuration file" on page 10.

Displaying information inside binary files (strings)

The **strings** command reads information encoded into some binary files, as follows:

- Information about the compiler version is encoded in the compiler binary executables and libraries.
- Information about the parent module, bit mode, the compiler that created the **.mod** file, the date and time the **.mod** file was created, and the source file is encoded in each **.mod** file.

For example to see the information embedded in **/opt/ibmcmp/xlf/10.1/exe/xlfentry**, issue the following command:

```
strings /opt/ibmcmp/xlf/10.1/exe/xlfentry | grep "@(#)"
```

Compiling for specific architectures

You can use **-qarch** and **-qtune** to target your program to instruct the compiler to generate code specific to a particular architecture. This allows the compiler to take advantage of machine-specific instructions that can improve performance. The **-qarch** option determines the architectures on which the resulting programs can run. The **-qtune** and **-qcache** options refine the degree of platform-specific optimization performed.

By default, the **-qarch** setting produces code using only instructions common to all supported architectures, with resultant settings of **-qtune** and **-qcache** that are relatively general. To tune performance for a particular processor set or architecture, you may need to specify different settings for one or more of these options. The natural progression to try is to use **-qarch**, and then add **-qtune**, and then add **-qcache**. Because the defaults for **-qarch** also affect the defaults for **-qtune** and **-qcache**, the **-qarch** option is often all that is needed.

If the compiling machine is also the target architecture, **-qarch=auto** will automatically detect the setting for the compiling machine. For more information on this compiler option setting, see "-qarch option" on page 91 and also **-O4** and **-O5** under the "-O option" on page 78.

If your programs are intended for execution mostly on particular architectures, you may want to add one or more of these options to the configuration file so that they become the default for all compilations.

Passing Fortran files through the C preprocessor

A common programming practice is to pass files through the C preprocessor (**cpp**). **cpp** can include or omit lines from the output file based on user-specified conditions ("conditional compilation"). It can also perform string substitution ("macro expansion").

XL Fortran can use **cpp** to preprocess a file before compiling it.

To call **cpp** for a particular file, use a file suffix of **.F**. If you specify the **-d** option, each **.F** file *filename***.F** is preprocessed into an intermediate file **F***filename***.f**, which is then compiled. If you do not specify the **-d** option, the intermediate file name is */tmpdir/F8xxxxxx*, where *x* is an alphanumeric character and *tmpdir* is the contents of the **TMPDIR** environment variable or, if you have not specified a value for **TMPDIR**, **/tmp**. You can save the intermediate file by specifying the **-d** compiler option; otherwise, the file is deleted. If you only want to preprocess and do not want to produce object or executable files, specify the **-qnoobject** option also.

When XL Fortran uses **cpp** for a file, the preprocessor will emit **#line** directives unless you also specify the **-d** option. The **#line** directive associates code that is created by **cpp** or any other Fortran source code generator with input code that you create. The preprocessor may cause lines of code to be inserted or deleted. Therefore, the **#line** directives that it emits can be useful in error reporting and debugging, because they identify the source statements found in the preprocessed code by listing the line numbers that were used in the original source.

The **_OPENMP** C preprocessor macro can be used to conditionally include code. This macro is defined when the C preprocessor is invoked and when you specify the **-qsmp=omp** compiler option. An example of using this macro follows:

```
      program par_mat_mul
        implicit none
        integer(kind=8)                 ::i,j,nthreads
        integer(kind=8),parameter       ::N=60
        integer(kind=8),dimension(N,N)  ::Ai,Bi,Ci
        integer(kind=8)                 ::Sumi
#ifdef _OPENMP
         integer omp_get_num_threads
#endif

         common/data/ Ai,Bi,Ci
!$OMP   threadprivate (/data/)

!$omp   parallel
         forall(i=1:N,j=1:N) Ai(i,j) = (i-N/2)**2+(j+N/2)
         forall(i=1:N,j=1:N) Bi(i,j) = 3-((i/2)+(j-N/2)**2)
!$omp   master
#ifdef _OPENMP
         nthreads=omp_get_num_threads()
#else
        nthreads=8
#endif
!$omp   end master
!$omp   end parallel

!$OMP parallel default(private),copyin(Ai,Bi),shared(nthreads)
!$omp do
      do i=1,nthreads
```

```
         call imat_mul(Sumi)
       enddo
!$omp end do
!$omp end parallel

     end
```

See *Conditional Compilation* in the *Language Elements* section of the *XL Fortran Language Reference* for more information on conditional compilation.

To customize **cpp** preprocessing, the configuration file accepts the attributes **cpp**, **cppsuffix**, and **cppoptions**.

The letter **F** denotes the C preprocessor with the **-t** and **-W** options.

Related information: See "-d option" on page 70, "-t option" on page 232, "-W option" on page 237, and "Customizing the configuration file" on page 10.

cpp Directives for XL Fortran programs

Macro expansion can have unexpected consequences that are difficult to debug, such as modifying a **FORMAT** statement or making a line longer than 72 characters in fixed source form. Therefore, we recommend using **cpp** primarily for conditional compilation of Fortran programs. The **cpp** directives that are most often used for conditional compilation are **#if**, **#ifdef**, **#ifndef**, **#elif**, **#else**, and **#endif**.

Passing options to the C preprocessor

Because the compiler does not recognize **cpp** options other than **-I** directly on the command line, you must pass them through the **-W** option. For example, if a program contains **#ifdef** directives that test the existence of a symbol named **LNXV1**, you can define that symbol to **cpp** by compiling with a command like:

```
xlf95 conditional.F -WF,-DLNXV1
```

Avoiding preprocessing problems

Because Fortran and C differ in their treatment of some sequences of characters, be careful when using **/*** or ***/**. These might be interpreted as C comment delimiters, possibly causing problems even if they occur inside Fortran comments. Also be careful when using three-character sequences that begin with **??** (which might be interpreted as C trigraphs).

Consider the following example:

```
program testcase
character a
character*4 word
a = '?'
word(1:2) = '??'
print *, word(1:2)
end program testcase
```

If the preprocessor matches your character combination with the corresponding trigraph sequence, your output may not be what you expected.

If your code does *not* require the use of the XL Fortran compiler option **-qnoescape**, a possible solution is to replace the character string with an escape sequence **word(1:2) = '\?\?'**. However, if you are using the **-qnoescape** compiler

option, this solution will not work. In this case, you require a **cpp** that will ignore the trigraph sequence. XL Fortran uses the **cpp** that is found in **/opt/ibmcmp/xlf/10.1/exe/cpp**. It is **ISO C** compliant and therefore recognizes trigraph sequences.

Linking XL Fortran programs

By default, you do not need to do anything special to link an XL Fortran program. The compiler invocation commands automatically call the linker to produce an executable output file. For example, running the following command:

```
xlf95 file1.f file2.o file3.f
```

compiles and produces object files `file1.o` and `file3.o`, then all object files are submitted to the linker to produce one executable.

After linking, follow the instructions in "Running XL Fortran programs" on page 28 to execute the program.

Compiling and linking in separate Steps

To produce object files that can be linked later, use the **-c** option.

```
xlf95 -c file1.f              # Produce one object file (file1.o)
xlf95 -c file2.f file3.f      # Or multiple object files (file1.o, file3.o)
xlf95 file1.o file2.o file3.o  # Link object files with appropriate libraries
```

It is often best to execute the linker through the compiler invocation command, because it passes some extra **ld** options and library names to the linker automatically.

Passing options to the ld command

If you need to link with **ld** options that are not part of the XL Fortran default, you can include those options on the compiler command line:

```
xlf95 -Wl,<options...> file.f # xlf95 passes all these options to ld
```

The compiler passes unrecognized options, except **-q** options, to the **ld** command.

Dynamic and Static Linking

XL Fortran allows your programs to take advantage of the operating system facilities for both dynamic and static linking:

- Dynamic linking means that the code for some external routines is located and loaded when the program is first run. When you compile a program that uses shared libraries, the shared libraries are dynamically linked to your program by default.

  Dynamically linked programs take up less disk space and less virtual memory if more than one program uses the routines in the shared libraries. During linking, they do not require any special precautions to avoid naming conflicts with library routines. They may perform better than statically linked programs if several programs use the same shared routines at the same time. They also allow you to upgrade the routines in the shared libraries without relinking.

  Because this form of linking is the default, you need no additional options to turn it on.
- Static linking means that the code for all routines called by your program becomes part of the executable file.

Statically linked programs can be moved to and run on systems without the XL Fortran libraries. They may perform better than dynamically linked programs if they make many calls to library routines or call many small routines. They do require some precautions in choosing names for data objects and routines in the program if you want to avoid naming conflicts with library routines (as explained in "Avoiding naming conflicts during linking"). They also may not work if you compile them on one level of the operating system and run them on a different level of the operating system.

To link statically, add the **--static** option to the linker command. For example:

```
xlf95 -Wl,--static test.f
```

Avoiding naming conflicts during linking

If you define an external subroutine, external function, or common block with the same name as a run-time subprogram, your definition of that name may be used in its place, or it may cause a link-edit error.

Try the following general solution to help avoid these kinds of naming conflicts:

- Compile all files with the **-qextname** option. It adds an underscore to the end of the name of each global entity, making it distinct from any names in the system libraries.

  Note: When you use this option, you do not need to use the final underscore in the names of Service and Utility Subprograms, such as **dtime_** and **flush_**.
- Link your programs dynamically, which is the default.

If you do not use the **-qextname** option, you must take the following extra precautions to avoid conflicts with the names of the external symbols in the XL Fortran and system libraries:

- Do not name a subroutine or function **main**, because XL Fortran defines an entry point **main** to start your program.
- Do not use *any* global names that begin with an underscore. In particular, the XL Fortran libraries reserve all names that begin with **_xl**.
- Do not use names that are the same as names in the XL Fortran library or one of the system libraries. To determine which names are not safe to use in your program, run the **nm** command on any libraries that are linked into the program and search the output for names you suspect might also be in your program.
- If your program calls certain XLF-provided routines, some restrictions apply to the common block and subprogram names that you can use:

XLF-Provided Function Name	Common Block or Subprogram Name You Cannot Use
mclock	times
rand	irand

Be careful not to use the names of subroutines or functions without defining the actual routines in your program. If the name conflicts with a name from one of the libraries, the program could use the wrong version of the routine and not produce any compile-time or link-time errors.

Running XL Fortran programs

The default file name for the executable program is **a.out**. You can select a different name with the **-o** compiler option. You should avoid giving your programs the same names as system or shell commands (such as **test** or **cp**), as you could accidentally execute the wrong command. If a name conflict does occur, you can execute the program by specifying a path name, such as **./test**.

You can run a program by entering the path name and file name of an executable file along with any run-time arguments on the command line.

Canceling execution

To suspend a running program, press the **Ctrl+Z** key while the program is in the foreground. Use the **fg** command to resume running.

To cancel a running program, press the **Ctrl+C** key while the program is in the foreground.

Compiling and executing on different systems

If you want to move an XL Fortran executable file to a different system for execution, you can link statically and copy the program, and optionally the run-time message catalogs. Alternatively, you can link dynamically and copy the program as well as the XL Fortran libraries if needed and optionally the run-time message catalogs. For non-SMP programs, **libxlf90.so**, **libxlfmath.so**, and **libxlomp_ser.so** are usually the only XL Fortran libraries needed. For SMP programs, you will usually need at least the **libxlf90_r.so**, **libxlfmath.so**, and **libxlsmp.so** libraries. **libxlfpmt*.so** and **libxlfpad.so** are only needed if the program is compiled with the **-qautodbl** option.

For a dynamically linked program to work correctly, the XL Fortran libraries and the operating system on the execution system must be at either the same level or a more recent level than on the compilation system.

For a statically linked program to work properly, the operating-system level may need to be the same on the execution system as it is on the compilation system.

Related information: See “Dynamic and Static Linking” on page 26.

Run-time libraries for POSIX pthreads support

There are two run-time libraries that are connected with POSIX thread support. The **libxlf90_r.so** library is a thread-safe version of the Fortran run-time library. The **libxlsmp.so** library is the SMP run-time library.

Depending on the invocation command, and in some cases, the compiler option, the appropriate set of libraries for thread support is bound in. For example:

Cmd.	Libraries Used	Include Directory
xlf90_r **xlf95_r** **xlf_r**	**/opt/ibmcmp/lib/libxlf90_r.so** **/opt/ibmcmp/lib64/libxlf90_r.so** **/opt/ibmcmp/lib/libxlsmp.so** **/opt/ibmcmp/lib64/libxlsmp.so**	/opt/ibmcmp/xlf/10.1/include

Selecting the language for run-time messages

To select a language for run-time messages that are issued by an XL Fortran program, set the **LANG** and **NLSPATH** environment variables before executing the program.

In addition to setting environment variables, your program should call the C library routine **setlocale** to set the program's locale at run time. For example, the following program specifies the run-time message category to be set according to the **LC_ALL**, **LC_MESSAGES**, and **LANG** environment variables:

```
PROGRAM MYPROG
PARAMETER(LC_MESSAGES = 5)
EXTERNAL SETLOCALE
CHARACTER NULL_STRING /Z'00'/
CALL SETLOCALE (%VAL(LC_MESSAGES), NULL_STRING)
END
```

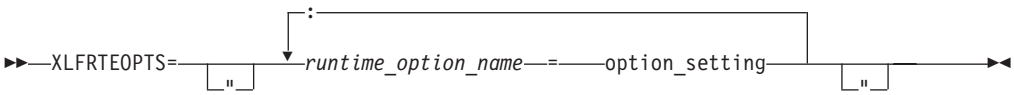
Related information: See "Environment variables for national language support" on page 8.

Setting run-time options

Internal switches in an XL Fortran program control run-time behavior, similar to the way compiler options control compile-time behavior. You can set the run-time options through either environment variables or a procedure call within the program. You can specify XL Fortran run-time option settings by using the following environment variables: **XLFRTEOPTS** and **XLSMPOPTS**.

The XLFRTEOPTS environment variable

The **XLFRTEOPTS** environment variable allows you to specify options that affect I/O, EOF error-handling, and the specification of random-number generators. You can declare **XLFRTEOPTS** by using the following **bash** command format:



You can specify option names and settings in uppercase or lowercase. You can add blanks before and after the colons and equal signs to improve readability. However, if the **XLFRTEOPTS** option string contains imbedded blanks, you must enclose the entire option string in double quotation marks (**"**).

The environment variable is checked when the program first encounters one of the following conditions:

- An I/O statement is executed.
- The **RANDOM_SEED** procedure is executed.
- An **ALLOCATE** statement needs to issue a run-time error message.
- A **DEALLOCATE** statement needs to issue a run-time error message.
- The multi-threaded implementation of the **MATMUL** procedure is executed.

Changing the **XLFRTEOPTS** environment variable during the execution of a program has no effect on the program.

The **SETRTEOPTS** procedure (which is defined in the *XL Fortran Language Reference*) accepts a single-string argument that contains the same name-value pairs as the **XLFRTEOPTS** environment variable. It overrides the environment variable and can be used to change settings during the execution of a program. The new

settings remain in effect for the rest of the program unless changed by another call to **SETRTEOPTS**. Only the settings that you specified in the procedure call are changed.

You can specify the following run-time options with the **XLFRTEOPTS** environment variable or the **SETRTEOPTS** procedure:

buffering={enable | disable_preconn | disable_all}
Determines whether the XL Fortran run-time library performs buffering for I/O operations.

The library reads data from, or writes data to the file system in chunks for **READ** or **WRITE** statements, instead of piece by piece. The major benefit of buffering is performance improvement.

If you have applications in which Fortran routines work with routines in other languages or in which a Fortran process works with other processes on the same data file, the data written by Fortran routines may not be seen immediately by other parties (and vice versa), because of the buffering. Also, a Fortran **READ** statement may read more data than it needs into the I/O buffer and cause the input operation performed by a routine in other languages or another process that is supposed to read the next data item to fail. In these cases, you can use the **buffering** run-time option to disable the buffering in the XL Fortran run-time library. As a result, a **READ** statement will read in exactly the data it needs from a file and the data written by a **WRITE** statement will be flushed out to the file system at the completion of the statement.

Note: I/O buffering is always enabled for files on sequential access devices (such as pipes, terminals, sockets). The setting of the **buffering** option has no effect on these types of files.

If you disable I/O buffering for a logical unit, you do not need to call the Fortran service routine **flush_** to flush the contents of the I/O buffer for that logical unit.

The suboptions for **buffering** are as follows:

enable	The Fortran run-time library maintains an I/O buffer for each connected logical unit. The current read-write file pointers that the run-time library maintains might not be synchronized with the read-write pointers of the corresponding files in the file system.
disable_preconn	The Fortran run-time library does not maintain an I/O buffer for each preconnected logical unit (0, 5, and 6). However, it does maintain I/O buffers for all other connected logical units. The current read-write file pointers that the run-time library maintains for the preconnected units are the same as the read-write pointers of the corresponding files in the file system.
disable_all	The Fortran run-time library does not maintain I/O buffers for any logical units. You should not specify the **buffering=disable_all** option with Fortran programs that perform asynchronous I/O.

In the following example, Fortran and C routines read a data file through redirected standard input. First, the main Fortran program reads one integer. Then, the C routine reads one integer. Finally, the main Fortran program reads another integer.

Fortran main program:

```
integer(4) p1,p2,p3
print *,'Reading p1 in Fortran...'
read(5,*) p1
call c_func(p2)
print *,'Reading p3 in Fortran...'
read(5,*) p3
print *,'p1 p2 p3 Read: ',p1,p2,p3
end
```

C subroutine (c_func.c):

```
#include <stdio.h>
void
c_func(int *p2)
{
    int n1 = -1;

    printf("Reading p2 in C...\n");
    setbuf(stdin, NULL);    /* Specifies no buffering for stdin */
    fscanf(stdin,"%d",&n1);
    *p2=n1;
    fflush(stdout);
}
```

Input data file (infile):

```
11111
22222
33333
44444
```

The main program runs by using infile as redirected standard input, as follows:

```
$ main < infile
```

If you turn on **buffering=disable_preconn**, the results are as follows:

```
Reading p1 in Fortran...
Reading p2 in C...
Reading p3 in Fortran...
p1 p2 p3 Read:  11111 22222 33333
```

If you turn on **buffering=enable**, the results are unpredictable.

cnverr={yes | no}

If you set this run-time option to **no**, the program does not obey the **IOSTAT=** and **ERR=** specifiers for I/O statements that encounter conversion errors. Instead, it performs default recovery actions (regardless of the setting of **err_recovery**) and may issue warning messages (depending on the setting of **xrf_messages**).

Related information: For more information about conversion errors, see *Data Transfer Statements* in the *XL Fortran Language Reference*. For more information about **IOSTAT** values, see *Conditions and IOSTAT Values* in the *XL Fortran Language Reference*.

cpu_time_type={usertime | systime | alltime | total_usertime | total_systime | total_alltime}

Determines the measure of time returned by a call to **CPU_TIME(TIME)**.

The suboptions for **cpu_time_type** are as follows:

usertime
Returns the user time of a process.

systime
Returns the system time of a process.

alltime
Returns the sum of the user and system time of a process.

total_usertime
Returns the total user time of a process. The total user time is the sum of the user time of a process and the total user times of its child processes, if any.

total_systime
Returns the total system time of a process. The total system time is the sum of the system time of the current process and the total system times of its child processes, if any.

total_alltime
Returns the total user and system time of a process. The total user and system time is the sum of the user and system time of the current process and the total user and system times of their child processes, if any.

default_recl={64 | 32}

Allows you to determine the default record size for sequential files opened without a **RECL=** specifier. The suboptions are as follows:

64 Uses a 64-bit value as the default record size.

32 Uses a 32-bit value as the default record size.

The **default_recl** run-time option applies only in 64-bit mode. In 32-bit mode, **default_recl** is ignored and the record size is 32-bit.

Use **default_recl** when porting 32-bit programs to 64-bit mode where a 64-bit record length will not fit into the specified integer variable. Consider the following:

```
INTEGER(4) I
OPEN (11)
INQUIRE (11, RECL=i)
```

A run-time error occurs in the above code sample in 64-bit mode when **default_recl=64**, since the default record length of 2**63-1 does not fit into the 4-byte integer I. Specifying **default_recl=32** ensures a default record size of 2**31-1, which fits into I.

For more information on the **RECL=** specifier, see the **OPEN** statement in the *XL Fortran Language Reference*.

erroreof={yes | no}

Determines whether the label specified by the **ERR=** specifier is to be branched to if no **END=** specifier is present when an end-of-file condition is encountered.

err_recovery={yes | no}
If you set this run-time option to **no**, the program stops if there is a recoverable error while executing an I/O statement with no **IOSTAT=** or **ERR=** specifiers. By default, the program takes some recovery action and continues when one of these statements encounters a recoverable error. Setting **cnverr** to **yes** and **err_recovery** to **no** can cause conversion errors to halt the program.

iostat_end={extended | 2003std}
Sets the **IOSTAT** values based on the XL Fortran definition or the Fortran 2003 Standard when end-of-file and end-of-record conditions occur. The suboptions are as follows:

extended
Sets the **IOSTAT** variables based on XL Fortran's definition of values and conditions.

2003std
Sets the **IOSTAT** variables based on Fortran 2003's definition of values and conditions.

For example, setting the **iostat_end=2003std** run-time option results in a different **IOSTAT** value from extensions being returned for the end-of-file condition

```
export XLFRTEOPTS=iostat_end=2003std
character(10) ifl
integer(4) aa(3), ios
ifl = "12344321  "
read(ifl, '(3i4)', iostat=ios) aa ! end-of-file condition occurs and
                                  ! ios is set to -1 instead of -2.
```

For more information on setting and using **IOSTAT** values, see the **READ**, **WRITE**, and *Conditions and IOSTAT Values* sections in the *XL Fortran Language Reference*.

intrinthds={num_threads}
Specifies the number of threads for parallel execution of the **MATMUL** and **RANDOM_NUMBER** intrinsic procedures. The default value for **num_threads** when using the **MATMUL** intrinsic equals the number of processors online. The default value for **num_threads** when using the **RANDOM_NUMBER** intrinsic is equal to the number of processors online*2.

Changing the number of threads available to the **MATMUL** and **RANDOM_NUMBER** intrinsic procedures can influence performance.

langlvl={extended | 90std | 95std | 2003std}
Determines the level of support for Fortran standards and extensions to the standards. The values of the suboptions are as follows:

90std Specifies that the compiler should flag any extensions to the Fortran 90 standard I/O statements and formats as errors.

95std Specifies that the compiler should flag any extensions to the Fortran 95 standard I/O statements and formats as errors.

2003std Specifies that the compiler should accept all standard I/O statements and formats that the Fortran 95 standard specifies, as well as those Fortran 2003 formats that XL Fortran supports. Anything else is flagged as an error.

For example, setting the **langlvl=2003std** run-time option results in a run-time error message.

```
integer(4) aa(100)
call setrteopts("langlvl=2003std")
    ...          ! Write to a unit without explicitly
    ...          ! connecting the unit to a file.
write(10, *) aa  ! The implicit connection to a file does not
    ...          ! comform with Fortran 2003 behavior.
```

extended Specifies that the compiler should accept the Fortran 95 language standard, Fortran 2003 features supported by XL Fortran, and extensions, effectively turning off language-level checking.

To obtain support for items that are part of the Fortran 95 standard and are available in XL Fortran (such as namelist comments), you must specify one of the following suboptions:

- **95std**
- **2003std**
- **extended**

The following example contains a Fortran 95 extension (the *file* specifier is missing from the **OPEN** statement):

```
program test1

call setrteopts("langlvl=95std")
open(unit=1,access="sequential",form="formatted")

10 format(I3)

write(1,fmt=10) 123

end
```

Specifying **langlvl=95std** results in a run-time error message.

The following example contains a Fortran 95 feature (namelist comments) that was not part of Fortran 90:

```
program test2

INTEGER I
LOGICAL G
NAMELIST /TODAY/G, I

call setrteopts("langlvl=95std:namelist=new")

open(unit=2,file="today.new",form="formatted", &
    & access="sequential", status="old")

read(2,nml=today)
close(2)

end

today.new:

&TODAY  ! This is a comment
I = 123, G=.true. /
```

If you specify **langlvl=95std**, no run-time error message is issued. However, if you specify **langlvl=90std**, a run-time error message is issued.

The **err_recovery** setting determines whether any resulting errors are treated as recoverable or severe.

multconn={yes | no}

Enables you to access the same file through more than one logical unit simultaneously. With this option, you can read more than one location within a file simultaneously without making a copy of the file.

You can only use multiple connections within the same program for files on random-access devices, such as disk drives. In particular, you cannot use multiple connections within the same program for:

- Files have been connected for write-only (**ACTION='WRITE'**)
- Asynchronous I/O
- Files on sequential-access devices (such as pipes, terminals, sockets)

To avoid the possibility of damaging the file, keep the following points in mind:

- The second and subsequent **OPEN** statements for the same file can only be for reading.
- If you initially opened the file for both input and output purposes (**ACTION='READWRITE'**), the unit connected to the file by the first **OPEN** becomes read-only (**ACCESS='READ'**) when the second unit is connected. You must close all of the units that are connected to the file and reopen the first unit to restore write access to it.
- Two files are considered to be the same file if they share the same device and i-node numbers. Thus, linked files are considered to be the same file.

multconnio={tty | nulldev | combined | no }

Enables you to connect a device to more than one logical unit. You can then write to, or read from, more than one logical unit that is attached to the same device. The suboptions are as follows:

combined
Enables you to connect a combination of null and TTY devices to more than one logical unit.

nulldev
Enables you to connect the null device to more than one logical unit.

tty Enables you to connect a TTY device to more than one logical unit.

Note: Using this option can produce unpredictable results.

In your program, you can now specify multiple **OPEN** statements that contain different values for the **UNIT** parameters but the same value for the **FILE** parameters. For example, if you have a symbolic link called **mytty** that is linked to TTY device **/dev/tty**, you can run the following program when you specify the **multconnio=tty** option:

```
PROGRAM iotest
OPEN(UNIT=3, FILE='mytty', ACTION="WRITE")
OPEN(UNIT=7, FILE='mytty', ACTION="WRITE")
END PROGRAM iotest
```

Fortran preconnects units 0, 5, and 6 to the same TTY device. Normally, you cannot use the **OPEN** statement to explicitly connect additional units to the TTY device that is connected to units 0, 5, and 6. However, this is possible if you specify the **multconnio=tty** option. For example, if units 0, 5, and 6 are preconnected to TTY device **/dev/tty**, you can run the following program if you specify the **multconnio=tty** option:

```
PROGRAM iotest
   ! /dev/pts/2 is your current tty, as reported by the 'tty' command.
   ! (This changes every time you login.)
```

```
      CALL SETRTEOPTS ('multconnio=tty')
      OPEN (UNIT=3, FILE='/dev/pts/2')
      WRITE (3, *) 'hello'  ! Display 'hello' on your screen
    END PROGRAM
```

namelist={new | old}
Determines whether the program uses the XL Fortran new or old **NAMELIST** format for input and output. The Fortran 90 and Fortran 95 standards require the new format.

Note: You may need the **old** setting to read existing data files that contain **NAMELIST** output.However, use the standard-compilant new format in writing any new data files.

With **namelist=old**, the nonstandard **NAMELIST** format is not considered an error by the **langlvl=95std**, **langlvl=90std**, or **langlvl=2003std** setting.

Related information: For more information about **NAMELIST** I/O, see *Namelist Formatting* in the *XL Fortran Language Reference*.

nlwidth=*record_width*
By default, a **NAMELIST** write statement produces a single output record long enough to contain all of the written **NAMELIST** items. To restrict **NAMELIST** output records to a given width, use the **nlwidth** run-time option.

Note: The **RECL=** specifier for sequential files has largely made this option obsolete, because programs attempt to fit **NAMELIST** output within the specified record length. You can still use **nlwidth** in conjunction with **RECL=** as long as the **nlwidth** width does not exceed the stated record length for the file.

random={generator1 | generator2}
Specifies the generator to be used by **RANDOM_NUMBER** if **RANDOM_SEED** has not yet been called with the **GENERATOR** argument. The value **generator1** (the default) corresponds to **GENERATOR=1**, and **generator2** corresponds to **GENERATOR=2**. If you call **RANDOM_SEED** with the **GENERATOR** argument, it overrides the random option from that point onward in the program. Changing the random option by calling **SETRTEOPTS** after calling **RANDOM_SEED** with the **GENERATOR** option has no effect.

scratch_vars={yes | no}
To give a specific name to a scratch file, set the **scratch_vars** run-time option to **yes**, and set the environment variable **XLFSCRATCH**_*unit* to the name of the file you want to be associated with the specified unit number. See *Naming scratch files* in the *XL Fortran Optimization and Programming Guide* for examples.

unit_vars={yes | no}
To give a specific name to an implicitly connected file or to a file opened with no **FILE=** specifier, you can set the run-time option **unit_vars=yes** and set one or more environment variables with names of the form **XLFUNIT**_*unit* to file names. See *Naming files that are connected with no explicit name* in the *XL Fortran Optimization and Programming Guide* for examples.

uwidth={32 | 64}
To specify the width of record length fields in unformatted sequential files, specify the value in bits. When the record length of an unformatted sequential file is greater than (2**31 - 1) bytes minus 8 bytes (for the record terminators surrounding the data), you need to set the run-time option **uwidth=64** to extend the record length fields to 64 bits. This allows the record length to be

up to (2**63 - 1) minus 16 bytes (for the record terminators surrounding the data). The run-time option **uwidth** is only valid for 64-bit mode applications.

xrf_messages={yes | no}
To prevent programs from displaying run-time messages for error conditions during I/O operations, **RANDOM_SEED** calls, and **ALLOCATE** or **DEALLOCATE** statements, set the **xrf_messages** run-time option to **no**. Otherwise, run-time messages for conversion errors and other problems are sent to the standard error stream.

The following examples set the **cnverr** run-time option to **yes** and the **xrf_messages** option to **no**.

```
# Basic format
  XLFRTEOPTS=cnverr=yes:xrf_messages=no
  export XLFRTEOPTS

# With imbedded blanks
  XLFRTEOPTS="xrf_messages = NO : cnverr = YES"
  export XLFRTEOPTS
```

As a call to **SETRTEOPTS**, this example could be:

```
  CALL setrteopts('xrf_messages=NO:cnverr=yes')
! Name is in lowercase in case -U (mixed) option is used.
```

Setting OMP and SMP run time options

The **XLSMPOPTS** environment variable allows you to specify options that affect SMP execution. The OpenMP environment variables, **OMP_DYNAMIC**, **OMP_NESTED**, **OMP_NUM_THREADS**, and **OMP_SCHEDULE**, allow you to control the execution of parallel code. For details on using these, see XLSMPOPTS and OpenMP environment variables sections in the *XL Fortran Optimization and Programming Guide*.

BLAS/ESSL environment variable

By default, the `libxlopt` library is linked with any application you compile with XL Fortran. However, if you are using a third-party Basic Linear Algebra Subprograms (BLAS) library or want to ship a binary that includes ESSL routines, you must specify these using the `XL_BLAS_LIB` environment variable. For example, if your own BLAS library is called `libblas`, set the environment variable as follows:

```
export XL_BLAS_LIB=/usr/lib/libblas.a
```

When the compiler generates calls to BLAS routines, the ones defined in the `libblas` library will be used at runtime instead of those defined in `libxlopt`.

XL_NOCLONEARCH

Use the **XL_NOCLONEARCH** to instruct 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. (See also the **-qipa=clonearch** option.)

Other environment variables that affect run-time behavior

The **LD_LIBRARY_PATH**, **LD_RUN_PATH**, and **TMPDIR** environment variables have an effect at run time, as explained in "Correct settings for environment variables" on page 8. They are not XL Fortran run-time options and cannot be set in either **XLFRTEOPTS** or **XLSMPOPTS**.

XL Fortran run-time exceptions

The following operations cause run-time exceptions in the form of **SIGTRAP** signals, which typically result in a "Trace/breakpoint trap" message:

- Character substring expression or array subscript out of bounds after you specified the **-C** option at compile time.
- Lengths of character pointer and target do not match after you specified the **-C** option at compile time.
- The flow of control in the program reaches a location for which a semantic error with severity of **S** was issued when the program was compiled.
- Floating-point operations that generate NaN values and loads of the NaN values after you specify the **-qfloat=nanq** option at compile time.
- Fixed-point division by zero.
- Calls to the TRAP hardware-specific intrinsic procedure.

The following operations cause run-time exceptions in the form of **SIGFPE** signals:

- Floating-point exceptions provided you specify the appropriate **-qflttrap** suboptions at compile time.

If you install one of the predefined XL Fortran exception handlers before the exception occurs, a diagnostic message and a traceback showing the offset within each routine called that led to the exception are written to standard error after the exception occurs. The file buffers are also flushed before the program ends. If you compile the program with the **-g** option, the traceback shows source line numbers in addition to the address offsets.

You can use a symbolic debugger to determine the error. **gdb** provides a specific error message that describes the cause of the exception.

Related information:

- "-C option" on page 67
- "-qflttrap option" on page 127
- "-qsigtrap option" on page 194

Also see the following topics in the *XL Fortran Optimization and Programming Guide*:

- *Detecting and trapping floating-point exceptions* for more details about these exceptions
- *Controlling the floating-point status and control register* for a list of exception handlers.

Chapter 5. XL Fortran compiler option reference

This section contains the following:

- Tables of compiler options. These tables are organized according to area of use and contain high-level information about the syntax and purpose of each option.
- Detailed information about each compiler option in "Detailed descriptions of the XL Fortran compiler options" on page 63.

Summary of the XL Fortran compiler options

The following tables show the compiler options available in the XL Fortran compiler that you can enter in the configuration file, on the command line, or in the Fortran source code by using the **@PROCESS** compiler directive.

You can enter compiler options that start with **-q**, suboptions, and **@PROCESS** directives in either uppercase or lowercase. However, note that if you specify the **-qmixed** option, procedure names that you specify for the **-qextern** option are case-sensitive.

In general, this document uses the convention of lowercase for **-q** compiler options and suboptions and uppercase for **@PROCESS** directives. However, in the ″Syntax″ sections of this section and in the ″Command-Line Option″ column of the summary tables, we use uppercase letters in the names of **-q** options, suboptions, and **@PROCESS** directives to represent the minimum abbreviation for the keyword. For example, valid abbreviations for **-qOPTimize** are **-qopt**, **-qopti**, and so on.

Understanding the significance of the options you use and knowing the alternatives available can save you considerable time and effort in making your programs work correctly and efficiently.

Options that control input to the compiler

The following options affect the compiler input at a high level. They determine which source files are processed and select case sensitivity, column sensitivity, and other global format issues.

Related information: See "XL Fortran input files" on page 18 and "Options that specify the locations of output files" on page 42.

Many of the options in "Options for compatibility" on page 51 change the permitted input format slightly.

Table 4. Options that control input to the compiler

Command-Line Option	@PROCESS Directive	Description	See Page
-I*dir*		Adds a directory to the search path for include files and **.mod** files. If XL Fortran calls **cpp**, this option adds a directory to the search path for **#include** files. Before checking the default directories for include and **.mod** files, the compiler checks each directory in the search path. For include files, this path is only used if the file name in an **INCLUDE** line is not provided with an absolute path. For **#include** files, refer to the **cpp** documentation for the details of the -I option. **Default:** The following directories are searched, in the following order: 1. The current directory 2. The directory where the source file is 3. **/usr/include**. Also, **/opt/ibmcmp/xlf/10.1/include** is searched; include and **.mod** files that are shipped with the compiler are located here.	73
-qci=*numbers*	CI(*numbers*)	Activates the specified **INCLUDE** lines. **Default:** No default value.	104
-qcr -qnocr		Allows you to control how the compiler interprets the CR (carriage return) character. This allows you to compile code written using a Mac OS or DOS/Windows editor. **Default: -qcr**	106

Table 4. Options that control input to the compiler (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qdirective [=*directive_list*] -qnodirective [=*directive_list*]	DIRECTIVE [(*directive_list*)] NODIRECTIVE [(*directive_list*)]	Specifies sequences of characters, known as trigger constants, that identify comment lines as compiler comment directives. **Default:** Comment lines beginning with **IBM*** are considered directives. If you specify **-qsmp=omp**, only **$OMP** is considered to be a directive trigger. All other directive triggers are turned off unless you explicitly turn them back on. If you specify **-qsmp=noomp** (noomp is the default for -qsmp), **IBMP**, **$OMP** and **SMP$** are considered directive triggers, along with any other directive triggers that are turned on (such as **IBM*** and **IBMT**). If you have also specified **-qthreaded**, comment lines beginning with **IBMT** are also considered directives.	111
-qenum= *value*		Specifies the range of the enumerator constant and enables storage size to be determined.	117
-qfixed [=*right_margin*]	FIXED [(*right_margin*)]	Indicates that the input source program is in fixed source form and optionally specifies the maximum line length. **Default: -qfree=f90** for the **f90**, **xlf90**, **xlf90_r**, **f95**, **xlf95**, and **xlf95_r** commands and **-qfixed=72** for the **xlf**, **xlf_r**, and **f77**/**fort77** commands.	123
-qfree[={f90|ibm}] -k	FREE[({F90|IBM})]	Indicates that the source code is in free form. The ibm and f90 suboptions specify compatibility with the free source form defined for VS FORTRAN and Fortran 90/Fortran 95, respectively. -k and -qfree are short forms for -qfree=f90. **Default: -qfree=f90** for the **f90**, **f95**, **xlf90**, **xlf90_r**, **xlf95**, and **xlf95_r** commands and **-qfixed=72** for the **xlf**, **xlf_r**, and **f77**/**fort77** commands.	129
-qmbcs -qnombcs	MBCS NOMBCS	Indicates to the compiler whether character literal constants, Hollerith constants, H edit descriptors, and character string edit descriptors can contain Multibyte Character Set (MBCS) or Unicode characters. **Default: -qnombcs**	160

Table 4. Options that control input to the compiler (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-U -qmixed -qnomixed	MIXED NOMIXED	Makes the compiler sensitive to the case of letters in names. **Default: -qnomixed**	233
-qsuffix={suboptions}		Specifies the source-file suffix on the command line.	207

Options that specify the locations of output files

The following options specify names or directories where the compiler stores output files.

In the table, an * indicates that the option is processed by the **ld** command, rather than by the XL Fortran compiler; you can find more information about these options in the Linux information for the **ld** command.

Related information: See "XL Fortran Output files" on page 19 and "Options that control input to the compiler" on page 40.

Table 5. Options that specify the locations of output files

Command-Line Option	@PROCESS Directive	Description	See Page
-d		Leaves preprocessed source files produced by **cpp**, instead of deleting them. **Default:** Temporary files produced by **cpp** are deleted.	70
-o *name**		Specifies a name for the output object, executable, or assembler source file. **Default:** -o a.out	80
-qmoddir=*directory*		Specifies the location for any module (**.mod**) files that the compiler writes. **Default: .mod** files are placed in the current directory.	163

Options for performance optimization

The following options can help you to speed up the execution of your XL Fortran programs or to find areas of poor performance that can then be tuned. The most important such option is **-O**. In general, the other performance-related options work much better in combination with **-O**; some have no effect at all without **-O**.

Related information: See *Optimizing XL compiler programs* in the *XL Fortran Optimization and Programming Guide*.

Some of the options in "Options for floating-point processing" on page 59 can also improve performance, but you must use them with care to avoid error conditions and incorrect results.

Table 6. Options for performance optimization

Command-Line Option	@PROCESS Directive	Description	See Page
-O[*level*] -qoptimize[=*level*] -qnooptimize	OPTimize[(*level*)] NOOPTimize	Specifies whether code is optimized during compilation and, if so, at which level (0, 2, 3, 4, or 5). **Default: -qnooptimize**	78
-p -pg		Sets up the object file for profiling. **Default:** No profiling.	81
-Q -Q! -Q+*names* -Q-*names*		Specifies whether procedures are inlined and/or particular procedures that should or should not be inlined. *names* is a list of procedure names separated by colons. **Default:** No inlining.	82
-qalias={[no]aryovrlp | [no]intptr | [no]pteovrlp | [no]std}...]	ALIAS({[NO]ARYOVRLP | [NO]INTPTR | [NO]PTEOVRLP | [NO]STD}...)	Indicates whether a program contains certain categories of aliasing. The compiler limits the scope of some optimizations when there is a possibility that different names are aliases for the same storage locations. **Default: -qalias=aryovrlp:nointptr:pteovrlp:std** for the **xlf95**, **xlf95_r**, **f90**, and **f95** commands; **-qalias= aryovrlp:intptr:pteovrlp:std** for the **xlf**, **xlf_r**, **f77**, and **fort77**, commands.	86
-qalign={[no]4k | struct {=subopt} | bindc {=subopt}}	ALIGN({[NO]4K | STRUCT{(subopt)} | BINDC{(subopt)}})	Specifies the alignment of data objects in storage, which avoids performance problems with misaligned data. The **[no]4k**, **bindc**, and **struct** options can be specified and are not mutually exclusive. The **[no]4k** option is useful primarily in combination with logical volume I/O and disk striping. **Default: -qalign=no4k:struct=natural:bindc=linuxppc**	89
-qarch=*architecture*		Controls which instructions the compiler can generate. Changing the default can improve performance but might produce code that can only be run on specific machines. The choices are com, ppc, ppcgr, ppc64, ppc64gr, ppc64grsq, rs64b, rs64c, pwr3, pwr4, pwr5, pwr5x, ppc64v, and ppc970. **Default: -qarch=ppc64grsq**	91
-qassert={deps | nodeps | itercnt=*n*}	ASSERT(DEPS | NODEPS | ITERCNT(N))	Provides information about the characteristics of the files that can help to fine-tune optimizations. **Default: -qassert=deps:itercnt=1024**	95

Table 6. Options for performance optimization (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qcache={ auto | assoc=*number* | cost=*cycles* | level=*level* | line=*bytes* | size=*Kbytes* | type={C|c|D|d| I|i}}[:...]		Specifies the cache configuration for a specific execution machine. The compiler uses this information to tune program performance, especially for loop operations that can be structured (or *blocked*) to process only the amount of data that can fit into the data cache. **Default:** The compiler uses typical values based on the **-qtune** setting, the **-qarch** setting, or both settings.	100
-qcompact -qnocompact	COMPACT NOCOMPACT	Reduces optimizations that increase code size. **Default: -qnocompact**	105
-qdirectstorage -qnodirectstorage		Informs the compiler that a given compilation unit may reference write-through-enabled or cache-inhibited storage. Use this option with discretion. It is intended for programmers who know how the memory and cache blocks work, and how to tune their applications for optimal performance. **Default: -qnodirectstorage**	113
-qenablevmx -qnoenablevmx		Enables the generation of Vector Multimedia eXtension (VMX) instructions. **Default: -qenablevmx**	116
-qessl		Allows the use of Engineering and Scientific Subroutine Library (ESSL) routines in place of Fortran 90 Intrinsic Procedures. Use the ESSL Serial Library when linking with **-lessl**. Use the ESSL SMP Library when linking with **-lesslsmp**. **Default: -qnoessl**	119
-qhot[=*suboptions*] -qnohot	HOT[=*suboptions*] NOHOT	Instructs the compiler to perform **h**igh-**o**rder loop analysis and **t**ransformations during optimization. **Default: -qnohot**	132
-qinlglue | -qnoinlglue		This option inlines glue code that optimizes external function calls in your application, when compiling at **-q64** and **-O2** and higher. **Default: -qnoinlglue**	139
-qipa[=*suboptions*] | -qnoipa		Enhances **-O** optimization by doing detailed analysis across procedures (interprocedural analysis or IPA). **Default: -O** analyzes each subprogram separately, ruling out certain optimizations that apply across subprogram boundaries. Note that specifying **-O5** is equivalent to specifying **-O4** and **-qipa=level=2**.	143
-qkeepparm -qnokeepparm		Ensures that incoming procedure parameters are stored on the stack even when optimizing. **Default: -qnokeepparm**	149

Table 6. Options for performance optimization (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qmaxmem=*Kbytes*	MAXMEM (*Kbytes*)	Limits the amount of memory that the compiler allocates while performing specific, memory-intensive optimizations to the specified number of kilobytes. A value of -1 allows optimization to take as much memory as it needs without checking for limits. **Default: -qmaxmem=8192**; At **-O3**, **-O4**, and **-O5**, **-qmaxmem=-1**.	158
-qpdf{1|2}		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. **Default:** Optimizations use fixed assumptions about branch frequency and other statistics.	172
-qprefetch | -qnoprefetch		Indicates whether or not the prefetch instructions should be inserted automatically by the compiler. **Default: -qprefetch**	182
-qshowpdf -qnoshowpdf		Adds additional call and block count profiling information to an executable. This option is used together with the **-qpdf1** option. **Default: -qnoshowpdf**	193
-qsmallstack[=dynlenonheap | nodynlenonheap] -qnosmallstack		Specifies that the compiler will minimize stack usage where possible. **Default: -qnosmallstack**	195
-qsmp[=*suboptions*] -qnosmp		When used with **xlf_r**, **xlf90_r**, or **xlf95_r**, controls automatic parallelization of loops, user-directed parallelization of loops and other items, and the choice of chunking algorithm. **Default: -qnosmp**	196
-NS*bytes* -qSPILLsize=*bytes*	SPILLsize (*bytes*)	Specifies the size of the register spill space. **Default:** -NS512	77
-qstacktemp={0 | -1 | *positive_integer*}	STACKTEMP={0 | -1 | *positive_integer*}	Determines where to allocate applicable XL Fortran compiler temporaries at run time. **Default: 0** The compiler allocates applicable temporaries on the heap or the stack at its discretion.	203
-qstrict -qnostrict	STRICT NOSTRICT	Ensures that optimizations done by the -O3, -O4, and -O5 options do not alter the semantics of a program. **Default:** With **-O3** and higher levels of optimization in effect, code may be rearranged so that results or exceptions are different from those in unoptimized programs. For **-O2**, the default is **-qstrict**. This option is ignored for **-qnoopt**.	204

Table 6. Options for performance optimization (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qstrict_induction -qnostrict_induction		Prevents the compiler from performing induction (loop counter) variable optimizations. These optimizations may be *unsafe* (may alter the semantics of your program) when there are integer overflow operations involving the induction variables. **Default: -qnostrict_induction**	206
-qthreaded		Specifies that the compiler should generate thread-safe code. This is turned on by default for the **xlf_r**, **xlf90_r**, and **xlf95_r** commands.	213
-qtune= *implementation*		Tunes instruction selection, scheduling, and other implementation-dependent performance enhancements for a specific implementation of a hardware architecture. The following settings are valid: auto, rs64b, rs64c, pwr3, pwr4, pwr5, or ppc970. **Default: -qtune=pwr4**	214
-qunroll[=auto | yes] -qnounroll		Specifies whether the compiler is allowed to automatically unroll **DO** loops. **Default: -qunroll=auto**	217
-qunwind -qnounwind	UNWIND NOUNWIND	Specifies that the compiler will preserve the default behavior for saves and restores to volatile registers during a procedure call. **Default: -qunwind**	218
-qzerosize -qnozerosize	ZEROSIZE NOZEROSIZE	Improves performance of FORTRAN 77 and some Fortran 90 and Fortran 95 programs by preventing checking for zero-sized character strings and arrays. **Default: -qzerosize** for the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, and **f95** commands and **-qnozerosize** for the **xlf**, **xlf_r**, **f77**, and **fort77** commands (meaning these commands cannot be used for programs that contain zero-sized objects).	230

Options for error checking and debugging

The following options help you avoid, detect, and correct problems in your XL Fortran programs and can save you having to refer as frequently to Chapter 7, "Problem determination and debugging," on page 243.

In particular, **-qlanglvl** helps detect portability problems early in the compilation process by warning of potential violations of the Fortran standards. These can be due to extensions in the program or due to compiler options that allow such extensions.

Other options, such as **-C** and **-qfltrap**, detect and/or prevent run-time errors in calculations, which could otherwise produce incorrect output.

Because these options require additional checking at compile time and some of them introduce run-time error checking that slows execution, you may need to experiment to find the right balance between extra checking and slower compilation and execution performance.

Using these options can help to minimize the amount of problem determination and debugging you have to do. Other options you may find useful while debugging include:

- "-# option" on page 64, "-v option" on page 235, and "-V option" on page 236
- "-qalias option" on page 86
- "-qci option" on page 104
- "-qobject option" on page 167
- "-qreport option" on page 187
- "-qsource option" on page 201

Table 7. Options for debugging and error checking

Command-Line Option	@PROCESS Directive	Description	See Page
-C -qcheck -qnocheck	CHECK NOCHECK	Checks each reference to an array element, array section, or character substring for correctness. Out-of-bounds references are reported as severe errors if found at compile time and generate **SIGTRAP** signals at run time. **Default: -qnocheck**	67
-D -qdlines -qnodlines	DLINES NODLINES	Specifies whether fixed source form lines with a D in column 1 are compiled or treated as comments. **Default: -qnodlines**	69
-g -qdbg -qnodbg	DBG NODBG	Generates debug information for use by a symbolic debugger. **Default: -qnodbg**	72
-qflttrap [=*suboptions*] -qnoflttrap	FLTTRAP [(*suboptions*)] NOFLTTRAP	Determines what types of floating-point exception conditions to detect at run time. The program receives a **SIGFPE** signal when the corresponding exception occurs. **Default: -qnoflttrap**	127
-qfullpath -qnofullpath		Records the full, or absolute, path names of source and include files in object files compiled with debugging information (-g option). **Default:** The relative path names of source files are recorded in the object files.	130
-qhalt=*sev*	HALT(*sev*)	Stops before producing any object, executable, or assembler source files if the maximum severity of compile-time messages equals or exceeds the specified severity. *severity* is one of i, l, w, e, s, u, or q, meaning informational, language, warning, error, severe error, unrecoverable error, or a severity indicating "don't stop". **Default: -qhalt=S**	131

Table 7. Options for debugging and error checking (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qinitauto[=*hex_value*] -qnoinitauto		Initializes each byte or word (4 bytes) of storage for automatic variables to a specific value, depending on the length of the *hex_value*. This helps you to locate variables that are referenced before being defined. For example, by using both the **-qinitauto** option to initialize **REAL** variables with a signaling NAN value and the **-qflttrap** option, it is possible to identify references to uninitialized **REAL** variables at run time. **Default: -qnoinitauto**. If you specify **-qinitauto** without a *hex_value*, the compiler initializes the value of each byte of automatic storage to zero.	137
-qlanglvl={ 77std | 90std | 90pure | 95std | 95pure | 2003std | 2003pure | extended}	LANGLVL({ 77STD | 90STD | 90PURE | 95STD | 95PURE | 2003STD | 2003PURE | EXTENDED})	Determines which language standard (or superset, or subset of a standard) to consult for nonconformance. It identifies nonconforming source code and also options that allow such nonconformances. **Default: -qlanglvl=extended**	150
-qlinedebug -qnolinedebug	LINEDEBUG NOLINEDEBUG	Generates line number and source file name information for the debugger. **Default: -qnolinedebug**	154
-qOBJect -qNOOBJect	OBJect NOOBJect	Specifies whether to produce an object file or to stop immediately after checking the syntax of the source files. **Default: -qobject**	167
-qsaa -qnosaa	SAA NOSAA	Checks for conformance to the SAA FORTRAN language definition. It identifies nonconforming source code and also options that allow such nonconformances. **Default: -qnosaa**	189
-qsaveopt -qnosaveopt		Saves the command-line options used for compiling a source file in the corresponding object file. **Default: -qnosaveopt**	191
-qsigtrap[= *trap_handler*]		Installs `xl__trce` or a predefined or user-written trap handler in a main program. **Default:** No trap handler installed; program core dumps when a **trap** instruction is executed.	194

Table 7. Options for debugging and error checking (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qtbtable={none | small | full}		Only applies to the 64-bit environment. Limits the amount of debugging traceback information in object files, to reduce the size of the program. **Default:** Full traceback information in the object file when compiling non-optimized (without **-O**) or for debugging (with **-g**). Otherwise, a small amount of traceback information in the object file.	212
-qwarn64 -qnowarn64		Detects the truncation of an 8-byte integer pointer to 4 bytes. Identifies, through informational messsages, statements that might cause problems during 32-bit to 64-bit migration. **Default: -qnowarn64**	220
-qxflag=dvz		Specifying **-qxflag=dvz** causes the compiler to generate code to detect floating-point divide-by-zero operations. **Default:** No code is generated to detect floating-point divide-by-zero operations.	221
-qxlines -qnoxlines	XLINES NOXLINES	Specifies whether fixed source form lines with a X in column 1 are treated as source code and compiled, or treated instead as comments. **Default: -qnoxlines**	227

Options that control listings and messages

The following options determine whether the compiler produces a listing (**.lst** file), what kinds of information go into the listing, and what the compiler does about any error conditions it detects.

Some of the options in "Options for error checking and debugging" on page 46 can also produce compiler messages.

Table 8. Options that control listings and messages

Command-Line Option	@PROCESS Directive	Description	See Page
-#		Generates information on the progress of the compilation without actually running the individual components. **Default:** No progress messages are produced.	64
-qattr[=full] -qnoattr	ATTR[(FULL)] NOATTR	Specifies whether to produce the attribute component of the attribute and cross-reference section of the listing. **Default: -qnoattr**	96

Table 8. Options that control listings and messages (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qflag= *listing_severity*: *terminal_severity* -w	FLAG (*listing_severity*, *terminal_severity*)	Limits the diagnostic messages to those of a specified level or higher. Only messages with severity *listing_severity* or higher are written to the listing file. Only messages with severity *terminal_severity* or higher are written to the terminal. -w is a short form for -qflag=e:e. **Default: -qflag=i:i**	124
-qlist[={[no]offset}] -qnolist	LIST[([NO]OFFSET)] NOLIST	Specifies whether to produce the object section of the listing. **Default: -qnolist**	155
-qlistopt -qnolistopt	LISTOPT NOLISTOPT	Determines whether to show the setting of every compiler option in the listing file or only selected options. These selected options include those specified on the command line or directives plus some that are always put in the listing. **Default: -qnolistopt**	156
-qnoprint		Prevents the listing file from being created, regardless of the settings of other listing options. **Default:** A listing is produced if you specify any of -qattr, -qlist, -qlistopt, -qphsinfo, -qreport, -qsource, or -qxref.	165
-qphsinfo -qnophsinfo	PHSINFO NOPHSINFO	Determines whether timing information is displayed on the terminal for each compiler phase. **Default: -qnophsinfo**	176
-qreport[={smplist | hotlist}...] -qnoreport	REPORT [({SMPLIST | HOTLIST}...)] NOREPORT	Determines whether to produce transformation reports showing how the program is parallelized and how loops are optimized. **Default: -qnoreport**	187
-qsource -qnosource	SOURCE NOSOURCE	Determines whether to produce the source section of the listing. **Default: -qnosource**	201
-qsuppress [= *nnnn-mmm*[:*nnnn-mmm*...] | cmpmsg] | -qnosuppress		Specifies which messages to suppress from the output stream.	208
-qversion -qnoversion		Displays the version and release of the compiler being invoked. **Default: -qnoversion**	219
-qxref -qnoxref -qxref=full	XREF NOXREF XREF(FULL)	Determines whether to produce the cross-reference component of the attribute and cross-reference section of the listing. **Default: -qnoxref**	229

Table 8. Options that control listings and messages (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-S		Produces one or more **.s** files showing equivalent assembler source for each Fortran source file. **Default:** No equivalent assembler source is produced.	231
-v		Traces the progress of the compilation by displaying the name and parameters of each compiler component that is executed by the invocation command. **Default:** No progress messages are produced.	235
-V		Traces the progress of the compilation by displaying the name and parameters of each compiler component that is executed by the invocation command. These are displayed in a shell-executable format. **Default:** No progress messages are produced.	236

Options for compatibility

The following options help you maintain compatibility between your XL Fortran source code on past, current, and future hardware platforms or help you port programs to XL Fortran with a minimum of changes.

Related information: *Porting programs to XL Fortran* in the *XL Fortran Optimization and Programming Guide* discusses this subject in more detail. *Duplicating the floating-point results of other systems* in the *XL Fortran Optimization and Programming Guide* explains how to use some of the options in "Options for floating-point processing" on page 59 to achieve floating-point results compatible with other systems.

The **-qfree=ibm** form of the "-qfree option" on page 129 also provides compatibility with VS FORTRAN free source form.

Table 9. Options for compatibility

Command-Line Option	@PROCESS Directive	Description	See Page
-qautodbl=*setting*	AUTODBL(*setting*)	Provides an automatic means of converting single-precision floating-point calculations to double-precision and of converting double-precision calculations to extended-precision. Use one of the following settings: none, dbl, dbl4, dbl8, dblpad, dblpad4, or dblpad8. **Default: -qautodbl=none**	97
-qbigdata -qnobigdata		In 32-bit mode, use this option for programs that exceed 16MB of initialized data (a gcc limitation) and call routines in shared libraries (like open, close, printf and so on). **Default:** -qnobigdata	161
-qcclines -qnocclines	CCLINES NOCCLINES	Determines whether the compiler recognizes conditional compilation lines. **Default: -qcclines** if you have specified the **-qsmp=omp** option; otherwise, **-qnocclines**.	102
-qctyplss [=([no]arg)] -qnoctyplss	CTYPLSS [([NO]ARG)] NOCTYPLSS	Specifies whether character constant expressions are allowed wherever typeless constants may be used. This language extension might be needed when you are porting programs from other platforms. Suboption **arg** specifies that Hollerith constants used as actual arguments will be treated as integer actual arguments. **Default: -qnoctyplss**	107

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qddim -qnoddim	DDIM NODDIM	Specifies that the bounds of pointee arrays are re-evaluated each time the arrays are referenced and removes some restrictions on the bounds expressions for pointee arrays. **Default: -qnoddim**	110
-qdpc -qdpc=e -qnodpc	DPC DPC(E) NODPC	Increases the precision of real constants, for maximum accuracy when assigning real constants to **DOUBLE PRECISION** variables. This language extension might be needed when you are porting programs from other platforms. **Default: -qnodpc**	115
-qescape -qnoescape	ESCAPE NOESCAPE	Specifies how the backslash is treated in character strings, Hollerith constants, H edit descriptors, and character string edit descriptors. It can be treated as an escape character or as a backslash character. This language extension might be needed when you are porting programs from other platforms. **Default: -qescape**	118

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qextern=*names*		Allows user-written procedures to be called instead of XL Fortran intrinsics. *names* is a list of procedure names separated by colons. The procedure names are treated as if they appear in an **EXTERNAL** statement in each compilation unit being compiled. If any of your procedure names conflict with XL Fortran intrinsic procedures, use this option to call the procedures in the source code instead of the intrinsic ones. **Default:** Names of intrinsic procedures override user-written procedure names when they are the same.	120
-qextname[=*name*:*name*...] -qnoextname	EXTNAME[(*name*:*name*...)] NOEXTNAME	Adds an underscore to the names of all global entities, which helps in porting programs from systems where this is a convention for mixed-language programs. **Default: -qnoextname**	121
-qinit=f90ptr	INIT(f90ptr)	Makes the initial association status of pointers disassociated. **Default:** The default association status of pointers is undefined.	136
-qintlog -qnointlog	INTLOG NOINTLOG	Specifies that you can mix integer and logical values in expressions and statements. **Default: -qnointlog**	140
-qintsize=*bytes*	INTSIZE(*bytes*)	Sets the size of default **INTEGER** and **LOGICAL** values. **Default: -qintsize=4**	141

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qlog4 -qnolog4	LOG4 NOLOG4	Specifies whether the result of a logical operation with logical operands is a **LOGICAL(4)** or is a **LOGICAL** with the maximum length of the operands. **Default: -qnolog4**	157
-qminimaltoc -qnominimaltoc		Ensures that the compiler creates only one TOC entry for each compilation unit. By default, the compiler will allocate at least one TOC entry for each unique non-automatic variable reference in your program. Only 8192 TOC entries are available, and duplicate entries are not discarded. This can cause errors when linking large programs in 64-bit mode if your program exceeds 8192 TOC entries. **Default:** -qnominimaltoc	161
-qmodule=mangle81		Specifies that the compiler should use the XL Fortran Version 8.1 naming convention for non-intrinsic module files. **Default:** The compiler uses the current naming convention for non-intrinsic module names. This convention is not compatible with that used by previous versions of the compiler.	164
-qnullterm -qnonullterm	NULLTERM NONULLTERM	Appends a null character to each character constant expression that is passed as a dummy argument, to make it more convenient to pass strings to C functions. **Default: -qnonullterm**	166

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-1 -qonetrip -qnoonetrip	ONETRIP NOONETRIP	Executes each **DO** loop in the compiled program at least once if its **DO** statement is executed, even if the iteration count is 0. **Default: -qnoonetrip**	65
-qport [=*suboptions*] -qnoport	PORT [(*suboptions*)] NOPORT	Increases flexibility when porting programs to XL Fortran by providing a number of options to accommodate other Fortran language extensions. **Default: -qnoport**	179
-qposition= {appendold | appendunknown}	POSITION({APPENDOLD | APPENDUNKNOWN})	Positions the file pointer at the end of the file when data is written after an **OPEN** statement with no **POSITION=** specifier and the corresponding **STATUS=** value (**OLD** or **UNKNOWN**) is specified. **Default:** Depends on the I/O specifiers in the **OPEN** statement and on the compiler invocation command: **-qposition=appendold** for the **xlf**, **xlf_r**, and **f77/fort77** commands and the defined Fortran 90 and Fortran 95 behaviors for the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, and **f95** commands.	181
-qqcount -qnoqcount	QCOUNT NOQCOUNT	Accepts the **Q** character-count edit descriptor (**Q**) as well as the extended-precision **Q** edit descriptor (**Q***w.d*). With -qnoqcount, all **Q** edit descriptors are interpreted as the extended-precision **Q** edit descriptor. **Default: -qnoqcount**	183

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qoldmod=compat		This option specifies that object files containing module data compiled with versions of XL Fortran earlier than V9.1.1 either do not contain uninitialized module data or were ported using the **convert_syms** script.	168
-qrealsize=*bytes*	REALSIZE(*bytes*)	Sets the default size of **REAL**, **DOUBLE PRECISION**, **COMPLEX**, and **DOUBLE COMPLEX** values. **Default: -qrealsize=4**	184
-qsave[={all | defaultinit}] -qnosave	SAVE{(ALL | DEFAULTINIT)} NOSAVE	Specifies the default storage class for local variables. **-qsave**, **-qsave=all**, or **-qsave=defaultinit** sets the default storage class to **STATIC**, while **-qnosave** sets it to **AUTOMATIC**. **Default: -qnosave** **-qsave** is turned on by default for **xlf**, **xlf_r**, **f77**, or **fort77** to duplicate the behavior of FORTRAN77 commands.	190
-qsclk=[centi | micro]		Specifies that when returning a value using the **SYSTEM_CLOCK** intrinsic procedure, the compiler will use centisecond resolution. You can specify a microsecond resolution by using **–qsclk=micro**. **Default: -qsclk=centi**	192
-qswapomp -qnoswapomp	SWAPOMP NOSWAPOMP	Specifies that the compiler should recognize and substitute OpenMP routines in XL Fortran programs. **Default: -qswapomp**	210

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-u -qundef -qnoundef	UNDEF NOUNDEF	Specifies whether implicit typing of variable names is permitted. -u and -qundef have the same effect as the **IMPLICIT NONE** statement that appears in each scope that allows implicit statements. **Default: -qnoundef**	234
-qxflag=oldtab	XFLAG(OLDTAB)	Interprets a tab in columns 1 to 5 as a single character (for fixed source form programs). **Default:** Tab is interpreted as one or more characters.	222
-qxlf77=*settings*	XLF77(*settings*)	Provides compatibility with FORTRAN 77 aspects of language semantics and I/O data format that have changed. Most of these changes are required by the Fortran 90 standard. **Default:** Default suboptions are `blankpad`, `nogedit77`, `nointarg`, `nointxor`, `leadzero`, `nooldboz`, `nopersistent`, and `nosofteof` for the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, and **f95** commands and are the exact opposite for the **xlf**, **xlf_r**, and **f77/fort77** commands.	223

Table 9. Options for compatibility (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-qxlf90= {[no]signedzero | [no]autodealloc}	XLF90({[no]signedzero | [no]autodealloc})	Determines whether the compiler provides the Fortran 90 or the Fortran 95 level of support for certain aspects of the language. **Default:** The default suboptions are **signedzero** and **autodealloc** for the **xlf95**, **xlf95_r**, and **f95** invocation commands. For all other invocation commands, the default suboptions are **nosignedzero** and **noautodealloc**.	225

Options for floating-point processing

To take maximum advantage of the system floating-point performance and precision, you may need to specify details of how the compiler and XLF-compiled programs perform floating-point calculations.

Related information: See "-qfltrap option" on page 127 and *Duplicating the floating-point results of other systems* in the *XL Fortran Optimization and Programming Guide*.

Table 10. Options for floating-point processing

Command-Line Option	@PROCESS Directive	Description	See Page
-qfloat=*options*	FLOAT(*options*)	Determines how the compiler generates or optimizes code to handle particular types of floating-point calculations. **Default:** Default suboptions are **nocomplexgcc**, **nofltint**, **fold**, **nohsflt**, **maf**, **nonans**, **norrm**, **norsqrt**, and **nostrictnmaf**; some of these settings are different with **-O3** optimization turned on or with **-qarch=ppc**.	125
-qieee={ Near | Minus | Plus | Zero} -y{n|m|p|z}	IEEE({Near | Minus | Plus | Zero})	Specifies the rounding mode for the compiler to use when evaluating constant floating-point expressions at compile time. **Default: -qieee=near**	135
-qstrictieeemod -qnostrictieeemod	STRICTIEEE-MOD NOSTRICTIEEE-MOD	Specifies whether the compiler will adhere to the Fortran 2003 IEEE arithmetic rules for the **ieee_arithmetic** and **ieee_exceptions** intrinsic modules. **Default: -qstrictieeemod**	205

Options that control linking

The following options control the way the **ld** command processes object files during compilation. Some of these options are passed on to **ld** and are not processed by the compiler at all.

You can actually include **ld** options on the compiler command line, because the compiler passes unrecognized options on to the linker.

In the table, an * indicates that the option is processed by the **ld** command, rather than the XL Fortran compiler; you can find more information about these options in the man pages for the **ld** command.

Table 11. Options that control linking

Command-Line Option	@PROCESS Directive	Description	See Page
-c		Produces an object file instead of an executable file. **Default:** Compile and link-edit, producing an executable file.	68
-L*dir**		Looks in the specified directory for libraries specified by the **-l** option. **Default: /usr/lib**	75
-l*key**		Searches the specified library file, where *key* selects the file **lib***key***.so** or **lib***key***.a**. **Default:** Libraries listed in **xlf.cfg**.	76
-qpic -qnopic		Generates Position Independent Code (PIC) that can be used in shared libraries. **Default: -qnopic** in 32-bit mode; **-qpic=small** in 64-bit mode.	178

Options that control other compiler operations

These options can help to do the following:

- Control internal size limits for the compiler
- Determine names and options for commands that are executed during compilation
- Determine the bit mode and instruction set for the target architecture

Table 12. Options that control the compiler internal operation

Command-Line Option	@PROCESS Directive	Description	See Page
-B*prefix*		Determines a substitute path name for executable files used during compilation, such as the compiler or linker. It can be used in combination with the **-t** option, which determines which of these components are affected by **-B**. **Default:** Paths for these components are defined in the configuration file, the **$PATH** environment variable, or both.	66
-F*config_file* -F*config_file*:*stanza* -F:*stanza*		Specifies an alternative configuration file, the stanza to use within the configuration file, or both. **Default:** The configuration file is **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**, and the stanza depends on the name of the command that executes the compiler.	71

Table 12. Options that control the compiler internal operation (continued)

Command-Line Option	@PROCESS Directive	Description	See Page
-q32		Sets the bit mode and instruction set for a 32-bit target architecture.	83
-q64		Sets the bit mode and instruction set for a 64-bit target architecture.	84
-t*components*		Applies the prefix specified by the -B option to the designated components. *components* can be one or more of F, c, d, I, a, h, b, z, or l, with no separators, corresponding to the C preprocessor, the compiler, the -S disassembler, the interprocedural analysis (IPA) tool, the assembler, the loop optimizer, the code generator, the binder, and the linker, respectively. **Default: -B** prefix, if any, applies to all components.	232
-W*component*,*options*		Passes the listed options to a component that is executed during compilation. *component* is F, c, d, I, a, z, or l, corresponding to the C preprocessor, the compiler, the -S disassembler, the interprocedural analysis (IPA) tool, the assembler, the binder, and the linker, respectively. **Default:** The options passed to these programs are as follows: • Those listed in the configuration file • Any unrecognized options on the command line (passed to the linker)	237

Options that are obsolete or not recommended

The following options are obsolete for either or both of the following reasons:

- It has been replaced by an alternative that is considered to be better. Usually this happens when a limited or special-purpose option is replaced by one with a more general purpose and additional features.
- We expect that few or no customers use the feature and that it can be removed from the product in the future with minimal impact to current users.

Notes:

1. If you do use any of these options in existing makefiles or compilation scripts, you should migrate to the new alternatives as soon as you can to avoid any potential problems in the future.
2. The **append** suboption of **-qposition** has been replaced by **appendunknown**.

Table 13. Options that are obsolete or not recommended

Command-Line Option	@PROCESS Directive	Description	See Page
-qcharlen=*length*	CHARLEN (*length*)	Obsolete. It is still accepted, but it has no effect. The maximum length for character constants and subobjects of constants is 32 767 bytes (32 KB). The maximum length for character variables is 268 435 456 bytes (256 MB) in 32-bit mode. The maximum length for character variables is 2**40 bytes in 64-bit mode. These limits are always in effect and are intended to be high enough to avoid portability problems with programs that contain long strings.	
-qrecur -qnorecur	RECUR NORECUR	Not recommended. Specifies whether external subprograms may be called recursively. For new programs, use the **RECURSIVE** keyword, which provides a standard-conforming way of using recursive procedures. If you specify the -qrecur option, the compiler must assume that any procedure could be recursive. Code generation for recursive procedures may be less efficient. Using the **RECURSIVE** keyword allows you to specify exactly which procedures are recursive.	186

Detailed descriptions of the XL Fortran compiler options

The following alphabetical list of options provides all the information you should need to use each option effectively.

How to read the syntax information:

- Syntax is shown first in command-line form, and then in **@PROCESS** form if applicable.
- Defaults for each option are underlined and in boldface type.
- Individual required arguments are shown with no special notation.
- When you must make a choice between a set of alternatives, they are enclosed by { and } symbols.
- Optional arguments are enclosed by [and] symbols.
- When you can select from a group of choices, they are separated by | characters.
- Arguments that you can repeat are followed by ellipses (...).

-# option

Syntax

```
-#
```

Generates information on the progress of the compilation without actually running the individual components.

Rules

At the points where the compiler executes commands to perform different compilation steps, this option displays a simulation of the system calls it would do and the system argument lists it would pass, but it does not actually perform these actions.

Examining the output of this option can help you quickly and safely determine the following information for a particular compilation:

- What files are involved
- What options are in effect for each step

It avoids the overhead of compiling the source code and avoids overwriting any existing files, such as **.lst** files. (If you are familiar with the **make** command, it is similar to **make -n**.)

Note that if you specify this option with **-qipa**, the compiler does not display linker information subsequent to the IPA link step. This is because the compiler does not actually call IPA.

Related information

The "-v option" on page 235 and "-V option" on page 236 produce the same output but also performs the compilation.

-1 option

Syntax

```
-1
ONETRIP | NOONETRIP
```

Executes each **DO** loop in the compiled program at least once if its **DO** statement is executed, even if the iteration count is 0. This option provides compatibility with FORTRAN 66. The default is to follow the behavior of later Fortran standards, where **DO** loops are not performed if the iteration count is 0.

Restrictions

It has no effect on **FORALL** statements, **FORALL** constructs, or array constructor implied-**DO** loops.

Related information

-qonetrip is the long form of **-1**.

-B option

Syntax

`-B`*`prefix`*

Determines a substitute path name for executable files used during compilation, such as the compiler or linker. It can be used in combination with the **-t** option, which determines which of these components are affected by **-B**.

Arguments

prefix is the name of a directory where the alternative executable files reside. It must end in a **/** (slash).

Rules

To form the complete path name for each component, the driver program adds *prefix* to the standard program names. You can restrict the components that are affected by this option by also including one or more **-t***mnemonic* options.

You can also specify default path names for these commands in the configuration file.

This option allows you to keep multiple levels of some or all of the XL Fortran components or to try out an upgraded component before installing it permanently. When keeping multiple levels of XL Fortran available, you might want to put the appropriate **-B** and **-t** options into a configuration-file stanza and to use the **-F** option to select the stanza to use.

Examples

In this example, an earlier level of the XL Fortran components is installed in the directory **/opt/ibmcmp/xlf/9.1/exe**. To test the upgraded product before making it available to everyone, the system administrator restores the latest install image under the directory **/home/jim** and then tries it out with commands similar to:

```
/home/jim/xlf/10.1/bin/xlf95 -tchIbdz -B/home/jim/xlf/9.1/exe/ test_suite.f
```

Once the upgrade meets the acceptance criteria, the system administrator installs it over the old level in **/opt/ibmcmp/xlf/10.1**.

Related information

See “-t option” on page 232, “-F option” on page 71, “Customizing the configuration file” on page 10, and “Running two levels of XL Fortran” on page 14.

-C option

Syntax

```
-C
CHECK | NOCHECK
```

Checks each reference to an array element, array section, or character substring for correctness.

Rules

At compile time, if the compiler can determine that a reference goes out of bounds, the severity of the error reported is increased to **S** (severe) when this option is specified.

At run time, if a reference goes out of bounds, the program generates a **SIGTRAP** signal. By default, this signal ends the program and produces a core dump. This is expected behavior and does not indicate there is a defect in the compiler product.

Because the run-time checking can slow execution, you should decide which is the more important factor for each program: the performance impact or the possibility of incorrect results if an error goes undetected. You might decide to use this option only while testing and debugging a program (if performance is more important) or also for compiling the production version (if safety is more important).

Related information

The **-C** option prevents some of the optimizations that the "-qhot option" on page 132 performs. You may want to remove the **-C** option after debugging of your code is complete and to add the **-qhot** option to achieve a more thorough optimization.

The valid bounds for character substring expressions differ depending on the setting of the **-qzerosize** option. See "-qzerosize option" on page 230.

"-qsigtrap option" on page 194 and *Installing an exception handler* in the *XL Fortran Optimization and Programming Guide* describe how to detect and recover from **SIGTRAP** signals without ending the program.

-qcheck is the long form of **-C**.

-c option

Syntax

```
-c
```

Prevents the completed object file from being sent to the **ld** command for link-editing. With this option, the output is a **.o** file for each source file.

Using the **-o** option in combination with **-c** selects a different name for the **.o** file. In this case, you can only compile one source file at a time.

Related information

See "-o option" on page 80.

-D option

Syntax

```
-D
DLINES | NODLINES
```

Specifies whether the compiler compiles fixed source form lines with a D in column 1 or treats them as comments.

If you specify **-D**, the fixed source form lines that have a **D** in column 1 are compiled. The default action is to treat these lines as comment lines. They are typically used for sections of debugging code that need to be turned on and off.

Note that in order to pass C-style **-D** macro definitions to the C preprocessor, for example, compiling a file that ends with **.F**, use the **-W** option. For example:

```
-WF,-DDEFINE_THIS
```

Related information

-qdlines is the long form of **-D**.

-d option

Syntax

```
-d
```

Causes preprocessed source files that are produced by **cpp** to be kept rather than to be deleted.

Rules

The files that this option produces have names of the form **F***filename***.f**, derived from the names of the original source files.

Related information

See "Passing Fortran files through the C preprocessor" on page 24.

-F option

Syntax

-F{*config_file* | *config_file:stanza* | :*stanza*}

Specifies an alternative configuration file, which stanza to use within the configuration file, or both.

The configuration file specifies different kinds of defaults, such as options for particular compilation steps and the locations of various files that the compiler requires. A default configuration file (**/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**) is supplied at installation time. The default stanza depends on the name of the command used to invoke the compiler (**xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **xlf**, **xlf_r**, **f77**, or **fort77**).

A simple way to customize the way the compiler works, as an alternative to writing complicated compilation scripts, is to add new stanzas to **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg**, giving each stanza a different name and a different set of default compiler options. You may find the single, centralized file easier to maintain than many scattered compilation scripts and makefiles.

By running the compiler with an appropriate **-F** option, you can select the set of options that you want. You might have one set for full optimization, another set for full error checking, and so on.

Restrictions

Because the default configuration file is replaced each time a new compiler release is installed, make sure to save a copy of any new stanzas or compiler options that you add.

Examples

```
 # Use stanza debug in default xlf.cfg.
   xlf95 -F:debug t.f

# Use stanza xlf95 in /home/fred/xlf.cfg.
   xlf95 -F/home/fred/xlf.cfg t.f

# Use stanza myxlf in /home/fred/xlf.cfg.
   xlf95 -F/home/fred/xlf.cfg:myxlf t.f
```

Related information

"Customizing the configuration file" on page 10 explains the contents of a configuration file and tells how to select different stanzas in the file without using the **-F** option.

-g option

Syntax

```
-g
DBG | NODBG
```

Generates debug information for use by a symbolic debugger.

-qdbg is the long form of **-g**.

-g implies the **-Q!** option.

Related information

- "-qlinedebug option" on page 154
- "Debugging a Fortran 90 or Fortran 95 program" on page 249
- "Symbolic debugger support" on page 5

-I option

Syntax

`-I`*dir*

Adds a directory to the search path for include files and **.mod** files. If XL Fortran calls **cpp**, this option adds a directory to the search path for **#include** files. Before checking the default directories for include and **.mod** files, the compiler checks each directory in the search path. For include files, this path is only used if the file name in an **INCLUDE** line is not provided with an absolute path. For **#include** files, refer to the **cpp** documentation for the details of the **-I** option.

Arguments

dir must be a valid path name (for example, **/home/dir**, **/tmp**, or **./subdir**).

Rules

The compiler appends a / to the *dir* and then concatenates that with the file name before making a search. If you specify more than one **-I** option on the command line, files are searched in the order of the *dir* names as they appear on the command line.

The following directories are searched, in this order, after any paths that are specified by **-I** options:

1. The current directory (from which the compiler is executed)
2. The directory where the source file is (if different from 1)
3. **/usr/include**.

Also, the compiler will search **/opt/ibmcmp/xlf/10.1/include** where include and **.mod** files shipped with the compiler are located.

Related information

The "-qmoddir option" on page 163 puts **.mod** files in a specific directory when you compile a file that contains modules.

-k option

Syntax

```
-k
FREE(F90)
```

Specifies that the program is in free source form.

Applicable product levels

The meaning of this option has changed from XL Fortran Version 2. To get the old behavior of **-k**, use the option **-qfree=ibm** instead.

Related information

See "-qfree option" on page 129 and *Free Source Form* in the *XL Fortran Language Reference*.

This option is the short form of **-qfree=f90**.

-L option

Syntax

-L*dir*

Looks in the specified directory for libraries that are specified by the **-l** option. If you use libraries other than the default ones in **/opt/ibmcmp/xlf/10.1/lib** or **/opt/ibmcmp/xlf/10.1/lib64**, you can specify one or more **-L** options that point to the locations of the other libraries. You can also specify the **LD_LIBRARY_PATH** and **LD_RUN_PATH** environment variables for search paths for libraries.

Rules

This option is passed directly to the **ld** command and is not processed by XL Fortran at all.

Related information

See "Options that control linking" on page 60 and "Linking XL Fortran programs" on page 26.

-l option

Syntax

-l*key*

Searches the specified library file, where *key* selects the library **lib***key***.so** or **lib***key***.a**.

Rules

This option is passed directly to the **ld** command and is not processed by XL Fortran at all.

Related information

See "Options that control linking" on page 60 and "Linking XL Fortran programs" on page 26.

-NS option

Syntax

-NS*bytes*
SPILLSIZE(*bytes*)

Specifies the size (in bytes) of the register spill space; the internal program storage areas used by the optimizer for register spills to storage.

Rules

It defines the number of bytes of stack space to reserve in each subprogram, in case there are too many variables to hold in registers and the program needs temporary storage for register contents.

Defaults

By default, each subprogram stack has 512 bytes of spill space reserved.

If you need this option, a compile-time message informs you of the fact.

Related information

-qspillsize is the long form of **-NS**.

-O option

Syntax

```
-O[level]
OPTimize[(level)] | NOOPTimize
```

Specifies whether to optimize code during compilation and, if so, at which level:

Arguments

not specified
Almost all optimizations are disabled. (This is equivalent to specifying **-O0** or **-qnoopt**.

-O For each release of XL Fortran, **-O** enables the level of optimization that represents the best tradeoff between compilation speed and run-time performance. If you need a specific level of optimization, specify the appropriate numeric value. Currently, **-O** is equivalent to **-O2**.

-O0 Almost all optimizations are disabled. This option is equivalent to **–qnoopt**.

-O1 Reserved for future use. This form does not currently do any optimization and is ignored.

-O2 Performs a set of optimizations that are intended to offer improved performance without an unreasonable increase in time or storage that is required for compilation.

-O3 Performs additional optimizations that are memory intensive, compile-time intensive, and may change the semantics of the program slightly, unless **-qstrict** is specified. We recommend these optimizations when the desire for run-time speed improvements outweighs the concern for limiting compile-time resources.

This level of optimization also affects the setting of the **-qfloat** option, turning on the **fltint** and **rsqrt** suboptions by default, and sets **-qmaxmem=-1**.

Specifying **-O3** implies **-qhot=level=0** unless you explicitly specify **-qhot** or **-qhot=level=1**.

-O4 Aggressively optimizes the source program, trading off additional compile time for potential improvements in the generated code. You can specify the option at compile time or at link time. If you specify it at link time, it will have no effect unless you also specify it at compile time for at least the file that contains the main program.

-O4 implies the following other options:
- **-qhot**
- **-qipa**
- **-O3** (and all the options and settings that it implies)
- **-qarch=auto**
- **-qtune=auto**
- **-qcache=auto**

Note that the **auto** setting of **-qarch**, **-qtune**, and **-qcache** implies that the execution environment will be the same as the compilation environment.

This option follows the ″last option wins″ conflict resolution rule, so any of the options that are modified by **-O4** can be subsequently changed. For

example, specifying **-O4 -qarch=com** allows aggressive intraprocedural optimization while maintaining code portability.

-O5 Provides all of the functionality of the **-O4** option, but also provides the functionality of the **-qipa=level=2** option.

Note: Combining **-O2** and higher optimizations with **-qsmp=omp** invokes additional optimization algorithms, including interprocedural analysis (IPA). IPA optimizations provide opportunities for the compiler to generate additional **fmadd** instructions.

To obtain the same floating-point accuracy for optimized and non-optimized applications, you must specify the **-qfloat=nomaf** compiler option. In cases where differences in floating-point accuracy still occur after specifying **-qfloat=nomaf**, the **-qstrict** compiler option allows you to exert greater control over changes that optimization can cause in floating-point semantics.

Restrictions

Generally, use the same optimization level for both the compile and link steps. This is important when using either the **-O4** or **-O5** optimization level to get the best run-time performance. For the **-O5** level, all loop transformations (as specified via the **-qhot** option) are done at the link step.

Increasing the level of optimization may or may not result in additional performance improvements, depending on whether the additional analysis detects any further optimization opportunities.

An optimization level of **-O3** or higher can change the behavior of the program and potentially cause exceptions that would not otherwise occur. Use of the **-qstrict** option can eliminate potential changes and exceptions.

If the **-O** option is used in an **@PROCESS** statement, only an optimization level of 0, 2, or 3 is allowed.

Compilations with optimization may require more time and machine resources than other compilations.

The more the compiler optimizes a program, the more difficult it is to debug the program with a symbolic debugger.

Related information

"-qstrict option" on page 204 shows how to turn off the effects of **-O3** that might change the semantics of a program.

"-qipa option" on page 143, "-qhot option" on page 132, and "-qpdf option" on page 172 turn on additional optimizations that may improve performance for some programs.

Optimizing XL compiler programs in the *XL Fortran Optimization and Programming Guide* discusses technical details of the optimization techniques the compiler uses and some strategies you can use to get maximum performance from your code.

-qOPTimize is the long form of **-O**.

-o option

Syntax

`-o` *name*

Specifies a name for the output object, executable, or assembler source file.

To choose the name for an object file, use this option in combination with the **-c** option. For an assembler source file, use it in combination with the **-S** option.

Defaults

The default name for an executable file is **a.out**. The default name for an object or assembler source file is the same as the source file except that it has a **.o** or **.s** extension.

Rules

Except when you specify the **-c** or **-S** option, the **-o** option is passed directly to the **ld** command, instead of being processed by XL Fortran.

Examples

```
xlf95 t.f                   # Produces "a.out"
xlf95 -c t.f                # Produces "t.o"
xlf95 -o test_program t.f   # Produces "test_program"
xlf95 -S -o t2.s t.f        # Produces "t2.s"
```

-p option

Syntax

```
-p[g]
```

Sets up the object file for profiling.

-p or **-pg** prepares the program for profiling. When you execute the program, it produces a **gmon.out** file with the profiling information. You can then use the **gprof** command to generate a run-time profile.

Rules

For profiling, the compiler produces monitoring code that counts the number of times each routine is called. The compiler replaces the startup routine of each subprogram with one that calls the monitor subroutine at the start. When the program ends normally, it writes the recorded information to the **gmon.out** file.

Examples

```
$ xlf95 -pg needs_tuning.f
$ a.out
$ gprof
 .
 .
 .

detailed and verbose profiling data
 .
 .
 .
```

Related information

For more information on profiling and the **gprof** command, see the man pages for this command.

-Q option

Syntax

-Q+*names* | -Q-*names* | -Q | **-Q!**

Specifies whether Fortran 90 or Fortran 95 procedures are inlined and/or the names of particular procedures that should or should not be inlined. *names* is a list of procedure names that are separated by colons.

Rules

By default, **-Q** only affects internal or module procedures. To turn on inline expansion for calls to procedures in different scopes, you must also use the **-qipa** option.

Arguments

The **-Q** option without any list inlines all appropriate procedures, subject to limits on the number of inlined calls and the amount of code size increase as a result. **+***names* specifies the names, separated by colons, of procedures to inline and raises these limits for those procedures. **-***names* specifies the names, separated by colons, of procedures not to inline. You can specify more than one of these options to precisely control which procedures are most likely to be inlined.

The **-Q!** option turns off inlining.

A procedure is not inlined by the basic **-Q** option unless it is quite small. In general, this means that it contains no more than several source statements (although the exact cutoff is difficult to determine). A procedure named by **-Q+** can be up to approximately 20 times larger and still be inlined.

Restrictions

You must specify at least an optimization level of **-O2** for inlining to take effect with **-Q**.

If you specify inlining for a procedure, the following **@PROCESS** compiler directives are only effective if they come before the first compilation unit in the file: **ALIAS**, **ALIGN**, **ATTR**, **COMPACT**, **DBG**, **EXTCHK**, **EXTNAME**, **FLOAT**, **FLTTRAP**, **HALT**, **IEEE**, **LIST**, **MAXMEM**, **OBJECT**, **OPTIMIZE**, **PHSINFO**, **SPILLSIZE**, **STRICT**, and **XREF**.

Examples

```
xlf95  -O -Q many_small_subprogs.f   # Compiler decides what to inline.
xlf95  -O -Q+bigfunc:hugefunc test.f # Inline even though these are big.
xlf95  -O -Q -Q-only_once pi.f       # Inline except for this one procedure.
```

Related information

- "-qipa option" on page 143
- *Benefits of Interprocedural Analysis* in the *XL Fortran Optimization and Programming Guide*

-q32 option

Syntax

`-q32`

Enables 32-bit compilation mode (or, more briefly, 32-bit mode) support in a 64-bit environment. The **-q32** option indicates the compilation bit mode and, together with the **-qarch** option, determines the target machines that the 32-bit executable will run on.

Rules

- The default integer and default real size are 4 bytes in 32-bit mode.
- The default integer pointer size is 4 bytes in 32-bit mode.
- 32-bit object modules are created when targeting 32-bit mode.
- **-q32** is the default.
- **-q64** can override **-q32**.
- All settings for **-qarch** are compatible with **-q32**. If you specify **-q32**, the default suboption is **ppc64grsq**, and the default **-qtune** suboption for **-q32** is **pwr4**.
- The **LOC** intrinsic returns an **INTEGER(4)** value.

Examples

- Using 32-bit compilation mode and targetting a generic PowerPC architecture:

  ```
  -qarch=ppc -q32
  ```

- Now keep the same compilation mode, but change the target to `RS64II`:

  ```
  -qarch=ppc -q32 -qarch=rs64b
  ```

  Notice that the last setting for **-qarch** wins.

- Now keep the same target, but change the compilation mode to 64-bit:

  ```
  -qarch=ppc -q32 -qarch=rs64b -q64
  ```

  Notice that specifying **-q64** overrides the earlier instance of **-q32**.

Related information

- "-qarch option" on page 91
- "-qtune option" on page 214
- "-qwarn64 option" on page 220
- Chapter 6, "Using XL Fortran in a 64-Bit Environment," on page 241
- "-q64 option" on page 84

-q64 option

Syntax

-q64

Indicates the 64-bit compilation bit mode and, together with the **-qarch** option, determines the target machines on which the 64-bit executable will run. The **-q64** option indicates that the object module will be created in 64-bit object format and that the 64-bit instruction set will be generated. Note that you may compile in a 32-bit environment to create 64-bit objects, but you must link them in a 64-bit environment with the **-q64** option.

Rules

- Settings for **-qarch** that are compatible with **-q64** are as follows:
  - **-qarch=auto** (if compiling on a 64-bit system)
  - **-qarch=com** (With **-q64** and **-qarch=com**, the compiler will silently upgrade the arch setting to **ppc64grsq**.)
  - **-qarch=ppc** (With **-q64** and **-qarch=ppc**, the compiler will silently upgrade the arch to **ppc64grsq**.)
  - **-qarch=ppcgr** (With **-q64** and **-qarch=ppcgr**, the compiler will silently upgrade the arch to **ppc64grsq**.)
  - **-qarch=ppc64**
  - **-qarch=ppc64v**
  - **-qarch=ppc64gr**
  - **-qarch=ppc64grsq**
  - **-qarch=rs64b**
  - **-qarch=rs64c**
  - **-qarch=pwr3**
  - **-qarch=pwr4**
  - **-qarch=pwr5**
  - **-qarch=pwr5x**
  - **-qarch=ppc970**
- The default **-qarch** setting for **-q64** is **ppc64**.
- 64-bit object modules are created when targeting 64-bit mode.
- **-q32** may override **-q64**.
- **-q64** will override a conflicting setting for **-qarch** and will result in the setting **-q64 -qarch=ppc64** along with a warning message.
- The default tune setting for **-q64** is **-qtune=pwr4**.
- The default integer and default real size is 4 bytes in 64-bit mode.
- The default integer pointer size is 8 bytes in 64-bit mode.
- The maximum array size increases to approximately 2**40 bytes (in static storage) or 2**60 bytes (in dynamic allocation on the heap). The maximum dimension bound range is extended to -2**63, 2**63-1 bytes.The theoretical maximum array size is 2**60 bytes, but this is subject to the limitations imposed by the operating system. The maximum array size for array constants has not been extended and will remain the same as the maximum in 32-bit mode. The maximum array size that you can initialize is 2**28 bytes.
- The maximum iteration count for array constructor implied DO loops increases to 2**63-1 bytes.
- The maximum character variable length extends to approximately 2**40 bytes. The maximum length of character constants and subobjects of constants remains the same as in 32-bit mode, which is 32 767 bytes (32 KB).
- The **LOC** intrinsic returns an **INTEGER(8)** value.
- If you must use **-qautodbl=dblpad** in 64-bit mode, you should use **-qintsize=8** to promote **INTEGER(4)** to **INTEGER(8)** for 8 byte integer arithmetic.

Examples

This example targets the RS64II (also known as RS64b) in 64-bit mode:

```
-q32 -qarch=rs64b -q64
```

In this example 64-bit compilation that targets the common group of 64-bit architectures (which currently consists only of the RS64II, RS64III, POWER3, POWER4, POWER5, POWER5+, and PowerPC 970):

```
-q64 -qarch=com
```

The arch setting is silently upgraded to **ppc64grsq**, the most "common" 64-bit mode compilation target.

Related information

- "-qarch option" on page 91
- "-qtune option" on page 214
- Chapter 6, "Using XL Fortran in a 64-Bit Environment," on page 241
- "-qwarn64 option" on page 220

-qalias option

Syntax

```
-qalias={argument_list}
ALIAS( {ARGUMENT_LIST} )
```

Indicates whether a program contains certain categories of aliasing. The compiler limits the scope of some optimizations when there is a possibility that different names are aliases for the same storage locations. See *Optimizing XL compiler programs* in the *XL Fortran Optimization and Programming Guide* for information on aliasing strategies you should consider.

Arguments

aryovrlp | **noaryovrlp**
: Indicates whether the compilation units contain any array assignments between storage-associated arrays. If not, specify **noaryovrlp** to improve performance.

intptr | **nointptr**
: Indicates whether the compilation units contain any integer **POINTER** statements. If so, specify **INTPTR.**

pteovrlp | **nopteovrlp**
: Indicates whether any pointee variables may be used to refer to any data objects that are not pointee variables, or whether two pointee variables may be used to refer to the same storage location. If not, specify **NOPTEOVRLP.**

std | **nostd**
: Indicates whether the compilation units contain any nonstandard aliasing (which is explained below). If so, specify **nostd**.

Rules

An alias exists when an item in storage can be referred to by more than one name. The Fortran 90 and Fortran 95 standards allow some types of aliasing and disallow some others. The sophisticated optimizations that the XL Fortran compiler performs increase the likelihood of undesirable results when nonstandard aliasing is present, as in the following situations:

- The same data object is passed as an actual argument two or more times in the same subprogram reference. The aliasing is not valid if either of the actual arguments becomes defined, undefined, or redefined.
- A subprogram reference associates a dummy argument with an object that is accessible inside the referenced subprogram. The aliasing is not valid if any part of the object associated with the dummy argument becomes defined, undefined, or redefined other than through a reference to the dummy argument.
- A dummy argument becomes defined, undefined, or redefined inside a called subprogram in some other way than through the dummy argument.
- Subscripting beyond the bounds of an array within a common block.

Examples

If the following subroutine is compiled with **-qalias=nopteovrlp**, the compiler may be able to generate more efficient code. You can compile this subroutine with **-qalias=nopteovrlp**, because the integer pointers, **ptr1** and **ptr2**, point at dynamically allocated memory only.

```
  subroutine sub(arg)
      real arg
      pointer(ptr1, pte1)
      pointer(ptr2, pte2)
      real pte1, pte2

      ptr1 = malloc(%val(4))
      ptr2 = malloc(%val(4))
      pte1 = arg*arg
      pte2 = int(sqrt(arg))
      arg = pte1 + pte2
      call free(%val(ptr1))
      call free(%val(ptr2))
  end subroutine
```

If most array assignments in a compilation unit involve arrays that do not overlap but a few assignments do involve storage-associated arrays, you can code the overlapping assignments with an extra step so that the **NOARYOVRLP** suboption is still safe to use.

```
@PROCESS ALIAS(NOARYOVRLP)
! The assertion that no array assignments involve overlapping
! arrays allows the assignment to be done without creating a
! temporary array.
      program test
        real(8) a(100)
        integer :: j=1, k=50, m=51, n=100

        a(1:50) = 0.0d0
        a(51:100) = 1.0d0

        ! Timing loop to achieve accurate timing results
        do i = 1, 1000000
           a(j:k) = a(m:n)    ! Here is the array assignment
        end do

        print *, a
      end program
```

In Fortran, this aliasing is not permitted if **J** or **K** are updated, and, if it is left undetected, it can have unpredictable results.

```
! We cannot assert that this unit is free
! of array-assignment aliasing because of the assignments below.
      subroutine sub1
      integer a(10), b(10)
      equivalence (a, b(3))
      a = b          ! a and b overlap.
      a = a(10:1:-1) ! The elements of a are reversed.
      end subroutine

! When the overlapping assignment is recoded to explicitly use a
! temporary array, the array-assignment aliasing is removed.
! Although ALIAS(NOARYOVRLP) does not speed up this assignment,
! subsequent assignments of non-overlapping arrays in this unit
! are optimized.
@PROCESS ALIAS(NOARYOVRLP)
      subroutine sub2
      integer a(10), b(10), t(10)
```

```
equivalence (a, b(3))
t = b; a = t
t = a(10:1:-1); a = t
end subroutine
```

When **SUB1** is called, an alias exists between **J** and **K**. **J** and **K** refer to the same item in storage.

```
CALL SUB1(I,I)
...
SUBROUTINE SUB1(J,K)
```

In the following example, the program might store 5 instead of 6 into **J** unless **-qalias=nostd** indicates that an alias might exist.

```
INTEGER BIG(1000)
INTEGER SMALL(10)
COMMON // BIG
EQUIVALENCE(BIG,SMALL)
...
BIG(500) = 5
SMALL (I) = 6   ! Where I has the value 500
J = BIG(500)
```

Restrictions

Because this option inhibits some optimizations of some variables, using it can lower performance.

Programs that contain nonstandard or integer **POINTER** aliasing may produce incorrect results if you do not compile them with the correct **-qalias** settings. The **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, and **f95** commands assume that a program contains only standard aliasing (**-qalias=aryovrlp:pteovrlp:std:nointptr**), while the **xlf_r**, **xlf**, and **f77/fort77** commands assume that integer **POINTER**s may be present (**-qalias=aryovrlp:pteovrlp:std:intptr**).

-qalign option

Syntax

```
-qalign={[no]4k|struct={suboption}|bindc={suboption}}
ALIGN({[NO]4K|STRUCT{(suboption)}|BINDC{(suboption)}})
```

Specifies the alignment of data objects in storage, which avoids performance problems with misaligned data. The **[no]4k**, **bindc**, and **struct** options can be specified and are not mutually exclusive. The **[no]4k** option is useful primarily in combination with logical volume I/O and disk striping.

Defaults

The default setting is **-qalign= no4k:struct=natural:bindc=linuxppc**.

Arguments

[no]4k Specifies whether to align large data objects on page (4 KB) boundaries, for improved performance with data-striped I/O. Objects are affected depending on their representation within the object file. The affected objects are arrays and structures that are 4 KB or larger and are in static or bss storage and also CSECTs (typically **COMMON** blocks) that are 8 KB or larger. A large **COMMON** block, equivalence group containing arrays, or structure is aligned on a page boundary, so the alignment of the arrays depends on their position within the containing object. Inside a structure of non-sequence derived type, the compiler adds padding to align large arrays on page boundaries.

bindc={suboption}

Specifies that the alignment and padding for an XL Fortran derived type with the BIND(C) attribute is compatible with a C struct type that is compiled with the corresponding XL C alignment option. The compatible alignment options include:

XL Fortran Option	Corresponding XL C Option
-qalign=bindc=bit_packed	**-qalign=bit_packed**
-qalign=bindc=linuxppc	**-qalign=linuxppc**

struct={suboption}

The struct option specifies how objects or arrays of a derived type declared using a record structure are stored, and whether or not padding is used between components. All program units must be compiled with the same settings of the **-qalign=struct** option. The three suboptions available are:

packed

If the **packed** suboption of the **struct** option is specified, objects of a derived type are stored with no padding between components, other than any padding represented by **%FILL** components. The storage format is the same as would result for a sequence structure whose derived type was declared using a standard derived type declaration.

natural

If the **natural** suboption of the **struct** option is specified, objects of a derived type are stored with sufficient padding such that components will be stored on their natural alignment boundaries, unless storage association requires otherwise. The natural alignment boundaries for objects of a type that appears in the

left-hand column of the following table is shown in terms of a multiple of some number of bytes in the corresponding entry in the right-hand column of the table.

Type	Natural Alignment (in multiples of bytes)
INTEGER(1), LOGICAL(1), BYTE, CHARACTER	1
INTEGER(2), LOGICAL(2)	2
INTEGER(4), LOGICAL(4), REAL(4)	4
INTEGER(8), LOGICAL(8), REAL(8), COMPLEX(4)	8
REAL(16), COMPLEX(8), COMPLEX(16)	16
Derived	Maximum alignment of its components

If the **natural** suboption of the **struct** option is specified, arrays of derived type are stored so that each component of each element is stored on its natural alignment boundary, unless storage association requires otherwise.

port

If the **port** suboption of the **struct** option is specified,

- Storage padding is the same as described above for the **natural** suboption, with the exception that the alignment of components of type complex is the same as the alignment of components of type real of the same kind.
- The padding for an object that is immediately followed by a union is inserted at the beginning of the first map component for each map in that union.

Restrictions

The **port** suboption does not affect any arrays or structures with the **AUTOMATIC** attribute or arrays that are allocated dynamically. Because this option may change the layout of non-sequence derived types, when compiling programs that read or write such objects with unformatted files, use the same setting for this option for all source files.

Related information

You can tell if an array has the **AUTOMATIC** attribute and is thus unaffected by **-qalign=4k** if you look for the keywords **AUTOMATIC** or **CONTROLLED AUTOMATIC** in the listing of the "-qattr option" on page 96. This listing also shows the offsets of data objects.

-qarch option

Syntax

-qarch=*architecture*

Controls which instructions the compiler can generate. Changing the default can improve performance but might produce code that can only be run on specific machines.

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 **com**, **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.

Arguments

Otherwise, the choices for *architecture* are:

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

com You can run the executable file that the compiler generated on any hardware platform supported by the compiler, because the file contains only instructions that are common to all machines. This choice is the same as the default, **-qarch=ppc64grsq**.

If you specify the **-q64** and **-qarch=com** options together, the target platform is 64-bit, and the **-qarch** option is silently upgraded to **ppc64grsq**. The instruction set will be restricted to those instructions common to all 64-bit machines. See Chapter 6, “Using XL Fortran in a 64-Bit Environment,” on page 241 for details.

ppc You can run the executable file on any PowerPC hardware platform, including those that are based on the RS64II, RS64III, POWER3, POWER4, POWER5, PowerPC 970, and future PowerPC chips. If you specify the compiler option **-q64**, the target platform is 64-bit PowerPC, and the compiler silently upgrades the **-qarch** setting to **ppc64grsq**. See Chapter 6, “Using XL Fortran in a 64-Bit Environment,” on page 241 for details.

ppcgr In 32-bit mode, produces object code that may contain optional graphics instructions for PowerPC hardware platforms.

In 64-bit mode, produces object code containing optional graphics instructions that will run on 64-bit PowerPC platforms, but not on 32-bit-only platforms, and the **-qarch** option will be silently upgraded to **-qarch=ppc64grsq**.

ppc64 You can run the executable file on any 64-bit PowerPC hardware platform. 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 PowerPC platforms that do not support 64-bit mode.

ppc64gr
You can run the executable file on any 64-bit PowerPC hardware platform that supports the optional graphics instructions.

ppc64grsq
You can run the executable file on any 64-bit PowerPC hardware platform that supports the optional graphics and square root instructions. This is the default option.

rs64b You can run the executable file on any RS64II machine.

rs64c You can run the executable file on any RS64III machine.

pwr3 You can run the executable file on any POWER3, POWER4, POWER5, POWER5+, or PowerPC 970 hardware platform. In previous releases, the **pwr3** setting was used to target the POWER3 and POWER4 group of processors. To have your compilation target a more general processor group, use the **ppc64grsq** setting, which includes the POWER3, POWER4, POWER5, POWER5+ or PowerPC 970 group of processors. Because executable files for these platforms may contain instructions that are not available on other PowerPC systems, they may be incompatible with those systems.

pwr4 You can run the executable file on any POWER4, POWER5, POWER5+ or PowerPC 970 hardware platform. Use of **-qarch=pwr4** will result in binaries that will not run on most previous PowerPC implementations.

pwr5 You can run the executable file on any POWER5 or POWER5+ hardware platform.

pwr5x You can run the executable file on any POWER5+ hardware platform.

ppc64v
You can run the executable file on any 64-bit PowerPC hardware platform that supports the optional VMX instructions, such as a PowerPC 970.

ppc970
You can run the executable file on any PowerPC 970 hardware platform.

Notes:

1. The **-qarch** setting determines the allowed choices and defaults for the **-qtune** setting. You can use **-qarch** and **-qtune** to target your program to particular machines.
2. Specifying **-q64** with **-qarch=com**, **-qarch=ppc**, or **-qarch= ppcgr** silently upgrades the setting **-qarch=ppc64grsq**.

If you intend your program to run only on a particular architecture, you can use the **-qarch** option to instruct the compiler to generate code specific to that architecture. This allows the compiler to take advantage of machine-specific instructions that can improve performance. The **-qarch** option provides arguments for you to specify certain chip models; for example, you can specify **-qarch=pwr3** to indicate that your program will be executed on POWER3 hardware platforms.

For a given application program, make sure that you specify the same **-qarch** setting when you compile each of its source files.

You can further enhance the performance of programs intended for specific machines by using other perfomance-related options like the **-qcache** and **-qhot** options.

Use these guidelines to help you decide whether to use this option:

- If your primary concern is to make a program widely distributable, keep the default (**ppc64grsq**). If your program is likely to be run on all types of processors equally often, do not specify any **-qarch** or **-qtune** options. The default supports only the common subset of instructions of all processors.
- If you want your program to run on more than one architecture, but to be tuned to a particular architecture, use a combination of the **-qarch** and **-qtune** options. Make sure that your **-qarch** setting covers all the processor types you intend your program to run on.
- If the program will only be used on a single machine or can be recompiled before being used on a different machine, specify the applicable **-qarch** setting. Doing so might improve performance and is unlikely to increase compile time. If you specify the **rs64b**, **rs64c**, **pwr3**, **pwr4**, **pwr5**, **pwr5x** or **ppc970** suboption, you do not need to specify a separate **-qtune** option.
- If your primary concern is execution performance, you may see some speedup if you specify the appropriate **-qarch** suboption and perhaps also specify the **-qtune** and **-qcache** options. In this case, you may need to produce different versions of the executable file for different machines, which might complicate configuration management. You will need to test the performance gain to see if the additional effort is justified.
- It is usually better to target a specific architecture so your program can take advantage of the targeted machine's characteristics. For example, specifying **-qarch=pwr4** when targeting a POWER4 machine will benefit those programs that are floating-point intensive or have integer multiplies. On PowerPC systems, programs that process mainly unpromoted single-precision variables are more efficient when you specify **-qarch=ppc**. On POWER3 systems, programs that process mainly double-precision variables (or single-precision variables promoted to double by one of the **-qautodbl** options) become more efficient with **-qarch=pwr3**, **-qarch=pwr4** and **-qarch=pwr5**.

Other considerations

The PowerPC instruction set includes two optional instruction groups that may be implemented by a particular hardware platform, but are not required. These two groups are the graphics instruction group and the sqrt instruction group. Code compiled with specific **-qarch** options (all of which refer to specific PowerPC machines) will run on any equivalent PowerPC machine that has an identical instruction group. The following table illustrates the instruction groups that are included for the various PowerPC machines.

Table 14. Instruction groups for PowerPC platforms

Processor	Graphics group	sqrt group	64-bit
ppc	no	no	no
ppcgr	yes	no	no
ppc64	no	no	yes
ppc64v	yes	yes	yes
ppc64gr	yes	no	yes
ppc64grsq	yes	yes	yes
rs64b	yes	yes	yes

Table 14. Instruction groups for PowerPC platforms (continued)

Processor	Graphics group	sqrt group	64-bit
rs64c	yes	yes	yes
pwr3	yes	yes	yes
pwr4	yes	yes	yes
pwr5	yes	yes	yes
pwr5x	yes	yes	yes
ppc970	yes	yes	yes

Related information

- "Compiling for specific architectures" on page 23
- "-qtune option" on page 214
- "-qcache option" on page 100
- "-qhot option" on page 132
- Choosing the best -qarch suboption in the *XL Fortran Optimization and Programming Guide*

-qassert option

Syntax

```
-qassert={deps | nodeps | itercnt=n}
ASSERT(DEPS) | NODEPS | ITERCNT(N))
```

Provides information about the characteristics of the files that can help to fine-tune optimizations.

Arguments

deps | nodeps
Specifies whether or not any loop-carried dependencies exist.

itercnt=*n* Specifies a value for unknown loop iteration counts.

Related information

See the following:

- *Benefits of High Order Transformation* in the *XL Fortran Optimization and Programming Guide* for background information and instructions on using these assertions.
- The **ASSERT** directive in the *XL Fortran Language Reference*.

-qattr option

Syntax

```
-qattr[=full] | -qnoattr
ATTR[(FULL)] | NOATTR
```

Specifies whether to produce the attribute component of the attribute and cross-reference section of the listing.

Arguments

If you specify only **-qattr**, only identifiers that are used are reported. If you specify **-qattr=full**, all identifiers, whether referenced or not, are reported.

If you specify **-qattr** after **-qattr=full**, the full attribute listing is still produced.

You can use the attribute listing to help debug problems caused by incorrectly specified attributes or as a reminder of the attributes of each object while writing new code.

Related information

See "Options that control listings and messages" on page 49 and "Attribute and cross-reference section" on page 254.

-qautodbl option

Syntax

```
-qautodbl=setting
AUTODBL(setting)
```

Provides an automatic means of converting single-precision floating-point calculations to double-precision and of converting double-precision calculations to extended-precision.

You might find this option helpful in porting code where storage relationships are significant and different from the XL Fortran defaults. For example, programs that are written for the IBM VS FORTRAN compiler may rely on that compiler's equivalent option.

Arguments

The **-qautodbl** suboptions offer different strategies to preserve storage relationships between objects that are promoted or padded and those that are not.

The settings you can use are as follows:

none Does not promote or pad any objects that share storage. This setting is the default.

dbl4 Promotes floating-point objects that are single-precision (4 bytes in size) or that are composed of such objects (for example, **COMPLEX** or array objects):
- **REAL(4)** is promoted to **REAL(8)**.
- **COMPLEX(4)** is promoted to **COMPLEX(8)**.

This suboption requires the **libxlfpmt4.a** library during linking.

dbl8 Promotes floating-point objects that are double-precision (8 bytes in size) or that are composed of such objects:
- **REAL(8)** is promoted to **REAL(16)**.
- **COMPLEX(8)** is promoted to **COMPLEX(16)**.

This suboption requires the **libxlfpmt8.a** library during linking.

dbl Combines the promotions that **dbl4** and **dbl8** perform.

This suboption requires the **libxlfpmt4.a** and **libxlfpmt8.a** libraries during linking.

dblpad4 Performs the same promotions as **dbl4** and pads objects of other types (except **CHARACTER**) if they could possibly share storage with promoted objects.

This suboption requires the **libxlfpmt4.a** and **libxlfpad.a** libraries during linking.

dblpad8 Performs the same promotions as **dbl8** and pads objects of other types (except **CHARACTER**) if they could possibly share storage with promoted objects.

This suboption requires the **libxlfpmt8.a** and **libxlfpad.a** libraries during linking.

dblpad Combines the promotions done by **dbl4** and **dbl8** and pads objects of other types (except **CHARACTER**) if they could possibly share storage with promoted objects.

This suboption requires the **libxlfpmt4.a**, **libxlfpmt8.a**, and **libxlfpad.a** libraries during linking.

Rules

If the appropriate **-qautodbl** option is specified during linking, the program is automatically linked with the necessary extra libraries. Otherwise, you must link them in manually.

- When you have both **REAL(4)** and **REAL(8)** calculations in the same program and want to speed up the **REAL(4)** operations without slowing down the **REAL(8)** ones, use **dbl4**. If you need to maintain storage relationships for promoted objects, use **dblpad4**. If you have few or no **REAL(8)** calculations, you could also use **dblpad**.
- If you want maximum precision of all results, you can use **dbl** or **dblpad**. **dbl4**, **dblpad4**, **dbl8**, and **dblpad8** select a subset of real types that have their precision increased.

By using **dbl4** or **dblpad4**, you can increase the size of **REAL(4)** objects without turning **REAL(8)** objects into **REAL(16)**s. **REAL(16)** is less efficient in calculations than **REAL(8)** is.

The **-qautodbl** option handles calls to intrinsics with arguments that are promoted; when necessary, the correct higher-precision intrinsic function is substituted. For example, if single-precision items are being promoted, a call in your program to **SIN** automatically becomes a call to **DSIN**.

Restrictions

- Because character data is not promoted or padded, its relationship with storage-associated items that are promoted or padded may not be maintained.
- If the storage space for a pointee is acquired through the system routine **malloc**, the size specified to **malloc** should take into account the extra space needed to represent the pointee if it is promoted or padded.
- If an intrinsic function cannot be promoted because there is no higher-precision specific name, the original intrinsic function is used, and the compiler displays a warning message.
- You must compile every compilation unit in a program with the same **-qautodbl** setting.

Related information

For background information on promotion, padding, and storage/value relationships and for some source examples, see “Implementation details for -qautodbl promotion and padding” on page 259.

“-qrealsize option” on page 184 describes another option that works like **-qautodbl**, but it only affects items that are of default kind type and does not do any padding. If you specify both the **-qrealsize** and the **-qautodbl** options, only **-qautodbl** takes effect. Also, **-qautodbl** overrides the **-qdpc** option.

-qbigdata option

Syntax

-qbigdata | **-qnobigdata**

In 32-bit mode, use this compiler option for programs that exceed 16MB of initialized data (a gcc limitation) and call routines in shared libraries (like open, close, printf and so on).

-qcache option

Syntax

```
-qcache=
{
   assoc=number |
   auto |
   cost=cycles |
   level=level |
   line=bytes |
   size=Kbytes |
   type={C|c|D|d|I|i}
}[:...]
```

Specifies the cache configuration for a specific execution machine. The compiler uses this information to tune program performance, especially for loop operations that can be structured (or *blocked*) to process only the amount of data that can fit into the data cache.

If you know exactly what type of system a program is intended to be executed on and that system has its instruction or data cache configured differently from the default case (as governed by the **-qtune** setting), you can specify the exact characteristics of the cache to allow the compiler to compute more precisely the benefits of particular cache-related optimizations.

For the **-qcache** option to have any effect, you must include the **level** and **type** suboptions and specify the **-qhot** option or an option that implies **-qhot**.

- If you know some but not all of the values, specify the ones you do know.
- If a system has more than one level of cache, use a separate **-qcache** option to describe each level. If you have limited time to spend experimenting with this option, it is more important to specify the characteristics of the data cache than of the instruction cache.
- If you are not sure of the exact cache sizes of the target systems, use relatively small estimated values. It is better to have some cache memory that is not used than to have cache misses or page faults from specifying a cache that is larger than the target system has.

Arguments

assoc=*number*
: Specifies the set associativity of the cache:

  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. It assumes that the execution environment will be the same as the compilation environment.

cost=*cycles*
: Specifies the performance penalty that results from a cache miss so that the compiler can decide whether to perform an optimization that might result in extra cache misses.

level=*level*
: Specifies which level of cache is affected:

  1 Basic cache

2 Level-2 cache or the table lookaside buffer (TLB) if the machine has no level-2 cache

3 TLB in a machine that does have a level-2 cache

Other levels are possible but are currently undefined. If a system has more than one level of cache, use a separate **-qcache** option to describe each level.

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

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

type={C|c| D|d|I|i}
Specifies the type of cache that the settings apply to, as follows:
- **C** or **c** for a combined data and instruction cache
- **D** or **d** for the data cache
- **I** or **i** for the instruction cache

Restrictions

If you specify the wrong values for the cache configuration or run the program on a machine with a different configuration, the program may not be as fast as possible but will still work correctly. Remember, if you are not sure of the exact values for cache sizes, use a conservative estimate.

Examples

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

```
xlf95 -O3 -qhot -qcache=type=c:level=1:size=8:line=64:assoc=2 file.f
```

To tune performance for a system with two levels of data cache, use two **-qcache** options:

```
xlf95 -O3 -qhot -qcache=type=D:level=1:size=256:line=256:assoc=4 \
      -qcache=type=D:level=2:size=512:line=256:assoc=2 file.f
```

To tune performance for a system with two types of cache, again use two **-qcache** options:

```
xlf95 -O3 -qhot -qcache=type=D:level=1:size=256:line=256:assoc=4 \
      -qcache=type=I:level=1:size=512:line=256:assoc=2 file.f
```

Related information

See “-qtune option” on page 214, “-qarch option” on page 91, and “-qhot option” on page 132.

-qcclines option

Syntax

```
-qcclines | -qnocclines
CCLINES |  NOCCLINES
```

Determines whether the compiler recognizes conditional compilation lines in fixed source form and F90 free source form. IBM free source form is not supported.

Defaults

The default is **-qcclines** if the **-qsmp=omp** option is turned on; otherwise, the default is **-qnocclines**.

Related information

See *Conditional Compilation* in the *Language Elements* section of the *XL Fortran Language Reference*.

-qcheck option

Syntax

-qcheck | **-qnocheck**
CHECK | **NOCHECK**

-qcheck is the long form of the "-C option" on page 67.

-qci option

Syntax

```
-qci=numbers
CI(numbers)
```

Specifies the identification numbers (from 1 to 255) of the **INCLUDE** lines to process. If an **INCLUDE** line has a number at the end, the file is only included if you specify that number in a **-qci** option. The set of identification numbers that is recognized is the union of all identification numbers that are specified on all occurrences of the **-qci** option.

This option allows a kind of conditional compilation because you can put code that is only sometimes needed (such as debugging **WRITE** statements, additional error-checking code, or XLF-specific code) into separate files and decide for each compilation whether to process them.

Examples

```
REAL X /1.0/
INCLUDE 'print_all_variables.f' 1
X = 2.5
INCLUDE 'print_all_variables.f' 1
INCLUDE 'test_value_of_x.f' 2
END
```

In this example, compiling without the **-qci** option simply declares **X** and assigns it a value. Compiling with **-qci=1** includes two instances of an include file, and compiling with **-qci=1:2** includes both include files.

Restrictions

Because the optional number in **INCLUDE** lines is not a widespread Fortran feature, using it may restrict the portability of a program.

Related information

See the section on the **INCLUDE** directive in the *XL Fortran Language Reference*.

-qcompact option

Syntax

-qcompact | **-qnocompact**
COMPACT | **NOCOMPACT**

Reduces optimizations that increase code size.

By default, some techniques the optimizer uses to improve performance, such as loop unrolling and array vectorization, may also make the program larger. For systems with limited storage, you can use **-qcompact** to reduce the expansion that takes place. If your program has many loop and array language constructs, using the **-qcompact** option will affect your application's overall performance. You may want to restrict using this option to those parts of your program where optimization gains will remain unaffected.

Rules

With **-qcompact** in effect, other optimization options still work; the reductions in code size come from limiting code replication that is done automatically during optimization.

-qcr option

Syntax

-qcr | -qnocr

Allows you to control how the compiler interprets the CR (carriage return) character. By default, the CR (Hex value X'0d') or LF (Hex value X'0a') character, or the CRLF (Hex value X'0d0a') combination indicates line termination in a source file. This allows you to compile code written using a Mac OS or DOS/Windows editor.

If you specify **-qnocr**, the compiler recognizes only the LF character as a line terminator. You must specify **-qnocr** if you use the CR character for a purpose other than line termination.

-qctyplss option

Syntax

```
-qctyplss[(=[no]arg)] | -qnoctyplss
CTYPLSS[([NO]ARG)]| NOCTYPLSS
```

Specifies whether character constant expressions are allowed wherever typeless constants may be used. This language extension might be needed when you are porting programs from other platforms.

Arguments

arg | **noarg** Suboptions retain the behavior of **-qctyplss**. Additionally, **arg** specifies that Hollerith constants used as actual arguments will be treated as integer actual arguments.

Rules

With **-qctyplss**, character constant expressions are treated as if they were Hollerith constants and thus can be used in logical and arithmetic expressions.

Restrictions

- If you specify the **-qctyplss** option and use a character-constant expression with the **%VAL** argument-list keyword, a distinction is made between Hollerith constants and character constants: character constants are placed in the rightmost byte of the register and padded on the left with zeros, while Hollerith constants are placed in the leftmost byte and padded on the right with blanks. All of the other **%VAL** rules apply.
- The option does not apply to character expressions that involve a constant array or subobject of a constant array at any point.

Examples

Example 1: In the following example, the compiler option **-qctyplss** allows the use of a character constant expression.

```
@PROCESS CTYPLSS
      INTEGER I,J
      INTEGER, PARAMETER :: K(1) = (/97/)
      CHARACTER, PARAMETER :: C(1) = (/'A'/)

      I = 4HABCD          ! Hollerith constant
      J = 'ABCD'          ! I and J have the same bit representation

! These calls are to routines in other languages.
      CALL SUB(%VAL('A')) ! Equivalent to CALL SUB(97)
      CALL SUB(%VAL(1HA)) ! Equivalent to CALL SUB(1627389952)

! These statements are not allowed because of the constant-array
! restriction.
!     I = C // C
!     I = C(1)
!     I = CHAR(K(1))
      END
```

Example 2: In the following example, the variable *J* is passed by reference. The suboption **arg** specifies that the Hollerith constant is passed as if it were an integer actual argument.

```
@PROCESS CTYPLSS(ARG)
      INTEGER :: J

      J = 3HIBM
! These calls are to routines in other languages.
      CALL SUB(J)
      CALL SUB(3HIBM)   ! The Hollerith constant is passed as if
                        ! it were an integer actual argument
```

Related information

See *Hollerith Constants* in the *XL Fortran Language Reference* and *Passing arguments by reference or by value* in the *XL Fortran Optimization and Programming Guide*.

-qdbg option

Syntax

```
-qdbg | -qnodbg
DBG | NODBG
```

-qdbg is the long form of the "-g option" on page 72.

-qddim option

Syntax

-qddim | **-qnoddim**
DDIM | **NODDIM**

Specifies that the bounds of pointee arrays are re-evaluated each time the arrays are referenced and removes some restrictions on the bounds expressions for pointee arrays.

Rules

By default, a pointee array can only have dimension declarators containing variable names if the array appears in a subprogram, and any variables in the dimension declarators must be dummy arguments, members of a common block, or use- or host-associated. The size of the dimension is evaluated on entry to the subprogram and remains constant during execution of the subprogram.

With the **-qddim** option:

- The bounds of a pointee array are re-evaluated each time the pointee is referenced. This process is called *dynamic dimensioning*. Because the variables in the declarators are evaluated each time the array is referenced, changing the values of the variables changes the size of the pointee array.
- The restriction on the variables that can appear in the array declarators is lifted, so ordinary local variables can be used in these expressions.
- Pointee arrays in the main program can also have variables in their array declarators.

Examples

```
@PROCESS DDIM
INTEGER PTE, N, ARRAY(10)
POINTER (P, PTE(N))
DO I=1, 10
   ARRAY(I)=I
END DO
N = 5
P = LOC(ARRAY(2))
PRINT *, PTE   ! Print elements 2 through 6.
N = 7          ! Increase the size.
PRINT *, PTE   ! Print elements 2 through 8.
END
```

-qdirective option

Syntax

```
-qdirective[=directive_list] | -qnodirective[=directive_list]
DIRECTIVE[(directive_list)] | NODIRECTIVE[(directive_list)]
```

Specifies sequences of characters, known as trigger constants, that identify comment lines as compiler comment directives.

Background information

A compiler comment directive is a line that is not a Fortran statement but is recognized and acted on by the compiler. To allow you maximum flexibility, any new directives that might be provided with the XL Fortran compiler in the future will be placed inside comment lines. This avoids portability problems if other compilers do not recognize the directives.

Defaults

The compiler recognizes the default trigger constant **IBM***. Specification of **-qsmp** implies **-qdirective=smp\$:\$omp:ibmp**, and, by default, the trigger constants **SMP$**, **$OMP**, and **IBMP** are also turned on. If you specify **-qsmp=omp**, the compiler ignores all trigger constants that you have specified up to that point and recognizes only the **$OMP** trigger constant. Specification of **-qthreaded** implies **-qdirective=ibmt**, and, by default, the trigger constant **IBMT** is also turned on.

Arguments

The **-qnodirective** option with no *directive_list* turns off all previously specified directive identifiers; with a *directive_list*, it turns off only the selected identifiers.

-qdirective with no *directive_list* turns on the default trigger constant **IBM*** if it has been turned off by a previous **-qnodirective**.

Notes

- Multiple **-qdirective** and **-qnodirective** options are additive; that is, you can turn directive identifiers on and off again multiple times.
- One or more *directive_list*s can be applied to a particular file or compilation unit; any comment line beginning with one of the strings in the *directive_list* is then considered to be a compiler comment directive.
- The trigger constants are not case-sensitive.
- The characters **(**, **)**, **'**, **"**, **:**, **=**, comma, and blank cannot be part of a trigger constant.
- To avoid wildcard expansion in trigger constants that you might use with these options, you can enclose them in single quotation marks on the command line. For example:

  ```
  xlf95 -qdirective='dbg*' -qnodirective='IBM*' directives.f
  ```
- This option only affects Fortran directives that the XL Fortran compiler provides, not those that any preprocessors provide.

Examples

```
! This program is written in Fortran free source form.
PROGRAM DIRECTV
INTEGER A, B, C, D, E, F
A = 1 ! Begin in free source form.
B = 2
!OLDSTYLE SOURCEFORM(FIXED)
! Switch to fixed source form for this include file.
      INCLUDE 'set_c_and_d.inc'
!IBM* SOURCEFORM(FREE)
! Switch back to free source form.
E = 5
F = 6
END
```

For this example, compile with the option **-qdirective=oldstyle** to ensure that the compiler recognizes the **SOURCEFORM** directive before the **INCLUDE** line. After processing the include-file line, the program reverts back to free source form, after the **SOURCEFORM(FREE)** statement.

Related information

See the section on the **SOURCEFORM** directive in the *XL Fortran Language Reference*.

As the use of incorrect trigger constants can generate warning messages or error messages or both, you should check the particular directive statement in the *Directives* section of the *XL Fortran Language Reference* for the suitable associated trigger constant.

-qdirectstorage option

Syntax

-qdirectstorage | **-qnodirectstorage**

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

Use this option with discretion. It is intended for programmers who know how the memory and cache blocks work, and how to tune their applications for optimal performance. For a program to execute correctly on all PowerPC implementations of cache organization, the programmer should assume that separate instruction and data caches exist, and should program to the separate cache model.

Note: Using the **-qdirectstorage** option together with the **CACHE_ZERO** directive may cause your program to fail, or to produce incorrect results..

-qdlines option

Syntax

-qdlines | **-qnodlines**
DLINES | **NODLINES**

-qdlines is the long form of the "-D option" on page 69.

-qdpc option

Syntax

```
-qdpc[=e] | -qnodpc
DPC[(E)] | NODPC
```

Increases the precision of real constants, for maximum accuracy when assigning real constants to **DOUBLE PRECISION** variables. This language extension might be needed when you are porting programs from other platforms.

Rules

If you specify **-qdpc**, all basic real constants (for example, 1.1) are treated as double-precision constants; the compiler preserves some digits of precision that would otherwise be lost during the assignment to the **DOUBLE PRECISION** variable. If you specify **-qdpc=e**, all single-precision constants, including constants with an `e` exponent, are treated as double-precision constants.

This option does not affect constants with a kind type parameter specified.

Examples

```
@process nodpc
        subroutine nodpc
        real x
        double precision y
        data x /1.000000000001/  ! The trailing digit is lost
        data y /1.000000000001/  ! The trailing digit is lost

        print *, x, y, x .eq. y  ! So x is considered equal to y
        end

@process dpc
        subroutine dpc
        real x
        double precision y
        data x /1.000000000001/  ! The trailing digit is lost
        data y /1.000000000001/  ! The trailing digit is preserved

        print *, x, y, x .eq. y  ! So x and y are considered different
        end

        program testdpc
        call nodpc
        call dpc
        end
```

When compiled, this program prints the following:

```
   1.000000000       1.00000000000000000     T
   1.000000000       1.00000000000100009     F
```

showing that with **-qdpc** the extra precision is preserved.

Related information

"-qautodbl option" on page 97 and "-qrealsize option" on page 184 are more general-purpose options that can also do what **-qdpc** does. **-qdpc** has no effect if you specify either of these options.

-qenablevmx option

Syntax

-qenablevmx | -qnoenablevmx

Enables the generation of Vector Multimedia eXtension (VMX) instructions. These instructions can offer higher performance when used with algorithmic-intensive tasks such as multimedia applications.

-qenablevmx must be on in order for the compiler to enable both the VMX intrinsic functions and **-qhot=simd** optimizations. **-qenablevmx** is only compatible with **-qarch** targets that support VMX instructions, like PowerPC 970 processors.

Related information

- "-qarch option" on page 91
- "-qhot option" on page 132
- VMX intrinsic procedures in the *XL Fortran Language Reference*
- Pixel, vector, and unsigned data types in the *XL Fortran Language Reference*

-qenum option

Syntax

`-qenum=value`

Specifies the range of the enumerator constant and enables storage size to be determined.

Arguments

Regardless of its storage size, the enumerator's value will be limited by the range that corresponds to *value*. If the enumerator value exceeds the range specified, a warning message is issued and truncation is performed as necessary. The range limit and kind type parameter corresponding to each *value* is as follows:

Table 15. Enumerator sizes and types

Value	Valid range of enumerator constant value	Kind type parameter
1	-128 to 127	4
2	-32768 to 32767	4
4	-2147483648 to 2147483647	4
8	-9223372036854775808 to 9223372036854775807	8

Related information

- ENUM / ENDENUM statement in the *XL Fortran Language Reference*

-qescape option

Syntax

-qescape | -qnoescape
ESCAPE | NOESCAPE

Specifies how the backslash is treated in character strings, Hollerith constants, H edit descriptors, and character string edit descriptors. It can be treated as an escape character or as a backslash character. This language extension might be needed when you are porting programs from other platforms.

Defaults

By default, the backslash is interpreted as an escape character in these contexts. If you specify **-qnoescape**, the backslash is treated as the backslash character.

The default setting is useful for the following:

- Porting code from another Fortran compiler that uses the backslash as an escape character.
- Including "unusual" characters, such as tabs or newlines, in character data. Without this option, the alternative is to encode the ASCII values (or EBCDIC values, on mainframe systems) directly in the program, making it harder to port.

If you are writing or porting code that depends on backslash characters being passed through unchanged, specify **-qnoescape** so that they do not get any special interpretation. You could also write \\ to mean a single backslash character under the default setting.

Examples

```
$ # Demonstrate how backslashes can affect the output
$ cat escape.f
       PRINT *,'a\bcde\fg'
       END
$ xlf95 escape.f
** _main === End of Compilation 1 ===
1501-510  Compilation successful for file escape.f.
$ a.out
cde
    g
$ xlf95 -qnoescape escape.f
** _main === End of Compilation 1 ===
1501-510  Compilation successful for file escape.f.
 $ a.out
  a\bcde\fg
```

In the first compilation, with the default setting of **-qescape**, **\b** is printed as a backspace, and **\f** is printed as a formfeed character. With the **-qnoescape** option specified, the backslashes are printed like any other character.

Related information

The list of escape sequences that XL Fortran recognizes is shown in *Escape sequences for character stringsXL Fortran Optimization and Programming Guide*.

-qessl Option

Syntax

-qessl | **-qnoessl**

Allows the use of the Engineering and Scientific Subroutine Library (ESSL) routines in place of Fortran 90 intrinsic procedures.

The ESSL is a collection of subroutines that provides a wide range of mathematical functions for various scientific and engineering applications. The subroutines are tuned for performance on specific architectures. Some of the Fortran 90 intrinsic procedures have similar counterparts in ESSL. Performance is improved when these Fortran 90 intrinsic procedures are linked with ESSL. In this case, you can keep the interface of Fortran 90 intrinsic procedures, and get the added benefit of improved performance using ESSL.

Rules

Use the ESSL Serial Library when linking with **-lessl**. Use the ESSL SMP Library when linking with **-lesslsmp**.

Either -lessl or -lesslsmp must be used whenever code is being compiled with **-qessl**. ESSL V4.1.1 or above is recommended. It supports both 32-bit and 64-bit environments.

Also, since **libessl.so** and **libesslsmp.so** have a dependency on **libxlf90_r.so**, compile with **xlf_r**, **xlf90_r**, or **xlf95_r**, which use **libxlf90_r.so** as the default to link. You can also specify **-lxlf90_r** on the link command line if you use the linker directly, or other commands to link.

The following MATMUL function calls may use ESSL routines when **-qessl** is enabled:

```
real a(10,10), b(10,10), c(10,10)
  c=MATMUL(a,b)
```

Related information

The ESSL libraries are not shipped with the XL Fortran compiler. For more information on these libraries, see the following URL: http://publib.boulder.ibm.com/clresctr/windows/public/esslbooks.html.

-qextern option

Syntax

-qextern=*names*

Allows user-written procedures to be called instead of XL Fortran intrinsics. *names* is a list of procedure names separated by colons. The procedure names are treated as if they appear in an **EXTERNAL** statement in each compilation unit being compiled. If any of your procedure names conflict with XL Fortran intrinsic procedures, use this option to call the procedures in the source code instead of the intrinsic ones.

Arguments

Separate the procedure names with colons.

Applicable product levels

Because of the many Fortran 90 and Fortran 95 intrinsic functions and subroutines, you might need to use this option even if you did not need it for FORTRAN 77 programs.

Examples

```
subroutine matmul(res, aa, bb, ext)
  implicit none
  integer ext, i, j, k
  real aa(ext, ext), bb(ext, ext), res(ext, ext), temp
  do i = 1, ext
    do j = 1, ext
      temp = 0
      do k = 1, ext
        temp = temp + aa(i, k) * bb(k, j)
      end do
      res(i, j) = temp
    end do
  end do
end subroutine

implicit none
integer i, j, irand
integer, parameter :: ext = 100
real ma(ext, ext), mb(ext, ext), res(ext, ext)

do i = 1, ext
  do j = 1, ext
    ma(i, j) = float(irand())
    mb(i, j) = float(irand())
  end do
end do

call matmul(res, ma, mb, ext)
end
```

Compiling this program with no options fails because the call to **MATMUL** is actually calling the intrinsic subroutine, not the subroutine defined in the program. Compiling with **-qextern=matmul** allows the program to be compiled and run successfully.

-qextname option

Syntax

```
-qextname[=name1[:name2...]] | -qnoextname
EXTNAME[(name1: name2:...)] | NOEXTNAME
```

Adds an underscore to the names of all global entities, which helps in porting programs from systems where this is a convention for mixed-language programs. Use **-qextname=name1[:name2...]** to identify a specific global entity (or entities). For a list of named entities, separate each name with a colon.

The name of a main program is not affected.

The **-qextname** option helps to port mixed-language programs to XL Fortran without modifications. Use of this option avoids naming problems that might otherwise be caused by:

- Fortran subroutines, functions, or common blocks that are named **main**, **MAIN**, or have the same name as a system subroutine
- Non-Fortran routines that are referenced from Fortran and contain an underscore at the end of the routine name

  Note: XL Fortran Service and Utility Procedures, such as **flush_** and **dtime_**, have these underscores in their names already. By compiling with the **-qextname** option, you can code the names of these procedures without the trailing underscores.
- Non-Fortran routines that call Fortran procedures and use underscores at the end of the Fortran names
- Non-Fortran external or global data objects that contain an underscore at the end of the data name and are shared with a Fortran procedure

Restrictions

You must compile all the source files for a program, including the source files of any required module files, with the same **-qextname** setting.

If you use the **xlfutility** module to ensure that the Service and Utility subprograms are correctly declared, you must change the name to **xlfutility_extname** when compiling with **-qextname**.

If there is more than one Service and Utility subprogram referenced in a compilation unit, using **-qextname** with no names specified and the **xlfutility_extname** module may cause the procedure declaration check not to work accurately.

Examples

```
@PROCESS EXTNAME
        SUBROUTINE STORE_DATA
        CALL FLUSH(10)  ! Using EXTNAME, we can drop the final underscore.
        END SUBROUTINE
```

```
@PROCESS(EXTNAME(sub1))
program main
  external :: sub1, sub2
  call sub1()               ! An underscore is added.
  call sub2()               ! No underscore is added.
end program
```

Related information

This option also affects the names that are specified in several other options, so you do not have to include underscores in their names on the command line. The affected options are "-qextern option" on page 120, "-Q option" on page 82, and "-qsigtrap option" on page 194.

-qfixed option

Syntax

```
-qfixed[=right_margin]
FIXED[(right_margin)]
```

Indicates that the input source program is in fixed source form and optionally specifies the maximum line length.

The source form specified when executing the compiler applies to all of the input files, although you can switch the form for a compilation unit by using a **FREE** or **FIXED @PROCESS** directive or switch the form for the rest of the file by using a **SOURCEFORM** comment directive (even inside a compilation unit).

For source code from some other systems, you may find you need to specify a right margin larger than the default. This option allows a maximum right margin of 132.

Defaults

-qfixed=72 is the default for the **xlf**, **xlf_r**, **f77**, and **fort77** commands. **-qfree=f90** is the default for the **f90**, **f95**, **xlf90**, **xlf90_r**, **xlf95**, and **xlf95_r** commands.

Related information

See "-qfree option" on page 129.

For the precise specifications of this source form, see *Fixed Source Form* in the *XL Fortran Language Reference*.

-qflag option

Syntax

```
-qflag=listing_severity:terminal_severity
FLAG(listing_severity,terminal_severity)
```

You must specify both *listing_severity* and *terminal_severity*.

Limits the diagnostic messages to those of a specified level or higher. Only messages with severity *listing_severity* or higher are written to the listing file. Only messages with severity *terminal_severity* or higher are written to the terminal. **-w** is a short form for **-qflag=e:e**.

Arguments

The severity levels (from lowest to highest) are:

i Informational messages. They explain things that you should know, but they usually do not require any action on your part.

l Language-level messages, such as those produced under the **-qlanglvl** option. They indicate possible nonportable language constructs.

w Warning messages. They indicate error conditions that might require action on your part, but the program is still correct.

e Error messages. They indicate error conditions that require action on your part to make the program correct, but the resulting program can probably still be executed.

s Severe error messages. They indicate error conditions that require action on your part to make the program correct, and the resulting program will fail if it reaches the location of the error. You must change the **-qhalt** setting to make the compiler produce an object file when it encounters this kind of error.

u Unrecoverable error messages. They indicate error conditions that prevent the compiler from continuing. They require action on your part before you can compile your program.

q No messages. A severity level that can never be generated by any defined error condition. Specifying it prevents the compiler from displaying messages, even if it encounters unrecoverable errors.

The **-qflag** option overrides any **-qlanglvl** or **-qsaa** options specified.

Defaults

The default for this option is **i:i**, which will show all compiler messages.

Related information

See "-qlanglvl option" on page 150 and "Understanding XL Fortran error messages" on page 243.

-qfloat option

Syntax

```
-qfloat=options
FLOAT(options)
```

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

You should be familiar with the information in *Implementation details of XL Fortran floating-point processing* in the *XL Fortran Optimization and Programming Guide* and the IEEE standard before attempting to change any **-qfloat** settings.

Defaults

The default setting uses the suboptions **nocomplexgcc**, **nofltint**, **fold**, **nohsflt**, **maf**, **nonans**, **norrm**, **norsqrt**, and **nostrictnmaf**. Some options change this default, as explained below.

The default setting of each suboption remains in effect unless you explicitly change it. For example, if you select **-qfloat=nofold**, the settings for **nohsflt**, or related options are not affected.

Arguments

The available suboptions each have a positive and negative form, such as **fold** and **nofold**, where the negative form is the opposite of the positive.

The suboptions are as follows:

complexgcc | nocomplexgcc
: Use Linux conventions when passing or returning complex numbers. This option preserves compatibility with gcc-compiled code and the default setting of IBM XL C/C++ compilers on Linux.

  Note: For this suboption, restrict intermixing of XL Fortran-compiled code with non XL Fortran-compiled code to small, self-contained, mathematically-oriented subprograms that do not rely on any run-time-library information or global data, such as module variables. Do not expect exception handling or I/O to work smoothly across programs compiled from different environments.

fltint | nofltint
: Speeds up floating-point-to-integer conversions by using an inline sequence of code instead of a call to a library function.

  The library function, which is called by default if **-qfloat=fltint** is not specified or implied by another option, checks for floating-point values outside the representable range of integers and returns the minimum or maximum representable integer if passed an out-of-range floating-point value.

  The Fortran language does not require checking for floating-point values outside the representable range of integers. In order to improve efficiency, the inline sequence used by **-qfloat=fltint** does not perform this check. If passed a value that is out of range, the inline sequence will produce undefined results.

  Although this suboption is turned off by default, it is turned on by the **-O3** optimization level unless you also specify **-qstrict**.

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

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

Note: Use **-qfloat=hsflt** on applications that perform complex division and floating-point conversions where floating-point calculations have known characteristics. In particular, all floating-point results must be within the defined range of representation of single precision. The use of this option when compiling other application programs may produce unexpected results without warning. Use with discretion. See "Technical details of the -qfloat=hsflt option" on page 258 for details.

maf | nomaf
Makes floating-point calculations faster and more accurate by using multiply-add instructions where appropriate. The possible disadvantage is that results may not be exactly equivalent to those from similar calculations that are performed at compile time or on other types of computers. Also, negative zero may be produced.

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

rrm | norrm
Turns off compiler optimizations that require the rounding mode to be the default, round-to-nearest, at run time. Use this option if your program changes the rounding mode by any means, such as by calling the **fpsets** procedure. Otherwise, the program may compute incorrect results.

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

Although this suboption is turned off by default, specifying **-O3** turns it on unless you also specify **-qstrict**.

strictnmaf | nostrictnmaf
Turns off floating-point transformations that are used to introduce negative MAF instructions, as these transformations do not preserve the sign of a zero value. By default, the compiler enables these types of transformations.

To ensure strict semantics, specify both **-qstrict** and **-qfloat=strictnmaf**.

-qflttrap option

Syntax

```
-qflttrap[=suboptions] | -qnoflttrap
FLTTRAP[(suboptions)] | NOFLTTRAP
```

Determines what types of floating-point exception conditions to detect at run time. The program receives a **SIGFPE** signal when the corresponding exception occurs.

Arguments

ENable Turn on checking for the specified exceptions in the main program so that the exceptions generate **SIGFPE** signals. You must specify this suboption if you want to turn on exception trapping without modifying your source code.

IMPrecise Only check for the specified exceptions on subprogram entry and exit. This suboption improves performance, but it can make the exact spot of the exception difficult to find.

INEXact Detect and trap on floating-point inexact if exception-checking is enabled. Because inexact results are very common in floating-point calculations, you usually should not need to turn this type of exception on.

INValid Detect and trap on floating-point invalid operations if exception-checking is enabled.

NANQ Detect and trap all quiet not-a-number values (NaNQs) and signaling not-a-number values (NaNSs). Trapping code is generated regardless of specifying the **enable** or **imprecise** suboption. This suboption detects all NaN values handled by or generated by floating point instructions, including those not created by invalid operations. This option can impact performance.

OVerflow Detect and trap on floating-point overflow if exception-checking is enabled.

UNDerflow Detect and trap on floating-point underflow if exception-checking is enabled.

ZEROdivide Detect and trap on floating-point division by zero if exception-checking is enabled.

Defaults

The **-qflttrap** option without suboptions is equivalent to **-qflttrap=ov:und:zero:inv:inex**. However, because this default does not include **enable**, it is probably only useful if you already use **fpsets** or similar subroutines in your source. If you specify **-qflttrap** more than once, both with and without suboptions, the **-qflttrap** without suboptions is ignored.

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

Examples

When you compile this program:

```
REAL X, Y, Z
DATA X /5.0/, Y /0.0/
Z = X / Y
PRINT *, Z
END
```

with the command:

```
xlf95 -qflttrap=zerodivide:enable -qsigtrap divide_by_zero.f
```

the program stops when the division is performed.

The **zerodivide** suboption identifies the type of exception to guard against. The **enable** suboption causes a **SIGFPE** signal when the exception occurs. The **-qsigtrap** option produces informative output when the signal stops the program.

Related information

- "-qsigtrap option" on page 194
- "-qarch option" on page 91
- *Detecting and trapping floating-point exceptions* in the *XL Fortran Optimization and Programming Guide* has full instructions on how and when to use the **-qflttrap** option, especially if you are just starting to use it.

-qfree option

Syntax

```
-qfree[={f90|ibm}]
FREE[({F90|IBM})]
```

Indicates that the source code is in free source form. The **ibm** and **f90** suboptions specify compatibility with the free source form defined for VS FORTRAN and Fortran 90, respectively. Note that the free source form defined for Fortran 90 also applies to Fortran 95.

The source form specified when executing the compiler applies to all of the input files, although you can switch the form for a compilation unit by using a **FREE** or **FIXED @PROCESS** directive or for the rest of the file by using a **SOURCEFORM** comment directive (even inside a compilation unit).

Defaults

-qfree by itself specifies Fortran 90 free source form.

-qfixed=72 is the default for the **xlf**, **xlf_r**, **f77**, and **fort77** commands. **-qfree=f90** is the default for the **f90**, **f95**, **xlf90**, **xlf90_r**, **xlf95**, and **xlf95_r** commands.

Related information

See "-qfixed option" on page 123.

-k is equivalent to **-qfree=f90**.

Fortran 90 free source form is explained in *Free Source Form* in the *XL Fortran Language Reference*. It is the format to use for maximum portability across compilers that support Fortran 90 and Fortran 95 features now and in the future.

IBM free source form is equivalent to the free format of the IBM VS FORTRAN compiler, and it is intended to help port programs from the z/OS® platform. It is explained in *IBM Free Source Form* in the *XL Fortran Language Reference*.

-qfullpath option

Syntax

-qfullpath | **-qnofullpath**

Records the full, or absolute, path names of source and include files in object files compiled with debugging information. (Debug information is produced when you compile with the **-g** option.)

If you need to move an executable file into a different directory before debugging it or have multiple versions of the source files and want to ensure that the debugger uses the original source files, use the **-qfullpath** option in combination with the **-g** option so that source-level debuggers can locate the correct source files.

Defaults

By default, the compiler records the relative path names of the original source file in each **.o** file. It may also record relative path names for include files.

Restrictions

Although **-qfullpath** works without the **-g** option, you cannot do source-level debugging unless you also specify the **-g** option.

Examples

In this example, the executable file is moved after being created, but the debugger can still locate the original source files:

```
$ xlf95 -g -qfullpath file1.f file2.f file3.f -o debug_version
...
$ mv debug_version $HOME/test_bucket
$ cd $HOME/test_bucket
$ gdb debug_version
```

Related information

See “-g option” on page 72.

-qhalt option

Syntax

```
-qhalt=severity
HALT(severity)
```

Stops before producing any object, executable, or assembler source files if the maximum severity of compile-time messages equals or exceeds the specified severity. *severity* is one of **i**, **l**, **w**, **e**, **s**, **u**, or **q**, meaning informational, language, warning, error, severe error, unrecoverable error, or a severity indicating "don't stop".

Arguments

The severity levels (from lowest to highest) are:

i Informational messages. They explain things that you should know, but they usually do not require any action on your part.

l Language-level messages, such as those produced under the **-qlanglvl** option. They indicate possible nonportable language constructs.

w Warning messages. They indicate error conditions that might require action on your part, but the program is still correct.

e Error messages. They indicate error conditions that require action on your part to make the program correct, but the resulting program can probably still be executed.

s Severe error messages. They indicate error conditions that require action on your part to make the program correct, and the resulting program will fail if it reaches the location of the error. You must change the **-qhalt** setting to make the compiler produce an object file when it encounters this kind of error.

u Unrecoverable error messages. They indicate error conditions that prevent the compiler from continuing. They require action on your part before you can compile your program.

q No messages. A severity level that can never be generated by any defined error condition. Specifying it prevents the compiler from displaying messages, even if it encounters unrecoverable errors.

Defaults

The default is **-qhalt=s**, which prevents the compiler from generating an object file when compilation fails.

Restrictions

The **-qhalt** option can override the **-qobject** option, and **-qnoobject** can override **-qhalt**.

Related information

- "-qhalt option"
- "-qobject option" on page 167

-qhot option

Syntax

-qhot[=*suboptions*] | **-qnohot**
HOT[=*suboptions*] | **NOHOT**

Instructs the compiler to perform **h**igh-**o**rder loop analysis and **t**ransformations during optimization.

The **-qhot** compiler option is a powerful alternative to hand tuning that provides opportunities to optimize loops and array language. This compiler option will always attempt to optimize loops, regardless of the suboptions you specify.

If you do not specify an optimization level of **2** or higher when using **-O** and **-qhot**, the compiler implies **-O2**.

If you specify **-O3**, the compiler assumes **-qhot=level=0**. To prevent all HOT optimizations with **-O3**, you must specify **-qnohot**.

Specifying **-qhot** without suboptions implies **-qhot=nosimd**, **-qhot=noarraypad**, **-qhot=vector**, and **-qhot=level=1**. These suboptions are also implied by the options **-qsmp**, **-O4**, or **-O5**.

If you specify **-qhot**, **-qenablevmx**, and either **-qarch=ppc970** or **-qarch=ppc64v**, **-qhot=simd** will be set as the default.

Array padding: In XL Fortran, array dimensions that are powers of two can lead to a decrease in cache utilization. The **arraypad** suboption allows the compiler to increase the dimensions of arrays where doing so could improve the efficiency of array-processing loops. This can reduce cache misses and page faults that slow your array processing programs.

Specify **-qhot=arraypad** when your source includes large arrays with dimensions that are powers of 2. This can be particularly effective when the first dimension is a power of 2.

The **-C** option turns off some array optimizations.

Vectorization: The **-qhot** compiler option supports the **simd** and **vector** suboptions that can optimize loops in source code for operations on array data, by ensuring that operations run in parallel where applicable. Though both suboptions can provide an increase in performance, each suboption best applies to a particular type of vectorization.

Short vectorization: –qhot=simd: The **simd** suboption optimizes array data to run mathematical operations in parallel where the target architecture allows such operations. 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 4-byte units (for example, 4 integer(4)s, or 4 real(4)s)
- 8 2–byte units
- 16 1–byte units

Short vectorization does not support double-precision floating point mathematics, and you must specify an architecture that supports VMX instructions, like

-qarch=ppc970. Users can typically see benefit when applying the **-qhot=simd** optimization to image processing applications, for example.

Long vectorization: –qhot=vector: The **vector** suboption, when used in conjunction with **-qnostrict** or an optimization level of **-O3** or higher, optimizes array data to run mathematical operations in parallel where applicable. The compiler uses standard registers with no vector size restrictions. Supporting single and double-precision floating-point mathematics, users can typically see benefit when applying **–qhot=vector** to applications with significant mathematical requirements.

Arguments

arraypad
: The compiler pads any arrays where there could be an increase in cache utilization. Not all arrays will necessarily be padded, and the compiler can pad different arrays by different amounts.

arraypad=*n*
: The compiler pads each array in the source. The pad amount must be a positive integer value. Each array will be padded by an integral number of elements. The integral value *n* must be multiples of the largest array element size for effective use of **arraypad**. This value is typically 4, 8, or 16.

When you specify the **arraypad** and **arraypad=n** options, the compiler does not check for reshaping or equivalences. If padding takes place, your program can produce unexpected results.

level={0 | 1}

level=0
: The compiler performs a subset of the of high-order transformations. Some of these include early distribution, loop interchange, and loop tiling, as examples.

  Optimization level **-O3** implies **-qhot=level=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 **-O3** implies **-qhot=level=0**, unless you explicitly specify **-qhot** or **-qhot=level=1**.

  Any of **-O4**, **-O5**, or **-qsmp** implies **-qhot=level=1**, unless you explicitly specify **-qhot=level=0**.

simd | nosimd
: The compiler converts certain operations in a loop that apply to successive elements of an array into a call to a VMX (Vector Multimedia eXtension) instruction. This call calculates several results at one time, which is faster than calculating each result sequentially.

  If you specify **-qhot=nosimd**, the compiler performs optimizations on loops and arrays, but avoids replacing certain code with calls to VMX instructions.

  This suboption has effect only when the specified architecture supports VMX instructions and **-qenablevmx** is in effect.

vector | **novector**

When specified with **-qnostrict** or an optimization level of **-O3** or higher, the compiler converts certain operations (for example, square root, reciprocal square root) into a call to a MASS library routine that is in the **libxlopt.a** library. If the operations are in a loop, the vector version of the routine is called. If the operations are scalar, the scalar version of the routine is called. This call will calculate several results at one time, which is faster than calculating each result sequentially.

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.

Related information

- "-qarch option" on page 91
- "-C option" on page 67
- "-qstrict option" on page 204
- "-qsmp option" on page 196
- "-qenablevmx option" on page 116
- "-O option" on page 78
- *Directives for loop optimization* in the *XL Fortran Language Reference*
- *Benefits of High Order Transformation* in the *XL Fortran Optimization and Programming Guide*

-qieee option

Syntax

```
-qieee={Near | Minus | Plus | Zero}
IEEE({Near | Minus | Plus | Zero})
```

Specifies the rounding mode for the compiler to use when it evaluates constant floating-point expressions at compile time.

Arguments

The choices are:

Near	Round to nearest representable number.
Minus	Round toward minus infinity.
Plus	Round toward plus infinity.
Zero	Round toward zero.

This option is intended for use in combination with the XL Fortran subroutine **fpsets** or some other method of changing the rounding mode at run time. It sets the rounding mode that is used for compile-time arithmetic (for example, evaluating constant expressions such as **2.0/3.5**). By specifying the same rounding mode for compile-time and run-time operations, you can avoid inconsistencies in floating-point results.

Note: Compile-time arithmetic is most extensive when you also specify the **-O** option.

If you change the rounding mode to other than the default (round-to-nearest) at run time, be sure to also specify **-qfloat=rrm** to turn off optimizations that only apply in the default rounding mode.

Related information

- *Selecting the rounding mode* in the *XL Fortran Optimization and Programming Guide*
- "-O option" on page 78
- "-qfloat option" on page 125

-qinit option

Syntax

```
-qinit=f90ptr
INIT(F90PTR)
```

Makes the initial association status of pointers disassociated. Note that this applies to Fortran 90 and above.

You can use this option to help locate and fix problems that are due to using a pointer before you define it.

Related information

See *Pointer Association* in the *XL Fortran Language Reference*.

-qinitauto option

Syntax

-qinitauto[=*hex_value*] | **-qnoinitauto**

Initializes each byte or word (4 bytes) of storage for automatic variables to a specific value, depending on the length of the *hex_value*. This helps you to locate variables that are referenced before being defined. For example, by using both the **-qinitauto** option to initialize **REAL** variables with a signaling NAN value and the **-qflttrap** option, it is possible to identify references to uninitialized **REAL** variables at run time.

Setting *hex_value* to zero ensures that all automatic variables are cleared before being used. Some programs assume that variables are initialized to zero and do not work when they are not. Other programs may work if they are not optimized but fail when they are optimized. Typically, setting all the variables to all zero bytes prevents such run-time errors. It is better to locate the variables that require zeroing and insert code in your program to do so than to rely on this option to do it for you. Using this option will generally zero more things than necessary and may result in slower programs.

To locate and fix these errors, set the bytes to a value other than zero, which will consistently reproduce incorrect results. This method is especially valuable in cases where adding debugging statements or loading the program into a symbolic debugger makes the error go away.

Setting *hex_value* to **FF** (255) gives **REAL** and **COMPLEX** variables an initial value of "negative not a number", or -quiet NAN. Any operations on these variables will also result in quiet NAN values, making it clear that an uninitialized variable has been used in a calculation.

This option can help you to debug programs with uninitialized variables in subprograms; for example, you can use it to initialize **REAL** variables with a signaling NAN value. You can initialize 8-byte **REAL** variables to double-precision signaling NAN values by specifying an 8-digit hexadecimal number, that, when repeated, has a double-precision signaling NAN value. For example, you could specify a number such as 7FBFFFFF, that, when stored in a **REAL(4)** variable, has a single-precision signaling NAN value. The value 7FF7FFFF, when stored in a **REAL(4)** variable, has a single-precision quiet NAN value. If the same number is stored twice in a **REAL(8)** variable (7FF7FFFF7FF7FFFF), it has a double-precision signaling NAN value.

Arguments

- The *hex_value* is a 1-digit to 8-digit hexadecimal (0-F) number.
- To initialize each byte of storage to a specific value, specify 1 or 2 digits for the *hex_value*. If you specify only 1 digit, the compiler pads the *hex_value* on the left with a zero.
- To initialize each word of storage to a specific value, specify 3 to 8 digits for the *hex_value*. If you specify more than 2 but fewer than 8 digits, the compiler pads the *hex_value* on the left with zeros.
- In the case of word initialization, if automatic variables are not a multiple of 4 bytes in length, the *hex_value* may be truncated on the left to fit. For example, if you specify 5 digits for the *hex_value* and an automatic variable is only 1 byte long, the compiler truncates the 3 digits on the left-hand side of the *hex_value* and assigns the two right-hand digits to the variable.

- You can specify alphabetic digits as either upper- or lower-case.

Defaults

- By default, the compiler does not initialize automatic storage to any particular value. However, it is possible that a region of storage contains all zeros.
- If you do not specify a *hex_value* suboption for **-qinitauto**, the compiler initializes the value of each byte of automatic storage to zero.

Restrictions

- Equivalenced variables, structure components, and array elements are not initialized individually. Instead, the entire storage sequence is initialized collectively.

Examples

The following example shows how to perform word initialization of automatic variables:

```
subroutine sub()
integer(4), automatic :: i4
character, automatic :: c
real(4), automatic :: r4
real(8), automatic :: r8
end subroutine
```

When you compile the code with the following option, the compiler performs word initialization, as the *hex_value* is longer than 2 digits:

```
-qinitauto=0cf
```

The compiler initializes the variables as follows, padding the *hex_value* with zeros in the cases of the `i4`, `r4`, and `r8` variables and truncating the first hexadecimal digit in the case of the `c` variable:

Variable	Value
`i4`	`000000CF`
`c`	`CF`
`r4`	`000000CF`
`r8`	`000000CF000000CF`

Related information

See "-qfltrap option" on page 127 and the section on the **AUTOMATIC** directive in the *XL Fortran Language Reference*.

-qinlglue option

Syntax

```
-qinlglue | -qnoinlglue
INLGLUE | NOINLGLUE
```

This option inlines glue code that optimizes external function calls in your application, when compiling at **-q64** and **-O2** and higher.

Glue code, generated by the linker, is used for passing control between two external functions. To aid performance, the optimizer automatically inlines glue code when you compile with **-qtune=pwr4**, **-qtune=pwr5**, **-qtune=ppc970**, or **-qtune=auto** on a machine with the appropriate processor. **-qnoinlglue** prevents the automatic inlining of glue code on these architectures.

The inlining of glue code can increase the size of your code. Specifying **-qcompact** overrides **-qinlglue** to prevent code growth.

Specifying **-qnoinlglue** or **-qcompact** can degrade performance; use these options with discretion.

Related information

- "-q64 option" on page 84
- "-qcompact option" on page 105
- "-qtune option" on page 214
- Inlining in the *XL Fortran Optimization and Programming Guide*
- Managing code size in the *XL Fortran Optimization and Programming Guide*

-qintlog option

Syntax

```
-qintlog | -qnointlog
INTLOG | NOINTLOG
```

Specifies that you can mix integer and logical data entities in expressions and statements. Logical operators that you specify with integer operands act upon those integers in a bit-wise manner, and integer operators treat the contents of logical operands as integers.

Restrictions

The following operations do not allow the use of logical variables:

- **ASSIGN** statement variables
- Assigned **GOTO** variables
- **DO** loop index variables
- Implied-**DO** loop index variables in **DATA** statements
- Implied-**DO** loop index variables in either input and output or array constructors
- Index variables in **FORALL** constructs

Related information

- **-qport=clogicals** option.

Examples

```
INTEGER I, MASK, LOW_ORDER_BYTE, TWOS_COMPLEMENT
I = 32767
MASK = 255
! Find the low-order byte of an integer.
LOW_ORDER_BYTE = I .AND. MASK
! Find the twos complement of an integer.
TWOS_COMPLEMENT = .NOT. I
END
```

Related information

You can also use the intrinsic functions **IAND**, **IOR**, **IEOR**, and **NOT** to perform bitwise logical operations.

-qintsize option

Syntax

```
-qintsize=bytes
INTSIZE(bytes)
```

Sets the size of default **INTEGER** and **LOGICAL** data entities (that is, those for which no length or kind is specified).

Background information

The specified size[1] applies to these data entities:

- **INTEGER** and **LOGICAL** specification statements with no length or kind specified.
- **FUNCTION** statements with no length or kind specified.
- Intrinsic functions that accept or return default **INTEGER** or **LOGICAL** arguments or return values unless you specify a length or kind in an **INTRINSIC** statement. Any specified length or kind must agree with the default size of the return value.
- Variables that are implicit integers or logicals.
- Integer and logical literal constants with no kind specified. If the value is too large to be represented by the number of bytes that you specified, the compiler chooses a size that is large enough. The range for 2-byte integers is -(2**15) to 2**15-1, for 4-byte integers is -(2**31) to 2**31-1, and for 8-byte integers is -(2**63) to 2**63-1.
- Typeless constants in integer or logical contexts.

Allowed sizes for *bytes* are:

- 2
- 4 (the default)
- 8

This option is intended to allow you to port programs unchanged from systems that have different default sizes for data. For example, you might need **-qintsize=2** for programs that are written for a 16-bit microprocessor or **-qintsize=8** for programs that are written for a CRAY computer. The default value of 4 for this option is suitable for code that is written specifically for many 32-bit computers. Note that specifying the **-q64** compiler option does not affect the default setting for **-qintsize**.

Restrictions

This option is not intended as a general-purpose method for increasing the sizes of data entities. Its use is limited to maintaining compatibility with code that is written for other systems.

You might need to add **PARAMETER** statements to give explicit lengths to constants that you pass as arguments.

1. In Fortran 90/95 terminology, these values are referred to as *kind type parameters*.

Examples

In the following example, note how variables, literal constants, intrinsics, arithmetic operators, and input/output operations all handle the changed default integer size.

```
@PROCESS INTSIZE(8)
      PROGRAM INTSIZETEST
      INTEGER I
      I = -9223372036854775807    ! I is big enough to hold this constant.
      J = ABS(I)                  ! So is implicit integer J.
      IF (I .NE. J) THEN
        PRINT *, I, '.NE.', J
      END IF
      END
```

The following example only works with the default size for integers:

```
      CALL SUB(17)
      END

      SUBROUTINE SUB(I)
      INTEGER(4) I                ! But INTSIZE may change "17"
                                  ! to INTEGER(2) or INTEGER(8).
      ...
      END
```

If you change the default value, you must either declare the variable **I** as **INTEGER** instead of **INTEGER(4)** or give a length to the actual argument, as follows:

```
@PROCESS INTSIZE(8)
      INTEGER(4) X
      PARAMETER(X=17)
      CALL SUB(X)      ! Use a parameter with the right length, or
      CALL SUB(17_4)   ! use a constant with the right kind.
      END
```

Related information

See "-qrealsize option" on page 184 and *Type Parameters and Specifiers* in the *XL Fortran Language Reference*.

-qipa option

Syntax

-qipa[=*suboptions*] | **-qnoipa**

Enhances **-O** optimization by doing detailed analysis across procedures (interprocedural analysis or IPA).

You must also specify the **-O**, **-O2**, **-O3**, **-O4**, or **-O5** option when you specify **-qipa**. (Specifying the **-O5** option is equivalent to specifying the **-O4** option plus **-qipa=level=2**.) For additional performance benefits, you can also specify the **-Q** option. The **-qipa** option extends the area that is examined during optimization and inlining from a single procedure to multiple procedures (possibly in different source files) and the linkage between them.

You can fine-tune the optimizations that are performed by specifying suboptions.

To use this option, the necessary steps are:

1. Do preliminary performance analysis and tuning before compiling with the **-qipa** option. This is necessary because interprocedural analysis uses a two-phase mechanism, a compile-time and a link-time phase, which increases link time. (You can use the **noobject** suboption to reduce this overhead.)
2. Specify the **-qipa** option on both the compile and link steps of the entire application or on as much of it as possible. Specify suboptions to indicate what assumptions to make about the parts of the program that are not compiled with **-qipa**. If your application contains C or C++ code compiled with IBM XL C/C++ compilers, you should also compile the C or C++ code with the **-qipa** option to allow for additional optimization opportunities at link time.)

   During compilation, the compiler stores interprocedural analysis information in the **.o** file. During linking, the **-qipa** option causes a complete reoptimization of the entire application.

Note that if you specify this option with **-#**, the compiler does not display linker information subsequent to the IPA link step. This is because the compiler does not actually call IPA.

Arguments

Compile-time suboptions

IPA uses the following suboptions during its compile-time phase:

object | **noobject**
Specifies whether to include standard object code in the object files. Specifying the **noobject** suboption can substantially reduce overall compilation time, by not generating object code during the first IPA phase. Note that if you specify **-S** with **noobject**, **noobject** will be ignored.

If compiling and linking are performed in the same step and you do not specify the **-S** or any listing option, **-qipa=noobject** is implied.

If your program contains object files created with the **noobject** suboption, you must use the **-qipa** option to compile any files containing an entry point (the main program for an executable program or an exported procedure for a library) before linking your program with **-qipa**.

Link-time suboptions

IPA uses the following suboptions during its link-time phase:

clonearch=*arch*{**,***arch*} | **noclonearch**
Specifies the architectures for which multiple versions of the same instruction set are produced. Use this suboption if you require optimal performance on multiple differing machines running the same copy of your application.

The compiler generates a generic version of the instruction set based on the **-qarch** setting in effect, and if appropriate, *clones* specialized versions of the instruction set for the architectures you specify in the **clonearch** suboption. The compiler inserts code into your application to check for the processor architecture at run time. When run, the application's version of the instruction set that is best optimized for the run-time environment is selected.

arch is a comma-separated list of architecture values. 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=***arch*.
2. When **-qcompact** is in effect, **-qarch=clonearch=***arch* is disabled.

Table 16. Compatible architecture and clonearch settings

-qarch setting	**Allowed clonearch value**
com, ppc, pwr3, ppc64, ppcgr, ppc64gr, ppc64grsq	pwr4, pwr5, ppc970
pwr4	pwr5, ppc970
ppc64v	ppc970

cloneproc=*name*{**,***name*} | **nocloneproc**[**=***name*{**,***name*}]
Specifies the name of the functions to clone for the architectures specified by the clonearch suboption. Where *name* is a comma-separated list of function names.

Note: If you do not specify **-qipa=clonearch=***arch* or specify **-qipa=noclonearch**, **-qipa=cloneproc=***name* and **-qipa=nocloneproc=***name* have no effect.

exits=*procedure_names*
Specifies a list of procedures, each of which always ends the program. The compiler can optimize calls to these procedures (for example, by eliminating save/restore sequences), because the calls never return to the program. These procedures must not call any other parts of the program that are compiled with **-qipa**.

inline=*inline-options*
The **-qipa=inline=** command can take a colon-separated list of inline options, as listed below:

auto | **noauto**
Specifies whether to automatically inline procedures.

limit=*number*

Changes the size limits that the **inline=auto** option uses to determine how much inline expansion to do. This established "limit" is the size below which the calling procedure must remain. *number* is the optimizer's approximation of the number of bytes of code that will be generated. Larger values for this number allow the compiler to inline larger subprograms, more subprogram calls, or both. This argument is implemented only when **inline=auto** is on.

procedure_names

Specifies a list of procedures to try to inline.

threshold=*number*

Specifies the upper size limit on procedures to be inlined, where *number* is a value as defined under the inline suboption "limit". This argument is implemented only when "inline=auto" is on.

Note: By default, the compiler will try to inline all procedures, not just those that you specified with the **inline=***procedure_names* suboption. If you want to turn on inlining for only certain procedures, specify **inline=noauto** after you specify **inline=***procedure_names*. (You must specify the suboptions in this order.) For example, to turn off inlining for all procedures other than for **sub1**, specify **-qipa=inline=sub1:inline=noauto.**

isolated=*procedure_names*

Specifies a comma-separated list of procedures that are not compiled with **-qipa**. Procedures that you specify as "isolated" or procedures within their call chains cannot refer directly to any global variable.

level=*level*

Determines the amount of interprocedural analysis and optimization that is performed:

0 Does only minimal interprocedural analysis and optimization.

1 Turns on inlining, limited alias analysis, and limited call-site tailoring.

2 Full interprocedural data flow and alias analysis. Specifying **-O5** is equivalent to specifying **-O4** and **-qipa=level=2**.

The default level is **1**.

list[=*filename* **| short | long]**

Specifies an output listing file name during the link phase, in the event that an object listing has been requested using either the **-qlist** or the **-qipa=list** compiler option and allows the user to direct the type of output. If you do not specify the *filename* suboption, the default file name is "a.lst".

If you specify **short**, the Object File Map, Source File Map, and Global Symbols Map sections are included. If you specify **long**, the preceding sections appear in addition to the Object Resolution Warnings, Object Reference Map, Inliner Report, and Partition Map sections.

If you specify the **-qipa** and **-qlist** options together, IPA generates an `a.lst` file that overwrites any existing `a.lst` file. If you have a source file named `a.f`, the IPA listing will overwrite the regular compiler listing `a.lst`. You can use the **list=***filename* suboption to specify an alternative listing file name.

lowfreq=*procedure_names*
Specifies a list of procedures that are likely to be called infrequently during the course of a typical program run. For example, procedures for initialization and cleanup might only be called once, and debugging procedures might not be called at all in a production-level program. The compiler can make other parts of the program faster by doing less optimization for calls to these procedures.

missing={unknown | safe | isolated | pure}
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 default is to assume **unknown**, which greatly restricts the amount of interprocedural optimization for calls to those procedures.

noinline=*procedure_names*
Specifies a list of procedures that are not to be inlined.

partition={small | medium | large}
Specifies the size of the regions within the program to analyze. Larger partitions contain more procedures, which result in better interprocedural analysis but require more storage to optimize. Reduce the partition size if compilation takes too long because of paging.

pdfname=[*filename***]**

Specifies the name of the profile data file containing the **PDF** profiling information. If you do not specify a ***filename***, the default file name is **__pdf**. The profile is placed in the current working directory or in the directory that the **PDFDIR** environment variable names. This allows you to do simultaneous runs of multiple executables using the same **PDFDIR**. This is especially useful when tuning with **PDF** on dynamic libraries. (See "-qpdf option" on page 172 for more information on tuning optimizations.)

pure=*procedure_names*
Specifies a list of procedures that are not compiled with **-qipa**. Any procedure that you specified as "pure" must be "isolated" and "safe". It must not alter the internal state nor have side-effects, which are defined as potentially altering any data object visible to the caller.

safe=*procedure_names*
Specifies a list of procedures that are not compiled with **-qipa**. Any procedure that you specified as "safe" may modify global variables and dummy arguments. No calls to procedures that are compiled with **-qipa** may be made from within a "safe" procedure's call chain.

stdexits | nostdexits
Specifies that certain predefined routines can be optimized as with the **exits** suboption. The procedures are: **abort**, **exit**, **_exit**, and **_assert**.

threads[=N] | nothreads
threads[=N] runs the number of parallel threads that are available, or as specified by *N*. *N* must be a positive integer. **nothreads** does not run any parallel threads. This is equivalent to running one serial thread.

Specifying **-qipa=threads** can reduce IPA optimization time. The threads suboption allows the IPA optimizer to run portions of the optimization process in parallel threads, which can speed up the compilation process on multi-processor systems.

unknown=*procedure_names*
Specifies a list of procedures that are not compiled with **-qipa**. Any

procedure specified as "unknown" may make calls to other parts of the program compiled with **-qipa** and modify global variables and dummy arguments.

The primary use of **isolated**, **missing**, **pure**, **safe**, and **unknown** is to specify how much optimization can safely be performed on calls to library routines that are not compiled with **-qipa**.

The following compiler options have an effect on the link-time phase of **-qipa**:

-qlibansi | -qnolibansi
Assumes that all functions with the name of an ANSI C defined library function are, in fact, the library functions.

-qlibposix | -qnolibposix
Assumes that all functions with the name of an IEEE 1003.1-2001 (POSIX) defined library function are, in fact, the system functions.

-qthreaded
Assumes that the compiler will attempt to generate thread-safe code.

Rules

Regular expressions are supported for the following suboptions:

exits
inline
lowfreq
noinline
pure
safe
unknown

Syntax rules for regular expressions are described below.

Table 17. Regular expression syntax

Expression	Description
`string`	Matches any of the characters specified in `string`. For example, `test` will match `testimony`, `latest`, `intestine`.
`^string`	Matches the pattern specified by `string` only if it occurs at the beginning of a line.
`string$`	Matches the pattern specified by `string` only if it occurs at the end of a line.
`str.ing`	Matches any character. For example, `t.st` will match `test`, `tast`, `tZst`, and `t1st`.
`string\.$`	The backslash (`\`) can be used to escape special characters so that you can match for the character. For example, if you want to find those lines ending with a period, the expression `.$` would show all lines that had at least one character. Specify `\.$` to escape the period (.).
`[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`.

Table 17. Regular expression syntax (continued)

Expression	Description
`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 more 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`, `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`.

Since only function names are being considered, the regular expressions are automatically bracketed with the ^ and $ characters. For example, **-qipa=noinline=^foo$** is equivalent to **-qipa=noinline=foo.** Therefore, **-qipa=noinline=bar** ensures that **bar** is never inlined but **bar1**, **teebar**, and **barrel** may be inlined.

Examples

The following example shows how you might compile a set of files with interprocedural analysis:

```
xlf95 -O -qipa f.f
xlf95 -c -O3 *.f -qipa=noobject
xlf95 -o product *.o -qipa -O
```

The following example shows how you might link these same files with interprocedural analysis, using regular expressions to improve performance. This example assumes that function **user_abort** exits the program, and that routines **user_trace1**, **user_trace2**, and **user_trace3** are rarely called.

```
xlf95 -o product *.o -qipa=exit=user_abort:lowfreq=user_trace[123] -O
```

Related information

See the “-O option” on page 78, “-p option” on page 81, and “-Q option” on page 82.

-qkeepparm option

Syntax

-qkeepparm | **-qnokeepparm**

Background information

A procedure usually stores its incoming parameters on the stack at the entry point. When you compile code with optimization, however, the optimizer may remove the stores into the stack if it sees opportunities to do so.

Specifying the **-qkeepparm** compiler option ensures that the parameters are stored on the stack even when optimizing. This may negatively impact execution performance. This option then provides access to the values of incoming parameters to tools, such as debuggers, simply by preserving those values on the stack.

-qlanglvl option

Syntax

```
-qlanglvl={suboption}
LANGLVL({suboption})
```

Determines which language standard (or superset, or subset of a standard) to consult for nonconformance. It identifies nonconforming source code and also options that allow such nonconformances.

Rules

The compiler issues a message with severity code **L** if it detects syntax that is not allowed by the language level that you specified.

Arguments

77std Accepts the language that the ANSI FORTRAN 77 standard specifies and reports anything else as an error.

90std Accepts the language that the ISO Fortran 90 standard specifies and reports anything else as an error.

90pure The same as **90std** except that it also reports errors for any obsolescent Fortran 90 features used.

95std Accepts the language that the ISO Fortran 95 standard specifies and reports anything else as an error.

95pure The same as **95std** except that it also reports errors for any obsolescent Fortran 95 features used.

2003std Accepts the language that the ISO Fortran 95 standard specifies, as well as all Fortran 2003 features supported by XL Fortran, and reports anything else as an error.

2003pure The same as **2003std** except that it also reports errors for any obsolescent Fortran 2003 features used.

extended Accepts the full Fortran 95 language standard, all Fortran 2003 features supported by XL Fortran, and all extensions, effectively turning off language-level checking.

Defaults

The default is **-qlanglvl=extended.**

Restrictions

The **-qflag** option can override this option.

Examples

The following example contains source code that conforms to a mixture of Fortran standards:

```
!------------------------------------------------------------
! in free source form
program tt
    integer :: a(100,100), b(100), i
    real :: x, y
    ...
    goto (10, 20, 30), i
10 continue
    pause 'waiting for input'

20 continue
    y= gamma(x)

30 continue
    b = maxloc(a, dim=1, mask=a .lt 0)

end program
!------------------------------------------------------------
```

The following chart shows examples of how some **-qlanglvl** suboptions affect this sample program:

-qlanglvl Suboption Specified	**Result**	**Reason**
95pure	Flags **PAUSE** statement Flags computed **GOTO** statement Flags **GAMMA** intrinsic	Deleted feature in Fortran 95 Obsolescent feature in Fortran 95 Extension to Fortran 95
95std	Flags **PAUSE** statement Flags **GAMMA** intrinsic	Deleted feature in Fortran 95 Extension to Fortran 95
extended	No errors flagged	

Related information

See "-qflag option" on page 124, "-qhalt option" on page 131, and "-qsaa option" on page 189.

The **langlvl** run-time option, which is described in "Setting run-time options" on page 29, helps to locate run-time extensions that cannot be checked for at compile time.

-qlibansi option

Syntax

–qlibansi | **–qnolibansi**

Assumes that all functions with the name of an ANSI C library function are, in fact, the system functions.

This option 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.

Note: Do not use this option if your application contains your own version of a C library function that is incompatible with the standard one

Related information

See "-qipa option" on page 143.

-qlibposix option

Related information

See “-qipa option” on page 143.

-qlinedebug option

Syntax

```
-qlinedebug | -qnolinedebug
LINEDEBUG | NOLINEDEBUG
```

Generates line number and source file name information for the debugger.

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.

As with **-g**, the higher the optimization level used, the more likely that debug information, including line numbers, will be misleading.

If you specify the **-qlinedebug** option, the inlining option defaults to **-Q!** (no functions are inlined).

The **-qnolinedebug** option has no effect on **-g**.

Related information

- "-g option" on page 72
- "-O option" on page 78

-qlist option

Syntax

```
-qlist[=offset | nooffset] | -qnolist
LIST[([NO]OFFSET)] | NOLIST
```

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.

If you specify the **-qipa** and **-qlist** options together, IPA generates an `a.lst` file that overwrites any existing `a.lst` file. If you have a source file named `a.f`, the IPA listing will overwrite the regular compiler listing `a.lst`. To avoid this, use the **list=***filename* suboption of **-qipa** to generate an alternative listing.

Notes

The **-qlist=offset** option is relevant only if there are multiple procedures in a compilation unit. For example, this may occur if nested procedures are used in a program.

If you specify **-qlist=offset**, the listing will show the offset from the start of the procedure rather than the offset from the start of code generation.

The offset of the PDEF header will contain the offset from the start of the text area. This allows any program reading the `.lst` file to add the value of the PDEF and the line in question, and produce the same value whether **-qlist=offset** or **-qlist=nooffset** is specified.

Specifying the **-qlist** option implies **-qlist=nooffset**.

Related information

- "Options that control listings and messages" on page 49
- "Object section" on page 255
- "-S option" on page 231
- Program units and procedures in the *XL Fortran Language Reference*

-qlistopt option

Syntax

-qlistopt | **-qnolistopt**
LISTOPT | **NOLISTOPT**

Determines whether to show the setting of every compiler option in the listing file or only selected options. These selected options include those specified on the command line or directives plus some that are always put in the listing.

You can use the option listing during debugging to check whether a problem occurs under a particular combination of compiler options or during performance testing to record the optimization options in effect for a particular compilation.

Rules

Options that are always displayed in the listing are:

- All "on/off" options that are on by default: for example, **-qobject**
- All "on/off" options that are explicitly turned off through the configuration file, command-line options, or **@PROCESS** directives
- All options that take arbitrary numeric arguments (typically sizes)
- All options that have multiple suboptions

Related information

See "Options that control listings and messages" on page 49 and "Options section" on page 251.

-qlog4 option

Syntax

-qlog4 | **-qnolog4**
LOG4 | **NOLOG4**

Specifies whether the result of a logical operation with logical operands is a **LOGICAL(4)** or is a **LOGICAL** with the maximum length of the operands.

You can use this option to port code that was originally written for the IBM VS FORTRAN compiler.

Arguments

-qlog4 makes the result always a **LOGICAL(4)**, while **-qnolog4** makes it depend on the lengths of the operands.

Restrictions

If you use **-qintsize** to change the default size of logicals, **-qlog4** is ignored.

-qmaxmem option

Syntax

```
-qmaxmem=Kbytes
MAXMEM(Kbytes)
```

Limits the amount of memory that the compiler allocates while performing specific, memory-intensive optimizations to the specified number of kilobytes. A value of -1 allows optimization to take as much memory as it needs without checking for limits.

Defaults

At the **-O2** optimization level, the default **-qmaxmem** setting is 8192 KB. At the **-O3** optimization level, the default setting is unlimited (-1).

Rules

If the specified amount of memory is insufficient for the compiler to compute a particular optimization, the compiler issues a message and reduces the degree of optimization.

This option has no effect except in combination with the **-O** option.

When compiling with **-O2**, you only need to increase the limit if a compile-time message instructs you to do so. When compiling with **-O3**, you might need to establish a limit if compilation stops because the machine runs out of storage; start with a value of 8192 or higher, and decrease it if the compilation continues to require too much storage.

Notes:

1. Reduced optimization does not necessarily mean that the resulting program will be slower. It only means that the compiler cannot finish looking for opportunities to improve performance.
2. Increasing the limit does not necessarily mean that the resulting program will be faster. It only means that the compiler is better able to find opportunities to improve performance if they exist.
3. Setting a large limit has no negative effect when compiling source files for which the compiler does not need to use so much memory during optimization.
4. As an alternative to raising the memory limit, you can sometimes move the most complicated calculations into procedures that are then small enough to be fully analyzed.
5. Not all memory-intensive compilation stages can be limited.
6. Only the optimizations done for **-O2** and **-O3** can be limited; **-O4** and **-O5** optimizations cannot be limited.
7. The **-O4** and **-O5** optimizations may also use a file in the /tmp directory. This is not limited by the **-qmaxmem** setting.
8. Some optimizations back off automatically if they would exceed the maximum available address space, but not if they would exceed the paging space available at that time, which depends on machine workload.

Restrictions

Depending on the source file being compiled, the size of subprograms in the source code, the machine configuration, and the workload on the system, setting the limit too high might fill up the paging space. In particular, a value of -1 can fill up the storage of even a well-equipped machine.

Related information

- "-O option" on page 78
- *Optimizing XL compiler programs* in the *XL Fortran Optimization and Programming Guide*

-qmbcs option

Syntax

-qmbcs | **-qnombcs**
MBCS | **NOMBCS**

Indicates to the compiler whether character literal constants, Hollerith constants, H edit descriptors, and character string edit descriptors can contain Multibyte Character Set (MBCS) or Unicode characters.

This option is intended for applications that must deal with data in a multibyte language, such as Japanese.

To process the multibyte data correctly at run time, set the locale (through the **LANG** environment variable or a call to the **libc setlocale** routine) to the same value as during compilation.

Rules

Each byte of a multibyte character is counted as a column.

Restrictions

To read or write Unicode data, set the locale value to **UNIVERSAL** at run time. If you do not set the locale, you might not be able to interchange data with Unicode-enabled applications.

-qminimaltoc option

Syntax

-qminimaltoc | **-qnominimaltoc**

This compiler option can change the generation of the table of contents (TOC), which the compiler creates for every executable file when you compile in 64-bit mode. By default, the compiler will allocate at least one TOC entry for each unique, non-automatic variable reference in your program. Currently, only 8192 TOC entries are available and duplicate entries are not discarded. This can cause errors when linking large programs in 64-bit mode if your program exceeds 8192 TOC entries.

Specifying **-qminimaltoc** ensures that the compiler creates only one TOC entry for each compilation unit. Specifying this option can minimize the use of available TOC entries, but its use impacts performance. Use the **-qminimaltoc** option with discretion, particularly with files that contain frequently executed code.

-qmixed option

Syntax

-qmixed | **-qnomixed**
MIXED | **NOMIXED**

This is the long form of the "-U option" on page 233.

-qmoddir option

Syntax

`-qmoddir=`*`directory`*

Specifies the location for any module (**.mod**) files that the compiler writes.

Defaults

If you do not specify **-qmoddir**, the **.mod** files are placed in the current directory.

To read the **.mod** files from this directory when compiling files that reference the modules, use the "`-I` option" on page 73.

Related information

See "XL Fortran Output files" on page 19.

Modules are a Fortran 90/95 feature and are explained in the Modules section of the *XL Fortran Language Reference*.

-qmodule option

Syntax

```
-qmodule=mangle81
```

Specifies that the compiler should use the XL Fortran Version 8.1 naming convention for non-intrinsic module files.

This option allows you to produce modules and their associated object files with the Version 10.1 compiler and link these object files with others compiled with the Version 8.1 compiler.

Use this option only if you need to link applications that were compiled with the Version 8.1 compiler. It is recommended that you avoid using this compiler switch and rebuild old code and modules with the new version of the compiler, if possible. Doing so will avoid any naming conflicts between your modules and intrinsic compiler modules.

Related information

- Modules section in the *XL Fortran Language Reference*. (Modules are a Fortran 90/95 feature.)
- *Conventions for XL Fortran external names* in the *XL Fortran Optimization and Programming Guide*
- "Avoiding naming conflicts during linking" on page 27

-qnoprint option

Syntax

```
-qnoprint
```

Prevents the compiler from creating the listing file, regardless of the settings of other listing options.

Specifying **-qnoprint** on the command line enables you to put other listing options in a configuration file or on **@PROCESS** directives and still prevent the listing file from being created.

Rules

A listing file is usually created when you specify any of the following options: **-qattr**, **-qlist**, **-qlistopt**, **-qphsinfo**, **-qsource**, **-qreport**, or **-qxref**. **-qnoprint** prevents the listing file from being created by changing its name to **/dev/null**, a device that discards any data that is written to it.

Related information

See "Options that control listings and messages" on page 49.

-qnullterm option

Syntax

-qnullterm | **-qnonullterm**
NULLTERM | **NONULLTERM**

Appends a null character to each character constant expression that is passed as a dummy argument, to make it more convenient to pass strings to C functions.

This option allows you to pass strings to C functions without having to add a null character to each string argument.

Background information

This option affects arguments that are composed of any of the following objects: basic character constants; concatenations of multiple character constants; named constants of type character; Hollerith constants; binary, octal, or hexadecimal typeless constants when an interface block is available; or any character expression composed entirely of these objects. The result values from the **CHAR** and **ACHAR** intrinsic functions also have a null character added to them if the arguments to the intrinsic function are initialization expressions.

Rules

This option does not change the length of the dummy argument, which is defined by the additional length argument that is passed as part of the XL Fortran calling convention.

Restrictions

This option affects those arguments that are passed with or without the **%REF** built-in function, but it does not affect those that are passed by value. This option does not affect character expressions in input and output statements.

Examples

Here are two calls to the same C function, one with and one without the option:

```
      @PROCESS NONULLTERM
      SUBROUTINE CALL_C_1
        CHARACTER*9, PARAMETER :: HOME = "/home/luc"
! Call the libc routine mkdir() to create some directories.
        CALL mkdir ("/home/luc/testfiles\0", %val(448))
! Call the libc routine unlink() to remove a file in the home directory.
        CALL unlink (HOME // "/.hushlogin" // CHAR(0))
      END SUBROUTINE

      @PROCESS NULLTERM
      SUBROUTINE CALL_C_2
        CHARACTER*9, PARAMETER :: HOME = "/home/luc"
! With the option, there is no need to worry about the trailing null
! for each string argument.
        CALL mkdir ("/home/luc/testfiles", %val(448))
        CALL unlink (HOME // "/.hushlogin")
      END SUBROUTINE
!
```

Related information

See *Passing character types between languages* in the *XL Fortran Optimization and Programming Guide*.

-qobject option

Syntax

-qOBJect | -qNOOBJect
OBJect | NOOBJect

Specifies whether to produce an object file or to stop immediately after checking the syntax of the source files.

When debugging a large program that takes a long time to compile, you might want to use the **-qnoobject** option. It allows you to quickly check the syntax of a program without incurring the overhead of code generation. The **.lst** file is still produced, so you can get diagnostic information to begin debugging.

After fixing any program errors, you can change back to the default (**-qobject**) to test whether the program works correctly. If it does not work correctly, compile with the **-g** option for interactive debugging.

Restrictions

The **-qhalt** option can override the **-qobject** option, and **-qnoobject** can override **-qhalt**.

Related information

See "Options that control listings and messages" on page 49 and "Object section" on page 255.

"The compiler phases" on page 257 gives some technical information about the compiler phases.

-qoldmod option

Syntax

```
-qoldmod=compat
```

This option specifies that object files containing module data compiled with versions of XL Fortran earlier than V9.1.1 either do not contain uninitialized module data or were ported using the **convert_syms** script.

The mangling scheme that XL Fortran uses for uninitialized module variables was changed with Version 9.1.1. The previous mangling scheme used the @ sign, which confused the Linux linker when creating shared libraries. The Linux linker reserves the @ sign for symbol versioning.

As a result of this change, XL Fortran modules containing uninitialized module variables and any compilation units using these modules need to be recompiled with the **-qoldmod=compat** option.

If recompilation is not feasible, you can port the object files created by older compilers by using the following script:

```
> cat convert_syms
#!/bin/bash
if [[ $# = 0 || "$1" = "-?" ]]
then
  echo "Usage: $0 object-files"
  echo "e.g.   $0 *.o *.a"
  exit
fi

for file in $*
do
  XLFSYMS=""
  for i in `nm $file | grep -o "&&\([NI]&\)\?@.*$" | sort -u`
  do
     XLFSYMS="$XLFSYMS --redefine-sym $i=`echo $i | sed -e 's/@/\&/'`"
  done
  if [[ -n "$XLFSYMS" ]]; then
    echo Converting symbols in $file...
    objcopy $XLFSYMS $file
  fi
done
```

Module symbol files (*.mod) do not need to be ported.

Examples

```
# If old_module.o and old_module.mod were produced using the original
# release of XL Fortran Advanced Edition V9.1 for Linux, you'll get
# the following error when you try to use them in new programs:
#
> xlf95 new_program.f old_module.o
"new_program.f", line 1.5: 1517-022 (S) Module old_module was compiled
using an incompatible version of the compiler.  Please see the -qoldmod
option for information on recovery.
1501-511  Compilation failed for file new_program.f.

# Convert the object file.  This needs to be done only once.
#
> ./convert_syms old_module.o
>

# You can now use the updated object file safely.
# Specify -qoldmod=compat
```

```
#
> xlf95 new_program.f old_module.o -qoldmod=compat
** _main   === End of Compilation 1 ===
1501-510  Compilation successful for file new_program.f.
>
```

-qonetrip option

Syntax

-qonetrip | **-qnoonetrip**
ONETRIP | **NOONETRIP**

This is the long form of the "-1 option" on page 65.

-qoptimize option

Syntax

```
-qOPTimize[=level] | -qNOOPTimize
OPTimize[(level)] | NOOPTimize
```

This is the long form of the "-O option" on page 78.

-qpdf option

Syntax

```
-qpdf{1|2}
```

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.

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 the **-O2** option, or preferably the **-O3**, **-O4**, or **-O5** option, for optimization. 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.

   If you want to avoid full recompilation in the **-qpdf2** step, first compile with **-qpdf1** but with no linking, so that the object files are saved. Then link the object files into an executable. To use this procedure, issue commands similar to the following:

   ```
   xlf -c -qpdf1 -O2 file1.f file2.f
   xlf -qpdf2 -O2 file1.o file2.o
   ```

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. Recompile and 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.

   Alternatively, if you saved the object files from 1, you can simply relink them. For example, issue the following command:

   ```
   xlf -qpdf2 -O2 file1.o file2.o
   ```

   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 (as in the example above). If your application contains C or C++ code compiled with IBM XL C/C+ compilers, you can achieve additional PDF optimization by specifying the **-qpdf1** and **-qpdf2** options available on those compilers. Combining **-qpdf1**/**-qpdf2** and **-qipa** or **-O5** options (that is, link with IPA) on all Fortran and C/C++ code will lead to maximum PDF information being available for optimization.

Rules

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.

Background information

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 also 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.
- If **-qipa** is not invoked either directly or through other options, **-qpdf1** and **-qpdf2** will invoke the **-qipa=level=0** option.
- If you do 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 commands, in the directory **/opt/ibmcmp/xlf/10.1/bin**, are available for managing the **PDFDIR** directory:

`cleanpdf [`*`pathname`*`]`

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 the profiling information reduces the run-time overhead if you change the program and then go through the PDF process again.

Run this program after compiling with **-qpdf2** or after finishing with the PDF process for a particular application. If you continue using PDF with an application after running **cleanpdf**, you must recompile all the files with **-qpdf1**.

`mergepdf` Generates a single pdf record from 2 or more input pdf records. All pdf records must come from the same executable.

mergepdf automatically scales each pdf record (that is, file) based on its ″weight″. A scaling ratio can be specified for each pdf record, so that more important training runs can be weighted heavier than less important ones. The syntax for **mergepdf** is:

```
mergepdf [-r1] record1 [-r2] record2 ... -outputrecname [-n] [-v]
```

where:

-r The scaling ratio for the pdf record. If -r is not specified for an input record, the default ratio is 1.0 and no external scaling is applied. The scaling ratio must be greater than or equal to zero, and can be a floating point number or an integer.

record The input file, or the directory that contains the pdf profile.

-o output_recordname
The pdf output directory name, or a file name that **mergepdf** will write the merged pdf record to. If a directory is specified, it must exist before you run the command.

-n Do not normalize the pdf records. By default, records are normalized based on an internally calculated ratio for each profile before applying any user-specified ratio with **-r**. When **-n** is specified, the pdf records are scaled by the user-specified ratio **-r**. If **-r** is not specified, the pdf records are not scaled at all.

-v Verbose mode displays the internal and user-specified scaling ratio used.

`resetpdf [`*pathname*`]` Same as **cleanpdf** [*pathname*], described above. This command is provided for compatibility with the previous version.

`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

Examples

Here is a simple example:

```
# Set the PDFDIR variable.
  export PDFDIR=$HOME/project_dir
# Compile all files with -qpdf1.
  xlf95 -qpdf1 -O3 file1.f file2.f file3.f
# Run with one set of input data.
  a.out <sample.data
# Recompile all files with -qpdf2.
  xlf95 -qpdf2 -O3 file1.f file2.f file3.f
# 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.
  xlf95 -qpdf1 -O3 -c file1.f file2.f file3.f
# This file is not so important to optimize.
  xlf95 -c file4.f
# Non-PDF object files such as file4.o can be linked in.
  xlf95 -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
# Do not need to recompile the source of non-PDF object files (file4.f).
  xlf95 -qpdf2 -O3 file1.f file2.f file3.f
# Link all the object files into the final application.
  xlf95 -qpdf2 -O3 file1.o file2.o file3.o file4.o
```

Here is an example that bypasses recompiling the source with -qpdf2:

```
# Set the PDFDIR variable.
  export PDFDIR=$HOME/project_dir
# Compile source with -qpdf1.
  xlf -O3 -qpdf1 -c file.f
# Link in object file.
  xlf -O3 -qpdf1 file.o
# Run with one set of input data.
  a.out <sample.data
# Link in object file from qpdf1 pass.
# (Bypass source recompilation with -qpdf2.)
  xlf -O3 -qpdf2 file.o
```

Here is an example of using pdf1 and pdf2 objects:

```
# Set the PDFDIR variable.
  export PDFDIR=$HOME/project_dir
# Compile source with -qpdf1.
  xlf -c -qpdf1 -O3 file1.f file2.f
# Link in object files.
  xlf -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.
  xlf -qpdf2 -O3 file1.o file2.o
```

Related information

- "XL Fortran input files" on page 18
- "XL Fortran Output files" on page 19
- *Benefits of Profile-Directed Feedback* in the *XL Fortran Optimization and Programming Guide*

-qphsinfo option

Syntax

-qphsinfo | **-qnophsinfo**
PHSINFO | **NOPHSINFO**

The **-qphsinfo** compiler option displays timing information on the terminal for each compiler phase.

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.

Examples

To compile **app.f**, which consists of 3 compilation units, and report the time taken for each phase of the compilation, enter:

```
xlf90 app.f  -qphsinfo
```

The output will look similar to:

```
FORTRAN phase 1 ftphas1      TIME =  0.000 / 0.000
** m_module   === End of Compilation 1 ===
FORTRAN phase 1 ftphas1      TIME =  0.000 / 0.000
** testassign   === End of Compilation 2 ===
FORTRAN phase 1 ftphas1      TIME =  0.000 / 0.010
** dataassign   === End of Compilation 3 ===
HOT       - Phase Ends;   0.000/  0.000
HOT       - Phase Ends;   0.000/  0.000
HOT       - Phase Ends;   0.000/  0.000
W-TRANS   - Phase Ends;   0.000/  0.010
OPTIMIZ   - Phase Ends;   0.000/  0.000
REGALLO   - Phase Ends;   0.000/  0.000
AS        - Phase Ends;   0.000/  0.000
W-TRANS   - Phase Ends;   0.000/  0.000
OPTIMIZ   - Phase Ends;   0.000/  0.000
REGALLO   - Phase Ends;   0.000/  0.000
AS        - Phase Ends;   0.000/  0.000
W-TRANS   - Phase Ends;   0.000/  0.000
OPTIMIZ   - Phase Ends;   0.000/  0.000
REGALLO   - Phase Ends;   0.000/  0.000
AS        - Phase Ends;   0.000/  0.000
1501-510  Compilation successful for file app.f.
```

Each phase is invoked three times, corresponding to each compilation unit. FORTRAN represents front-end parsing and semantic analysis, HOT loop transformations, W-TRANS intermediate language translation, OPTIMIZ high–level optimization, REGALLO register allocation and low–level optimization, and AS final assembly.

Compile **app.f** at the **-O4** optimization level with **-qphsinfo** specified:

```
xlf90 myprogram.f  -qphsinfo -O4
```

The following output results:

```
FORTRAN phase 1 ftphas1      TIME =  0.010 / 0.020
** m_module   === End of Compilation 1 ===
FORTRAN phase 1 ftphas1      TIME =  0.000 / 0.000
** testassign   === End of Compilation 2 ===
FORTRAN phase 1 ftphas1      TIME =  0.000 / 0.000
** dataassign   === End of Compilation 3 ===
HOT       - Phase Ends;   0.000/  0.000
HOT       - Phase Ends;   0.000/  0.000
HOT       - Phase Ends;   0.000/  0.000
IPA       - Phase Ends;   0.080/  0.100
1501-510  Compilation successful for file app.f.
IPA       - Phase Ends;   0.050/  0.070
W-TRANS   - Phase Ends;   0.010/  0.030
OPTIMIZ   - Phase Ends;   0.020/  0.020
REGALLO   - Phase Ends;   0.040/  0.040
AS        - Phase Ends;   0.000/  0.000
```

Note that during the IPA (interprocedural analysis) optimization phases, the program has resulted in one compilation unit; that is, all procedures have been inlined.

Related information

"The compiler phases" on page 257.

-qpic option

Syntax

```
-qpic[=small|large] | -qnopic (in 32-bit mode)
-qpic[=small|large] | -qnopic (in 64-bit mode)
```

The **-qpic** compiler option generates Position Independent Code (PIC) that can be used in shared libraries.

Arguments

small | large The **small** suboption tells the compiler to assume that the size of the Global Offset Table be at most, 64K. The **large** suboption allows the size of the Global Offset Table to be larger than 64K. This suboption allows more addresses to be stored in the Global Offset Table. However, it does generate code that is usually larger than that generated by the **small** suboption.

In **64–bit** mode, **-qpic=small** is the default.

-qnopic The compiler does not generate Position Independent Code.

In **32–bit** mode, **-qnopic** is the default.

Related information

For more information on linker options, refer to the man pages for the **ld** command.

-qport option

Syntax

```
-qport[=suboptions]| -qnoport
PORT[(suboptions)]| NOPORT
```

The **-qport** compiler option increases flexibility when porting programs to XL Fortran, providing a number of options to accommodate other Fortran language extensions. A particular suboption will always function independently of other **-qport** and compiler options.

Arguments

clogicals | noclogicals
: If you specify this option, the compiler treats all non-zero integers that are used in logical expressions as `TRUE`. You must specify **-qintlog** for **-qport=clogicals** to take effect.

  The **-qport=clogicals** option is useful when porting applications from other Fortran compilers that expect this behavior. However, it is unsafe to mix programs that use different settings for non-zero integers if they share or pass logical data between them. Data files already written with the default **-qintlog** setting will produce unexpected behavior if read with the **-qport=clogicals** option active.

hexint | nohexint
: If you specify this option, typeless constant hexadecimal strings are converted to integers when passed as an actual argument to the **INT** intrinsic function. Typeless constant hexadecimal strings not passed as actual arguments to **INT** remain unaffected.

mod | nomod Specifying this option relaxes existing constraints on the **MOD** intrinsic function, allowing two arguments of the same data type parameter to be of different kind type parameters. The result will be of the same type as the argument, but with the larger kind type parameter value.

nullarg | nonullarg
: For an external or internal procedure reference, specifying this option causes the compiler to treat an empty argument, which is delimited by a left parenthesis and a comma, two commas, or a comma and a right parenthesis, as a null argument. This suboption has no effect if the argument list is empty.

  Examples of empty arguments are:

  ```
  call foo(,,z)

  call foo(x,,z)

  call foo(x,y,)
  ```

  The following program includes a null argument.

  Fortran program:

  ```
  program nularg
  real(4) res/0.0/
  integer(4) rc
  integer(4), external :: add
  rc = add(%val(2), res, 3.14, 2.18,) ! The last argument is a
  ```

```
                                                ! null argument.
if (rc == 0) then
print *, "res = ", res
else
print *, "number of arguments is invalid."
endif
end program
```

C program:

```
int add(int a, float *res, float *b, float *c, float *d)
{
   int ret = 0;
   if (a == 2)
     *res = *b + *c;
   else if (a == 3)
     *res = (*b + *c + *d);
   else
     ret = 1;
   return (ret);
}
```

sce | **nosce**
By default, the compiler performs short circuit evaluation in selected logical expressions using XL Fortran rules. Specifying **sce** allows the compiler to use non-XL Fortran rules. The compiler will perform short circuit evaluation if the current rules allow it.

typestmt | **notypestmt**
The TYPE statement, which behaves in a manner similar to the PRINT statement, is supported whenever this option is specified.

typlssarg | **notyplssarg**
Converts all typeless constants to default integers if the constants are actual arguments to an intrinsic procedure whose associated dummy arguments are of integer type. Dummy arguments associated with typeless actual arguments of noninteger type remain unaffected by this option.

Using this option may cause some intrinsic procedures to become mismatched in kinds. Specify **-qxlf77=intarg** to convert the kind to that of the longest argument.

Related information

See the section on the **INT** and **MOD** intrinsic functions in the *XL Fortran Language Reference* for further information.

-qposition option

Syntax

```
-qposition={appendold | appendunknown} ...
POSITION({APPENDOLD | APPENDUNKNOWN} ...)
```

Positions the file pointer at the end of the file when data is written after an **OPEN** statement with no **POSITION=** specifier and the corresponding **STATUS=** value (**OLD** or **UNKNOWN**) is specified.

The default setting depends on the I/O specifiers in the **OPEN** statement and on the compiler invocation command: **-qposition=appendold** for the **xlf**, **xlf_r**, and **f77/fort77** commands and the defined Fortran 90 and Fortran 95 behaviors for the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, and **f95** commands.

Rules

The position becomes **APPEND** when the first I/O operation moves the file pointer if that I/O operation is a **WRITE** or **PRINT** statement. If it is a **BACKSPACE**, **ENDFILE**, **READ**, or **REWIND** statement instead, the position is **REWIND**.

Examples

In the following example, **OPEN** statements that do not specify a **POSITION=** specifier, but specify **STATUS='old'** will open the file as if **POSITION='append'** was specified.

```
xlf95 -qposition=appendold opens_old_files.f
```

In the following example, **OPEN** statements that do not specify a **POSITION=** specifier, but specify **STATUS='unknown'** will open the file as if **POSITION='append'** was specified.

```
xlf95 -qposition=appendunknown opens_unknown_files.f
```

In the following example, **OPEN** statements that do not specify a **POSITION=** specifier, but specify either **STATUS='old'** or **STATUS='unknown'** will open the file as if **POSITION='append'** was specified.

```
xlf95 -qposition=appendold:appendunknown opens_many_files.f
```

Related information

- *File positioning* in the *XL Fortran Optimization and Programming Guide*
- **OPEN** statement in the *XL Fortran Language Reference*

-qprefetch option

Syntax

-qprefetch | -qnoprefetch

Instructs the compiler to insert the prefetch instructions automatically where there are opportunities to improve code performance.

Related information

For more information on prefetch directives, see **PREFETCH directives** in the *XL Fortran Language Reference* and *The POWER4 Processor Introduction and Tuning Guide*. To selectively control prefetch directives using trigger constants, see the "-qdirective option" on page 111.

-qqcount option

Syntax

-qqcount | **-qnoqcount**
QCOUNT | **NOQCOUNT**

Accepts the **Q** character-count edit descriptor (**Q**) as well as the extended-precision **Q** edit descriptor (**Q***w.d*). With **-qnoqcount**, all **Q** edit descriptors are interpreted as the extended-precision **Q** edit descriptor.

Rules

The compiler interprets a **Q** edit descriptor as one or the other depending on its syntax and issues a warning if it cannot determine which one is specified.

Related information

See *Q (Character Count) Editing* in the *XL Fortran Language Reference*.

-qrealsize option

Syntax

```
-qrealsize=bytes
REALSIZE(bytes)
```

Sets the default size of **REAL**, **DOUBLE PRECISION**, **COMPLEX**, and **DOUBLE COMPLEX** values.

This option is intended for maintaining compatibility with code that is written for other systems. You may find it useful as an alternative to **-qautodbl** in some situations.

Rules

The option affects the sizes[2] of constants, variables, derived type components, and functions (which include intrinsic functions) for which no kind type parameter is specified. Objects that are declared with a kind type parameter or length, such as **REAL(4)** or **COMPLEX*16**, are not affected.

Arguments

The allowed values for *bytes* are:

- 4 (the default)
- 8

Results

This option determines the sizes of affected objects as follows:

Data Object	REALSIZE(4) in Effect	REALSIZE(8) in Effect
1.2	REAL(4)	REAL(8)
1.2e0	REAL(4)	REAL(8)
1.2d0	REAL(8)	REAL(16)
1.2q0	REAL(16)	REAL(16)
REAL	REAL(4)	REAL(8)
DOUBLE PRECISION	REAL(8)	REAL(16)
COMPLEX	COMPLEX(4)	COMPLEX(8)
DOUBLE COMPLEX	COMPLEX(8)	COMPLEX(16)

Similar rules apply to intrinsic functions:

- If an intrinsic function has no type declaration, its argument and return types may be changed by the **-qrealsize** setting.
- Any type declaration for an intrinsic function must agree with the default size of the return value.

This option is intended to allow you to port programs unchanged from systems that have different default sizes for data. For example, you might need **-qrealsize=8** for programs that are written for a CRAY computer. The default value of 4 for this option is suitable for programs that are written specifically for many 32-bit computers.

Setting **-qrealsize** to 8 overrides the setting of the **-qdpc** option.

2. In Fortran 90/95 terminology, these values are referred to as *kind type parameters*.

Examples

This example shows how changing the **-qrealsize** setting transforms some typical entities:

```
@PROCESS REALSIZE(8)
         REAL R                 ! treated as a real(8)
         REAL(8) R8             ! treated as a real(8)
         DOUBLE PRECISION DP    ! treated as a real(16)
         DOUBLE COMPLEX DC      ! treated as a complex(16)
         COMPLEX(4) C           ! treated as a complex(4)
         PRINT *,DSIN(DP)       ! treated as qsin(real(16))
! Note: we cannot get dsin(r8) because dsin is being treated as qsin.
         END
```

Specifying **-qrealsize=8** affects intrinsic functions, such as **DABS**, as follows:

```
INTRINSIC DABS        ! Argument and return type become REAL(16).
DOUBLE PRECISION DABS ! OK, because DOUBLE PRECISION = REAL(16)
                      ! with -qrealsize=8 in effect.
REAL(16) DABS         ! OK, the declaration agrees with the option setting.
REAL(8) DABS          ! The declaration does not agree with the option
                      ! setting and is ignored.
```

Related information

"-qintsize option" on page 141 is a similar option that affects integer and logical objects. "-qautodbl option" on page 97 is related to **-qrealsize**, although you cannot combine the options. When the **-qautodbl** option turns on automatic doubling, padding, or both, the **-qrealsize** option has no effect.

Type Parameters and Specifiers in the *XL Fortran Language Reference* discusses kind type parameters.

-qrecur option

Syntax

-qrecur | **-qnorecur**
RECUR | **NORECUR**

Not recommended. Specifies whether external subprograms may be called recursively. For new programs, use the **RECURSIVE** keyword, which provides a standard-conforming way of using recursive procedures. If you specify the **-qrecur** option, the compiler must assume that any procedure could be recursive. Code generation for recursive procedures may be less efficient. Using the **RECURSIVE** keyword allows you to specify exactly which procedures are recursive.

Examples

```
! The following RECUR recursive function:

        @process recur
        function factorial (n)
        integer factorial
        if (n .eq. 0) then
           factorial = 1
        else
           factorial = n * factorial (n-1)
        end if
        end function factorial

! can be rewritten to use F90/F95 RECURSIVE/RESULT features:

        recursive function factorial (n) result (res)
        integer res
        if (n .eq. 0) then
           res = 1
        else
           res = n * factorial (n-1)
        end if
        end function factorial
```

Restrictions

If you use the **xlf**, **xlf_r**, **f77**, or **fort77** command to compile programs that contain recursive calls, specify **-qnosave** to make the default storage class automatic.

-qreport option

Syntax

```
-qreport[={smplist | hotlist}...]
-qnoreport
REPORT[({SMPLIST | HOTLIST}...)] NOREPORT
```

Determines whether to produce transformation reports showing how the program is parallelized and how loops are optimized.

You can use the **smplist** suboption to debug or tune the performance of SMP programs by examining the low-level transformations. You can see how the program deals with data and the automatic parallelization of loops. Comments within the listing tell you how the transformed program corresponds to the original source code and include information as to why certain loops were not parallelized.

You can use the **hotlist** suboption to generate a report showing how loops are transformed.

Arguments

smplist
: Produces a pseudo-Fortran listing that shows how the program is parallelized. This listing is produced before loop and other optimizations are performed. It includes messages that point out places in the program that can be modified to be more efficient. This report will only be produced if the **-qsmp** option is in effect.

hotlist
: Produces a pseudo-Fortran listing that shows how loops are transformed, to assist you in tuning the performance of all loops. This suboption is the default if you specify **-qreport** with no suboptions.

  In addition, if you specify the **-qreport=hotlist** option when the **-qsmp** option is in effect, a pseudo-Fortran listing will be produced that shows the calls to the SMP runtime and the procedures created for parallel constructs.

Background information

The transformation listing is part of the compiler listing file.

Restrictions

Loop transformation and auto parallelization are done on the link step at a **-O5** (or **-qipa=level=2**) optimization level. The **-qreport** option will generate the report in the listing file on the link step.

You must specify the **-qsmp** orthe **-qhot** option to generate a loop transformation listing. You must specify the **-qsmp** option to generate a parallel transformation listing or parallel performance messages.

The code that the listing shows is not intended to be compilable. Do not include any of this code in your own programs or explicitly call any of the internal routines whose names appear in the listing.

Examples

To produce a listing file that you can use to tune parallelization:

```
xlf_r -qsmp -O3 -qhot -qreport=smplist needs_tuning.f
```

To produce a listing file that you can use to tune both parallelization and loop performance:

```
xlf_r -qsmp -O3 -qhot -qreport=smplist:hotlist needs_tuning.f
```

To produce a listing file that you can use to tune only the performance of loops:

```
xlf95_r -O3 -qhot -qreport=hotlist needs_tuning.f
```

Related information

See "-qpdf option" on page 172.

-qsaa option

Syntax

-qsaa | **-qnosaa**
SAA | **NOSAA**

Checks for conformance to the SAA FORTRAN language definition. It identifies nonconforming source code and also options that allow such nonconformances.

Rules

These warnings have a prefix of **(L)**, indicating a problem with the language level.

Restrictions

The **-qflag** option can override this option.

Related information

Use the "-qlanglvl option" on page 150 to check your code for conformance to international standards.

-qsave option

Syntax

```
-qsave[={all|defaultinit}] | -qnosave
SAVE[({all|defaultinit})] NOSAVE
```

This specifies the default storage class for local variables.

If **-qsave=all** is specified, the default storage class is **STATIC**; if **-qnosave** is specified, the default storage class is **AUTOMATIC**; if **-qsave=defaultinit** is specified, the default storage class is **STATIC** for variables of derived type that have default initialization specified, and **AUTOMATIC** otherwise. The default suboption for the **-qsave** option is **all**. The two suboptions are mutually exclusive.

The default for this option depends on the invocation used. For example, you may need to specify **-qsave** to duplicate the behavior of FORTRAN 77 programs. The **xlf**, **xlf_r**, **f77**, and **fort77** commands have **-qsave** listed as a default option in **/etc/opt/ibmcmp/xlf/10.1/xlf.cfg** to preserve the previous behavior.

The following example illustrates the impact of the **-qsave** option on derived data type:

```
PROGRAM P
  CALL SUB
  CALL SUB
END PROGRAM P

SUBROUTINE SUB
  LOGICAL, SAVE :: FIRST_TIME = .TRUE.
  STRUCTURE /S/
    INTEGER I/17/
  END STRUCTURE
  RECORD /S/ LOCAL_STRUCT
  INTEGER LOCAL_VAR

  IF (FIRST_TIME) THEN
    LOCAL_STRUCT.I = 13
    LOCAL_VAR = 19
    FIRST_TIME = .FALSE.
  ELSE
    ! Prints " 13" if compiled with -qsave or -qsave=all
    ! Prints " 13" if compiled with -qsave=defaultinit
    ! Prints " 17" if compiled with -qnosave
    PRINT *, LOCAL_STRUCT
    ! Prints " 19" if compiled with -qsave or -qsave=all
    ! Value of LOCAL_VAR is undefined otherwise
    PRINT *, LOCAL_VAR
  END IF
END SUBROUTINE SUB
```

Related information

The **-qnosave** option is usually necessary for multi-threaded applications and subprograms that are compiled with the "-qrecur option" on page 186.

See *Storage Classes for Variables* in the *XL Fortran Language Reference* for information on how this option affects the storage class of variables.

-qsaveopt option

Syntax

-qsaveopt | **-qnosaveopt**

Saves the command-line options used for compiling a source file, and other information, in the corresponding object file. The compilation must produce an object file for this option to take effect. Only one copy of the command-line options is saved, even though each object may contain multiple compilation units.

To list the options used, issue the **strings -a** command on the object file. The following is listed:

```
opt source_type invocation_used compilation_options
```

For example, if the object file is **t.o**, the **strings -a t.o** command may produce information similar to the following:

```
@(#) opt f /opt/ibmcmp/xlf/10.1/bin/xlf90 -qlist -qsaveopt t.f
```

where **f** identifies the source used as Fortran, **/opt/ibmcmp/xlf/10.1/bin/xlf90** shows the invocation command used, and **-qlist -qsaveopt** shows the compilation options.

-qsclk option

Syntax

```
-qsclk[={centi | micro}]
```

Specifies the resolution that the **SYSTEM_CLOCK** intrinsic procedure uses in a program. The default is centisecond resolution (**–qsclk=centi**). To use microsecond resolution, specify **–qsclk=micro**.

Related information

See **SYSTEM_CLOCK** in the *XL Fortran Language Reference* for more information on returning integer data from a real-time clock.

-qshowpdf option

Syntax

-qshowpdf | **-qnoshowpdf**

Used together with **-qpdf1** and a minimum optimization level of **-O** to add additional call and block count profiling information to an executable.

When specified together with **-qpdf1**, 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 **._pdf** file.

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 "-qpdf option" on page 172.

-qsigtrap option

Syntax

`-qsigtrap[=trap_handler]`

When you are compiling a file that contains a main program, this option sets up the specified trap handler to catch **SIGTRAP** and **SIGFPE** exceptions. This option enables you to install a handler for **SIGTRAP** or **SIGFPE** signals without calling the **SIGNAL** subprogram in the program.

Arguments

To enable the `xl__trce` trap handler, specify **-qsigtrap** without a handler name. To use a different trap handler, specify its name with the **-qsigtrap** option.

If you specify a different handler, ensure that the object module that contains it is linked with the program. To show more detailed information in the tracebacks generated by the trap handlers provided by XL Fortran (such as xl__trce), specify the **-qlinedebug** or **-g** option.

Related information

- "XL Fortran run-time exceptions" on page 38 describes the possible causes of exceptions.
- *Detecting and trapping floating-point exceptions* in the *XL Fortran Optimization and Programming Guide* describes a number of methods for dealing with exceptions that result from floating-point computations.
- *Installing an exception handler* in the *XL Fortran Optimization and Programming Guide* lists the exception handlers that XL Fortran supplies.

-qsmallstack option

Syntax

```
-qsmallstack[=[no]dynlenonheap]
 | –qnosmallstack
```

Specifies that the compiler will minimize stack usage where possible.

This compiler option controls two distinct, but related sets of transformations: general small stack transformations and dynamic length variable allocation transformations. These two kinds of transformations can be controlled independently of each other.

The default, **–qnosmallstack**, implies that all suboptions are off.

The **-qsmallstack=dynlenonheap** suboption affects automatic objects that have nonconstant character lengths or a nonconstant array bound (DYNamic LENgth ON HEAP). When specified, those automatic variables are allocated on the heap. When this suboption is not specified, those automatic variables are allocated on the stack.

Using this option may adversely affect program performance; it should be used only for programs that allocate large amounts of data on the stack.

Rules

- **-qsmallstack** with no suboptions enables only the general small stack transformations.
- **-qnosmallstack** only disables the general small stack transformations. To disable **dynlenonheap** transformations, specify **-qsmallstack=nodynlenonheap** as well.
- **-qsmallstack=dynlenonheap** enables the dynamic length variable allocation and general small stack transformations.
- To enable only the **dynlenonheap** transformations, specify **-qsmallstack=dynlenonheap -qnosmallstack** .
- When both **-qsmallstack** and **-qstacktemp** options are used, the **-qstacktemp** setting will be used to allocate applicable temporary variables if its value is non-zero, even if this setting conflicts with that of **-qsmallstack**. The **-qsmallstack** setting will continue to apply transformations not affected by **-qstacktemp**.

Related information

- "-qstacktemp option" on page 203

-qsmp option

Syntax

-qsmp[=*suboptions*]
-qnosmp

Indicates that code should be produced for an SMP system. The default is to produce code for a uniprocessor machine. When you specify this option, the compiler recognizes all directives with the trigger constants **SMP$**, **$OMP**, and **IBMP** (unless you specify the **omp** suboption).

Only the **xlf_r**, **xlf90_r**, and **xlf95_r** invocation commands automatically link in all of the thread-safe components. You can use the **-qsmp** option with the **xlf**, **xlf90**, **xlf95**, **f77**, and **fort77** invocation commands, but you are responsible for linking in the appropriate components. . If you use the **-qsmp** option to compile any source file in a program, then you must specify the **-qsmp** option at link time as well, unless you link by using the **ld** command.

Arguments

auto | **noauto**

This suboption controls automatic parallelization. By default, the compiler will attempt to parallelize explicitly coded **DO** loops as well as those that are generated by the compiler for array language. If you specify the suboption **noauto**, automatic parallelization is turned off, and only constructs that are marked with prescriptive directives are parallelized. If the compiler encounters the **omp** suboption and the **-qsmp** or **-qsmp=auto** suboptions are not explicitly specified on the command line, the **noauto** suboption is implied. Also, note that **-qsmp=noopt** implies **-qsmp=noauto**. No automatic parallelization occurs under **-qsmp=noopt**; only user-directed parallelization will occur.

nested_par | **nonested_par**

If you specify the **nested_par** suboption, the compiler parallelizes prescriptive nested parallel constructs (**PARALLEL DO**, **PARALLEL SECTIONS**). This includes not only the loop constructs that are nested within a scoping unit but also parallel constructs in subprograms that are referenced (directly or indirectly) from within other parallel constructs. By default, the compiler serializes a nested parallel construct. Note that this option has no effect on loops that are automatically parallelized. In this case, at most one loop in a loop nest (in a scoping unit) will be parallelized.

Note that the implementation of the **nested_par** suboption does not comply with the OpenMP API. If you specify this suboption, the run-time library uses the same threads for the nested **PARALLEL DO** and **PARALLEL SECTIONS** constructs that it used for the enclosing **PARALLEL** constructs.

omp | **noomp**

If you specify **-qsmp=omp**, the compiler enforces compliance with the OpenMP API. Specifying this option has the following effects:

- Automatic parallelization is turned off.
- All previously recognized directive triggers are ignored.

- The **-qcclines** compiler option is turned on if you specify **-qsmp=omp**.
- The **-qcclines** compiler option is not turned on if you specify **-qnocclines** and **-qsmp=omp**.
- The only recognized directive trigger is **$OMP**. However, you can specify additional triggers on subsequent **-qdirective** options.
- The compiler issues warning messages if your code contains any language constructs that do not conform to the OpenMP API.

Specifying this option when the C preprocessor is invoked also defines the **_OPENMP** C preprocessor macro automatically, with the value *200505*, which is useful in supporting conditional compilation. This macro is only defined when the C preprocessor is invoked.

See *Conditional Compilation* in the *Language Elements* section of the *XL Fortran Language Reference* for more information.

opt | **noopt**
If the **-qsmp=noopt** suboption is specified, the compiler will do the smallest amount of optimization that is required to parallelize the code. This is useful for debugging because **-qsmp** enables the **-O2** and **-qhot** options by default, which may result in the movement of some variables into registers that are inaccessible to the debugger. However, if the **-qsmp=noopt** and **-g** options are specified, these variables will remain visible to the debugger.

rec_locks | **norec_locks**
This suboption specifies whether recursive locks are used to avoid problems associated with **CRITICAL** constructs. If you specify the **rec_locks** suboption, a thread can enter a **CRITICAL** construct from within the dynamic extent of another **CRITICAL** construct that has the same name. If you specify **norec_locks**, a deadlock would occur in such a situation.

The default is **norec_locks**, or regular locks.

schedule=*option*
The **schedule** suboption can take any one of the following subsuboptions:

affinity[=*n***]**
The iterations of a loop are initially divided into *number_of_threads* partitions, containing **CEILING**(number_of_iterations / number_of_threads) iterations. Each partition is initially assigned to a thread and is then further subdivided into chunks that each contain *n* iterations. If *n* has not been specified, then the chunks consist of **CEILING**(number_of_iterations_left_in_partition / 2) loop iterations.

When a thread becomes free, it takes the next chunk from its initially assigned partition. If there are no more chunks in that partition, then the thread takes the next available chunk from a partition initially assigned to another thread.

The work in a partition initially assigned to a sleeping thread will be completed by threads that are active.

dynamic[=*n*]
The iterations of a loop are divided into chunks containing *n* iterations each. If *n* has not been specified, then the chunks consist of **CEILING**(number_of_iterations / number_of_threads) iterations.

Active threads are assigned these chunks on a "first-come, first-do" basis. Chunks of the remaining work are assigned to available threads until all work has been assigned.

If a thread is asleep, its assigned work will be taken over by an active thread once that thread becomes available.

guided[=*n*]
The iterations of a loop are divided into progressively smaller chunks until a minimum chunk size of *n* loop iterations is reached. If *n* has not been specified, the default value for *n* is 1 iteration.

The first chunk contains **CEILING**(number_of_iterations / number_of_threads) iterations. Subsequent chunks consist of **CEILING**(number_of_iterations_left / number_of_threads) iterations. Active threads are assigned chunks on a "first-come, first-do" basis.

runtime
Specifies that the chunking algorithm will be determined at run time.

static[=*n*]
The iterations of a loop are divided into chunks containing *n* iterations each. Each thread is assigned chunks in a "round-robin" fashion. This is known as *block cyclic scheduling*. If the value of *n* is 1, then the scheduling type is specifically referred to as *cyclic scheduling*.

If you have not specified *n*, the chunks will contain **CEILING**(number_of_iterations / number_of_threads) iterations. Each thread is assigned one of these chunks. This is known as *block scheduling*.

If a thread is asleep and it has been assigned work, it will be awakened so that it may complete its work.

For more information on chunking algorithms and **SCHEDULE**, refer to the *Directives* section in the *XL Fortran Language Reference*.

threshold=*n* Controls the amount of automatic loop parallelization that occurs. The value of *n* represents the lower limit allowed for parallelization of a loop, based on the level of "work" present in a loop. Currently, the calculation of "work" is weighted heavily by the number of iterations in the loop. In general, the higher the value specified for *n*, the fewer loops are parallelized. If this suboption is not specified, the program will use the default value *n*=100.

Rules

- If you specify **-qsmp** more than once, the previous settings of all suboptions are preserved, unless overridden by the subsequent suboption setting. The compiler does not override previous suboptions that you specify. The same is true for the version of **-qsmp** without suboptions; the default options are saved.

- Specifying the **omp** suboption always implies **noauto**. Specify **-qsmp=omp:auto** to apply automatic parallelization on OpenMP compliant applications, as well.
- Specifying the **noomp** suboption always implies **auto**.
- The **omp** and **noomp** suboptions only appear in the compiler listing if you explicitly set them.
- If **-qsmp** is specified without any suboptions, **-qsmp=opt** becomes the default setting. If **-qsmp** is specified after the **-qsmp=noopt** suboption has been set, the **-qsmp=noopt** setting will always be ignored.
- If the option **-qsmp** with no suboptions follows the suboption**-qsmp=noopt** on a command line, the **-qsmp=opt** and **-qsmp=auto** options are enabled.
- Specifying the **-qsmp=noopt** suboption implies **-qsmp=noauto**. It also implies **-qnoopt**. This option overrides performance options such as **-O2**, **-O3**, **-qhot**, anywhere on the command line unless **-qsmp** appears after **-qsmp=noopt**.
- Specifying **-qsmp** implies **-qhot** is in effect.
- Object files generated with the **-qsmp=opt** option can be linked with object files generated with **-qsmp=noopt**. The visibility within the debugger of the variables in each object file will not be affected by linking.

Restrictions

The **-qsmp=noopt** suboption may affect the performance of the program.

Within the same **-qsmp** specification, you cannot specify the **omp** suboption before or after certain suboptions. The compiler issues warning messages if you attempt to specify them with **omp**:

auto This suboption controls automatic parallelization, but **omp** turns off automatic parallelization.

nested_par
Note that the implementation of the **nested_par** suboption does not comply with the OpenMP API. If you specify this suboption, the run-time library uses the same threads for the nested **PARALLEL DO** and **PARALLEL SECTIONS** constructs that it used for the enclosing **PARALLEL** constructs.

rec_locks
This suboption specifies a behavior for **CRITICAL** constructs that is inconsistent with the OpenMP API.

schedule=affinity=*n*
The affinity scheduling type does not appear in the OpenMP API standard.

Examples

The **-qsmp=noopt** suboption overrides performance optimization options anywhere on the command line unless **-qsmp** appears after **-qsmp=noopt**. The following examples illustrate that all optimization options that appear after **-qsmp=noopt** are processed according to the normal rules of scope and precedence.

Example 1

```
     xlf90 -qsmp=noopt -O3...
is equivalent to
     xlf90 -qsmp=noopt...
```

Example 2

```
     xlf90 -qsmp=noopt -O3 -qsmp...
is equivalent to
     xlf90 -qsmp -O3...
```

Example 3

```
     xlf90 -qsmp=noopt -O3 -qhot -qsmp -O2...
is equivalent to
     xlf90 -qsmp -qhot -O2...
```

If you specify the following, the compiler recognizes both the **$OMP** and **SMP$** directive triggers and issues a warning if a directive specified with either trigger is not allowed in OpenMP.

```
-qsmp=omp -qdirective=SMP$
```

If you specify the following, the **noauto** suboption is used. The compiler issues a warning message and ignores the **auto** suboption.

```
-qsmp=omp:auto
```

In the following example, you should specify **-qsmp=rec_locks** to avoid a deadlock caused by **CRITICAL** constructs.

```
   program t
     integer  i, a, b

     a = 0
     b = 0
!smp$ parallel do
     do i=1, 10
!smp$ critical
     a = a + 1
!smp$ critical
     b = b + 1
!smp$ end critical
!smp$ end critical
     enddo
   end
```

Related information

If you use the **xlf**, **xlf_r**, **f77**, or **fort77** command with the **-qsmp** option to compile programs, specify **-qnosave** to make the default storage class automatic, and specify **-qthreaded** to tell the compiler to generate thread-safe code.

-qsource option

Syntax

-qsource | **-qnosource**
SOURCE | **NOSOURCE**

Determines whether to produce the source section of the listing.

This option displays on the terminal each source line where the compiler detects a problem, which can be very useful in diagnosing program errors in the Fortran source files.

You can selectively print parts of the source code by using **SOURCE** and **NOSOURCE** in **@PROCESS** directives in the source files around those portions of the program you want to print. This is the only situation where the **@PROCESS** directive does not have to be before the first statement of a compilation unit.

Examples

In the following example, the point at which the incorrect call is made is identified more clearly when the program is compiled with the **-qsource** option:

```
$ cat argument_mismatch.f
         subroutine mult(x,y)
         integer x,y
         print *,x*y
         end

         program wrong_args
         interface
                 subroutine mult(a,b)   ! Specify the interface for this
                         integer a,b    ! subroutine so that calls to it
                 end subroutine mult    ! can be checked.
         end interface
         real i,j
         i = 5.0
         j = 6.0
         call mult(i,j)
         end
$ xlf95 argument_mismatch.f
** mult   === End of Compilation 1 ===
"argument_mismatch.f", line 16.12: 1513-061 (S) Actual argument attributes
do not match those specified by an accessible explicit interface.
** wrong_args  === End of Compilation 2 ===
1501-511  Compilation failed for file argument_mismatch.f.
$ xlf95 -qsource argument_mismatch.f
** mult   === End of Compilation 1 ===
        16 |   call mult(i,j)
              ............a...
a - 1513-061 (S) Actual argument attributes do not match those specified by
an accessible explicit interface.
** wrong_args   === End of Compilation 2 ===
1501-511  Compilation failed for file argument_mismatch.f.
```

Related information

See “Options that control listings and messages” on page 49 and “Source section” on page 252.

-qspillsize option

Syntax

```
-qspillsize=bytes
SPILLSIZE(bytes)
```

-qspillsize is the long form of **-NS**. See "-NS option" on page 77.

-qstacktemp option

Syntax

```
-qstacktemp={0 | -1 | positive signed integer value}
STACKTEMP={0 | -1 | positive signed integer value}
```

Determines where to allocate applicable XL Fortran compiler temporaries at run time.

Applicable compiler temporaries are the set of temporary variables created by the compiler for its own use when it determines it can safely apply these. Most typically, the compiler creates these kinds of temporaries to hold copies of XL Fortran arrays for array language semantics, especially in conjunction with calls to intrinsic functions or user subprograms. If you have programs that make use of large arrays, you may need to use this option to help prevent stack space overflow when running them. For example, for SMP or OpenMP applications that are constrained by stack space, you can use this option to move some compiler temporaries onto the heap from the stack.

The compiler cannot detect whether or not the stack limits will be exceeded when an application runs. You will need to experiment with several settings before finding the one that works for your application. To override an existing setting, you must specify a new setting.

Note: The **-qstacktemp** option can take precedence over the **-qsmallstack** option for certain compiler-generated temporaries.

Arguments

The possible suboptions are:

0 Based on the target environment, the compiler determines whether it will allocate applicable temporaries on the heap or the stack. If this setting causes your program to run out of stack storage, try specifying a nonzero value instead, or try using the **-qsmallstack** option.

-1 Allocates applicable temporaries on the stack. Generally, this is the best performing setting but uses the most amount of stack storage.

positive signed integer value
Allocates applicable temporaries less than this *value* on the stack and those greater than or equal to this *value* on the heap. A value of 1 Mb has been shown to be a good compromise between stack storage and performance for many programs, but you may need to adjust this number based on your application's characteristics.

-qstrict option

Syntax

```
-qstrict | -qnostrict
STRICT | NOSTRICT
```

Ensures that optimizations done by default with the **-O3**, **-O4**, and **-O5** options, and optionally with the **-O2** option, do not alter the semantics of a program.

Defaults

For **-O3**, **-O4**, and **-O5**, the default is **-qnostrict**. For **-O2**, the default is **-qstrict**. This option is ignored for **-qnoopt**. With **-qnostrict**, optimizations may rearrange code so that results or exceptions are different from those of unoptimized programs.

This option is intended for situations where the changes in program execution in optimized programs produce different results from unoptimized programs. Such situations are likely rare because they involve relatively little-used rules for IEEE floating-point arithmetic.

Rules

With **-qnostrict** in effect, the following optimizations are turned on, unless **-qstrict** is also specified:

- Code that may cause an exception may be rearranged. The corresponding exception might happen at a different point in execution or might not occur at all. (The compiler still tries to minimize such situations.)
- Floating-point operations may not preserve the sign of a zero value. (To make certain that this sign is preserved, you also need to specify **-qfloat=rrm**, **-qfloat=nomaf**, or **-qfloat=strictnmaf**.)
- Floating-point expressions may be reassociated. For example, **(2.0*3.1)*4.2** might become **2.0*(3.1*4.2)** if that is faster, even though the result might not be identical.
- The **fltint** and **rsqrt** suboptions of the **-qfloat** option are turned on. You can turn them off again by also using the **-qstrict** option or the **nofltint** and **norsqrt** suboptions of **-qfloat**. With lower-level or no optimization specified, these suboptions are turned off by default.

Related information

See "-O option" on page 78, "-qhot option" on page 132, and "-qfloat option" on page 125.

-qstrictieeemod option

Syntax

-qstrictieeemod | -qnostrictieeemod
STRICTIEEEMOD | NOSTRICTIEEEMOD

Specifies whether the compiler will adhere to the Fortran 2003 IEEE arithmetic rules for the **ieee_arithmetic** and **ieee_exceptions** intrinsic modules. When you specify **-qstrictieeemod**, the compiler adheres to the following rules:

- If there is an exception flag set on entry into a procedure that uses the IEEE intrinsic modules, the flag is set on exit. If a flag is clear on entry into a procedure that uses the IEEE intrinsic modules, the flag can be set on exit.
- If there is an exception flag set on entry into a procedure that uses the IEEE intrinsic modules, the flag clears on entry into the procedure and resets when returning from the procedure.
- When returning from a procedure that uses the IEEE intrinsic modules, the settings for halting mode and rounding mode return to the values they had at procedure entry.
- Calls to procedures that do not use the **ieee_arithmetic** or **ieee_exceptions** intrinsic modules from procedures that do use these modules, will not change the floating-point status except by setting exception flags.

Since the above rules can impact performance, specifying **–qnostrictieeemod** will relax the rules on saving and restoring floating-point status. This prevents any associated impact on performance.

-qstrict_induction option

Syntax

-qSTRICT_INDUCtion | **-qNOSTRICT_INDUCtion**

Prevents the compiler from performing induction (loop counter) variable optimizations. These optimizations may be *unsafe* (may alter the semantics of your program) when there are integer overflow operations involving the induction variables.

You should avoid specifying **-qstrict_induction** unless absolutely necessary, as it may cause performance degradation.

Examples

Consider the following two examples:

Example 1

```
    integer(1) :: i, j                ! Variable i can hold a
    j = 0                             ! maximum value of 127.

    do i = 1, 200                     ! Integer overflow occurs when 128th
      j = j + 1                       ! iteration of loop is attempted.
    enddo
```

Example 2

```
    integer(1) :: i
    i = 1_1                           ! Variable i can hold a maximum
                                      ! value of 127.
100 continue
    if (i == -127) goto 200           ! Go to label 200 once decimal overflow
      i = i + 1_1                     ! occurs and i == -127.
      goto 100
200 continue
    print *, i
    end
```

If you compile these examples with the **-qstrict_induction** option, the compiler does not perform induction variable optimizations, but the performance of the code may be affected. If you compile the examples with the **-qnostrict_induction** option, the compiler may perform optimizations that may alter the semantics of the programs.

-qsuffix option

Syntax

```
-qsuffix=option=suffix
```

Specifies the source-file suffix on the command line instead of in the **xlf.cfg** file. This option saves time for the user by permitting files to be used as named with minimal makefile modifications and removes the risk of problems associated with modifying the **xlf.cfg** file. Only one setting is supported at any one time for any particular file type.

Arguments

f=*suffix*
: Where *suffix* represents the new *source-file-suffix*

o=*suffix*
: Where *suffix* represents the new *object-file-suffix*

s=*suffix*
: Where *suffix* represents the new *assembler-source-file-suffix*

cpp=*suffix*
: Where *suffix* represents the new *preprocessor-source-file-suffix*

Rules

- The new suffix setting is case-sensitive.
- The new suffix can be of any length.
- Any setting for a new suffix will override the corresponding default setting in the **xlf.cfg** file.
- If both **-qsuffix** and **-F** are specified, **-qsuffix** is processed last, so its setting will override the setting in the **xlf.cfg** file.

Examples

For instance,

```
xlf a1.f2k a2.F2K -qsuffix=f=f2k:cpp=F2K
```

will cause these effects:

- The compiler is invoked for source files with a suffix of .f2k and .F2K.
- cpp is invoked for files with a suffix of .F2K.

-qsuppress option

Syntax

```
-qsuppress[=nnnn-mmm[:nnnn-mmm ...] | cmpmsg]
-qnosuppress
```

Arguments

nnnn-mmm[:nnnn-mmm ...]
: Suppresses the display of a specific compiler message (*nnnn-mmm*) or a list of messages (*nnnn-mmm[:nnnn-mmm ...]*). *nnnn-mmm* is the message number. To suppress a list of messages, separate each message number with a colon.

cmpmsg
: Suppresses the informational messages that report compilation progress and a successful completion.

  This sub-option has no effect on any error messages that are emitted.

Background information

In some situations, users may receive an overwhelming number of compiler messages. In many cases, these compiler messages contain important information. However, some messages contain information that is either redundant or can be safely ignored. When multiple error or warning messages appear during compilation, it can be very difficult to distinguish which messages should be noted. By using **-qsuppress**, you can eliminate messages that do not interest you.

- The compiler tracks the message numbers specified with **-qsuppress**. If the compiler subsequently generates one of those messages, it will not be displayed or entered into the listing.
- Only compiler and driver messages can be suppressed. Linker or operating system message numbers will be ignored if specified on the **-qextname** compiler option.
- If you are also specifying the **-qipa** compiler option, then **-qipa** must appear before the **-qextname** compiler option on the command line for IPA messages to be suppressed.

Restrictions

- The value of *nnnn* must be a four-digit integer between 1500 and 1585, since this is the range of XL Fortran message numbers.
- The value of *mmm* must be any three-digit integer (with leading zeros if necessary).

Examples

```
@process nullterm
      i = 1; j = 2;
      call printf("i=%d\n",%val(i));
      call printf("i=%d, j=%d\n",%val(i),%val(j));
      end
```

Compiling this sample program would normally result in the following output:

```
"t.f", line 4.36: 1513-029 (W) The number of arguments to "printf" differ
from the number of arguments in a previous reference.  You should use the
OPTIONAL attribute and an explicit interface to define a procedure with
optional arguments.
** _main   === End of Compilation 1 ===
1501-510  Compilation successful for file t.f.
```

When the program is compiled with **-qsuppress=1513-029**, the output is:

```
** _main   === End of Compilation 1 ===
1501-510   Compilation successful for file t.f.
```

Related information

For another type of message suppression, see "-qflag option" on page 124.

-qswapomp option

Syntax

-qswapomp | -qnoswapomp
SWAPOMP | NOSWAPOMP

Specifies that the compiler should recognize and substitute OpenMP routines in XL Fortran programs.

The OpenMP routines for Fortran and C have different interfaces. To support multi-language applications that use OpenMP routines, the compiler needs to recognize OpenMP routine names and substitute them with the XL Fortran versions of these routines, regardless of the existence of other implementations of such routines.

The compiler does not perform substitution of OpenMP routines when you specify the **-qnoswapomp** option.

Restrictions

The **-qswapomp** and **-qnoswapomp** options only affect Fortran sub-programs that reference OpenMP routines that exist in the program.

Rules

- If a call to an OpenMP routine resolves to a dummy procedure, module procedure, an internal procedure, a direct invocation of a procedure itself, or a statement function, the compiler will not perform the substitution.
- When you specify an OpenMP routine, the compiler substitutes the call to a different special routine depending upon the setting of the **-qintsize** option. In this manner, OpenMP routines are treated as generic intrinsic procedures.
- Unlike generic intrinsic procedures, if you specify an OpenMP routine in an **EXTERNAL** statement, the compiler will not treat the name as a user-defined external procedure. Instead, the compiler will still substitute the call to a special routine depending upon the setting of the **-qintsize** option.
- An OpenMP routine cannot be extended or redefined, unlike generic intrinsic procedures.

Examples

In the following example, the OpenMP routines are declared in an **INTERFACE** statement.

```
@PROCESS SWAPOMP

        INTERFACE
           FUNCTION OMP_GET_THREAD_NUM()
               INTEGER OMP_GET_THREAD_NUM
           END FUNCTION OMP_GET_THREAD_NUM

           FUNCTION OMP_GET_NUM_THREADS()
               INTEGER OMP_GET_NUM_THREADS
           END FUNCTION OMP_GET_NUM_THREADS
        END INTERFACE

        IAM = OMP_GET_THREAD_NUM()
        NP = OMP_GET_NUM_THREADS()
        PRINT *, IAM, NP
        END
```

Related information

See the *OpenMP Execution Environment Routines and Lock Routines* section in the *XL Fortran Language Reference*.

-qtbtable option

Syntax

```
-qtbtable={none | small | full}
```

Note: Applies to the 64–bit environment only.

Limits the amount of debugging traceback information in object files, which reduces the size of the program.

You can use this option to make your program smaller, at the cost of making it harder to debug. When you reach the production stage and want to produce a program that is as compact as possible, you can specify **-qtbtable=none**. Otherwise, the usual defaults apply: code compiled with **-g** or without **-O** has full traceback information (**-qtbtable=full**), and code compiled with **-O** contains less (**-qtbtable=small**).

Arguments

none The object code contains no traceback information at all. You cannot debug the program, because a debugger or other code-examination tool cannot unwind the program's stack at run time. If the program stops because of a run-time exception, it does not explain where the exception occurred.

small The object code contains traceback information but not the names of procedures or information about procedure parameters. You can debug the program, but some non-essential information is unavailable to the debugger. If the program stops because of a run-time exception, it explains where the exception occurred but reports machine addresses rather than procedure names.

full The object code contains full traceback information. The program is debuggable, and if it stops because of a run-time exception, it produces a traceback listing that includes the names of all procedures in the call chain.

Background information

This option is most suitable for programs that contain many long procedure names, such as the internal names constructed for module procedures. You may find it more applicable to C++ programs than to Fortran programs.

Related information

- "-g option" on page 72
- "-qcompact option" on page 105
- "-O option" on page 78
- *Debugging optimized code* in the *XL Fortran Optimization and Programming Guide*

-qthreaded option

Syntax

```
-qthreaded
```

Used by the compiler to determine when it must generate thread-safe code.

The **-qthreaded** option does not imply the **-qnosave** option. The **-qnosave** option specifies a default storage class of automatic for user local variables. In general, both of these options need to be used to generate thread-safe code. Specifying these options ensures that variables and code created by the compiler are threadsafe; it does not guarantee the thread safety of user-written code. If you use the **ENTRY** statement to have an alternate entry point for a subprogram and the **xlf_r** command to compile, also specify the **-qxlf77=nopersistent** option to be thread-safe. You should implement the appropriate locking mechanisms, as well.

Defaults

-qthreaded is the default for the **xlf90_r**, **xlf95_r**, and **xlf_r** commands.

Specifying the **-qthreaded** option implies **-qdirective=ibmt**, and by default, the *trigger_constant* **IBMT** is recognized.

-qtune option

Syntax

-qtune=*implementation*

Tunes instruction selection, scheduling, and other implementation-dependent performance enhancements for a specific implementation of a hardware architecture. The compiler will use a **-qtune** setting that is compatible with the target architecture, which is controlled by the **-qarch**, **-q32**, and **-q64** options.

If you want your program to run on more than one architecture, but to be tuned to a particular architecture, you can use a combination of the **-qarch** and **-qtune** options. These options are primarily of benefit for floating-point intensive programs.

By arranging (scheduling) the generated machine instructions to take maximum advantage of hardware features such as cache size and pipelining, **-qtune** can improve performance. It only has an effect when used in combination with options that enable optimization.

Although changing the **-qtune** setting may affect the performance of the resulting executable, it has no effect on whether the executable can be executed correctly on a particular hardware platform.

Arguments

The choices are:

auto Automatically detects the specific processor type of the compiling machine. It assumes that the execution environment will be the same as the compilation environment.

rs64b The optimizations are tuned for the RS64II processor.

rs64c The optimizations are tuned for the RS64III processor.

pwr3 The optimizations are tuned for the POWER3 processors.

pwr4 The optimizations are tuned for the POWER4 processors.

pwr5 The optimizations are tuned for the POWER5 processors.

ppc970 The optimizations are tuned for the PowerPC 970 processors.

If you do not specify **-qtune**, its setting is determined by the setting of the **-qarch** option, as follows:

-qarch Setting	**Allowed -qtune Settings**	**Default -qtune Setting**
ppc	See the list of acceptable **-qtune** settings under the **-qarch=ppc64** entry.	pwr4
ppcgr	See the list of acceptable **-qtune** settings under the **-qarch=ppc64gr** entry.	pwr4
ppc64	rs64b, rs64c, pwr3, pwr4, pwr5, ppc970, auto	pwr4
ppc64gr	rs64b, rs64c, pwr3, pwr4, pwr5, ppc970, auto	pwr4
ppc64grsq	rs64b, rs64c, pwr3, pwr4, pwr5, ppc970, auto	pwr4

-qarch Setting	Allowed -qtune Settings	Default -qtune Setting
rs64b	rs64b, auto	rs64b
rs64c	rs64c, auto	rs64c
pwr3	pwr3, pwr4, pwr5, ppc970, auto	pwr3
pwr4	pwr4, pwr5, ppc970, auto	pwr4
pwr5	pwr5, auto	pwr5
pwr5x	pwr5, auto	pwr5
ppc970	ppc970, auto	ppc970

Note that you can specify any **-qtune** suboption with **-qarch=auto** as long as you are compiling on a machine that is compatible with the **-qtune** suboption. For example, if you specify **-qarch=auto** and **-qtune=pwr5**, you must compile on a POWER3, POWER4, or POWER5 machine.

Related information

- "Compiling for specific architectures" on page 23
- "-qarch option" on page 91
- "-qcache option" on page 100

-qundef option

Syntax

-qundef | **-qnoundef**
UNDEF | **NOUNDEF**

-qundef is the long form of the "-u option" on page 234.

-qunroll option

Syntax

-qunroll[=**auto** | yes] | -qnounroll

Specifies whether unrolling **DO** loops is allowed in a program. Unrolling is allowed on outer and inner **DO** loops.

Arguments

auto The compiler performs basic loop unrolling. This is the default if **-qunroll** is not specified on the command line.

yes The compiler looks for more opportunities to perform loop unrolling than that performed with **-qunroll=auto**. Specifying **-qunroll** with no suboptions is equivalent to **-qunroll=yes**. In general, this suboption has more chances to increase compile time or program size than **-qunroll=auto** processing, but it may also improve your application's performance.

If you decide to unroll a loop, specifying one of the above suboptions does not automatically guarantee that the compiler will perform the operation. Based on the performance benefit, the compiler will determine whether unrolling will be beneficial to the program. Experienced compiler users should be able to determine the benefit in advance.

Rules

The **-qnounroll** option prohibits unrolling unless you specify the **STREAM_UNROLL**, **UNROLL**, or **UNROLL_AND_FUSE** directive for a particular loop. These directives always override the command line options.

Examples

In the following example, the **UNROLL(2)** directive is used to tell the compiler that the body of the loop can be replicated so that the work of two iterations is performed in a single iteration. Instead of performing 1000 iterations, if the compiler unrolls the loop, it will only perform 500 iterations.

```
!IBM* UNROLL(2)
      DO I = 1, 1000
         A(I) = I
      END DO
```

If the compiler chooses to unroll the previous loop, the compiler translates the loop so that it is essentially equivalent to the following:

```
      DO I = 1, 1000, 2
         A(I) = I
         A(I+1) = I + 1
      END DO
```

Related information

See the appropriate directive on unrolling loops in the *XL Fortran Language Reference*:

- **STREAM_UNROLL**
- **UNROLL**
- **UNROLL_AND_FUSE**

See *Benefits of High Order Transformation* in the *XL Fortran Optimization and Programming Guide*.

-qunwind option

Syntax

```
-qunwind |-qnounwind
 UNWIND | NOUNWIND
```

Specifies that the compiler will preserve the default behavior for saves and restores to volatile registers during a procedure call. If you specify **-qnounwind**, the compiler rearranges subprograms to minimize saves and restores to volatile registers. This rearrangement may make it impossible for the program or debuggers to walk through or ″unwind″ subprogram stack frame chains.

While code semantics are preserved, applications such as exception handlers that rely on the default behavior for saves and restores can produce undefined results. When using **-qnounwind** in conjunction with the **-g** compiler option, debug information regarding exception handling when unwinding the program's stack can be inaccurate.

-qversion option

Syntax

`-qversion | -qnoversion`

Displays the version and release of the compiler being invoked.

Specify this option on its own with the compiler command. For example:
`xlf90 -qversion`

-qwarn64 option

Syntax

-qwarn64 | **-qnowarn64**

Aids in porting code from a 32-bit environment to a 64-bit environment by detecting the truncation of an 8-byte integer pointer to 4 bytes. The **-qwarn64** option uses informational messages to identify statements that may cause problems with the 32-bit to 64-bit migration.

Rules

- The default setting is **-qnowarn64**.
- You can use the **-qwarn64** option in both 32-bit and 64-bit modes.
- The compiler flags the following situations with informational messages:
  - The assignment of a reference to the **LOC** intrinsic to an **INTEGER(4)** variable.
  - The assignment between an **INTEGER(4)** variable or **INTEGER(4)** constant and an integer pointer.
  - The specification of an integer pointer within a common block.
  - The specification of an integer pointer within an equivalence statement.

Related information

- "-q32 option" on page 83
- "-q64 option" on page 84
- Chapter 6, "Using XL Fortran in a 64-Bit Environment," on page 241

-qxflag=dvz option

Syntax

```
-qxflag=dvz
```

Specifying **-qxflag=dvz** causes the compiler to generate code to detect floating-point divide-by-zero operations.

This option is only effective when you specify an optimization level of **-O** or higher.

With this option on, the extra code calls the external handler function **__xl_dzx** when the divisor is zero. The return value of this function is used as the result of the division. Users are required to provide the function to handle the divide-by-zero operations. Specifying **-qxflag=dvz** handles only single-precision (REAL*4) and double-precision (REAL*8) division.

The interface of the function is as follows:

```
real(8) function __xl_dzx(x, y, kind_type)
  real(8), value :: x, y
  integer, value :: kind_type
end function
```

where:

x is the dividend value

y is the divisor value

kind_type
specifies the size of the actual arguments associated with **x** and **y**.

A **kind_type** value equal to zero indicates that the actual arguments associated with x and y are of type REAL(8). A **kind_type** value equal to one indicates that the actual arguments associated with x and y are of type REAL(4).

The division always executes before the handler routine is called. This means that any exception is posted and handled before the handler function is called.

Related information

- *Implementation details of XL Fortran floating-point processing* in the *XL Fortran Optimization and Programming Guide*
- "-qflttrap option" on page 127
- "Understanding XL Fortran error messages" on page 243

-qxflag=oldtab option

Syntax

```
-qxflag=oldtab
XFLAG(OLDTAB)
```

Interprets a tab in columns 1 to 5 as a single character (for fixed source form programs).

Defaults

By default, the compiler allows 66 significant characters on a source line after column 6. A tab in columns 1 through 5 is interpreted as the appropriate number of blanks to move the column counter past column 6. This default is convenient for those who follow the earlier Fortran practice of including line numbers or other data in columns 73 through 80.

Rules

If you specify the option **-qxflag=oldtab**, the source statement still starts immediately after the tab, but the tab character is treated as a single character for counting columns. This setting allows up to 71 characters of input, depending on where the tab character occurs.

-qxlf77 option

Syntax

```
-qxlf77=settings
XLF77(settings)
```

Provides compatibility with FORTRAN 77 aspects of language semantics and I/O data format that have changed. Most of these changes are required by the Fortran 90 standard.

Defaults

By default, the compiler uses settings that apply to Fortran 95, Fortran 90, and the most recent compiler version in all cases; the default suboptions are **blankpad**, **nogedit77**, **nointarg**, **nointxor**, **leadzero**, **nooldboz**, **nopersistent**, and **nosofteof**. However, these defaults are only used by the **xlf95**, **xlf95_r**, **xlf90**, **xlf90_r**, **f90**, and **f95** commands, which you should use to compile new programs.

If you only want to compile and run old programs unchanged, you can continue to use the appropriate invocation command and not concern yourself with this option. You should only use this option if you are using existing source or data files with Fortran 90 or Fortran 95 and the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, or **f95** command and find some incompatibility because of behavior or data format that has changed. Eventually, you should be able to recreate the data files or modify the source files to remove the dependency on the old behavior.

Arguments

To get various aspects of XL Fortran Version 2 behavior, select the nondefault choice for one or more of the following suboptions. The descriptions explain what happens when you specify the nondefault choices.

blankpad | **noblankpad**
: For internal, direct-access, and stream-access files, uses a default setting equivalent to **pad='no'**. This setting produces conversion errors when reading from such a file if the format requires more characters than the record has. This suboption does not affect direct-access or stream-access files opened with a **pad=** specifier.

gedit77 | **nogedit77**
: Uses FORTRAN 77 semantics for the output of **REAL** objects with the **G** edit descriptor. Between FORTRAN 77 and Fortran 90, the representation of 0 for a list item in a formatted output statement changed, as did the rounding method, leading to different output for some combinations of values and **G** edit descriptors.

intarg | **nointarg**
: Converts all integer arguments of an intrinsic procedure to the kind of the longest argument if they are of different kinds. Under Fortran 90/95 rules, some intrinsics (for example, **IBSET**) determine the result type based on the kind of the first argument; others (for example, **MIN** and **MAX**) require that all arguments be of the same kind.

intxor | nointxor
Treats **.XOR.** as a logical binary intrinsic operator. It has a precedence equivalent to the **.EQV.** and **.NEQV.** operators and can be extended with an operator interface. (Because the semantics of **.XOR.** are identical to those of **.NEQV.**, **.XOR.** does not appear in the Fortran 90 or Fortran 95 language standard.)

Otherwise, the **.XOR.** operator is only recognized as a defined operator. The intrinsic operation is not accessible, and the precedence depends on whether the operator is used in a unary or binary context.

leadzero | noleadzero
Produces a leading zero in real output under the **D**, **E**, **L**, **F**, and **Q** edit descriptors.

oldboz | nooldboz
Turns blanks into zeros for data read by **B**, **O**, and **Z** edit descriptors, regardless of the **BLANK=** specifier or any **BN** or **BZ** control edit descriptors. It also preserves leading zeros and truncation of too-long output, which is not part of the Fortran 90 or Fortran 95 standard.

persistent | nopersistent
Saves the addresses of arguments to subprograms with **ENTRY** statements in static storage. This is an implementation choice that has been changed for increased performance.

softeof | nosofteof
Allows **READ** and **WRITE** operations when a unit is positioned after its endfile record unless that position is the result of executing an **ENDFILE** statement. This suboption reproduces a FORTRAN 77 extension of earlier versions of XL Fortran that some existing programs rely on.

-qxlf90 option

Syntax

```
-qxlf90={settings}
XLF90({settings})
```

Provides compatibility with the Fortran 90 standard for certain aspects of the Fortran language.

Defaults

The default suboptions for **-qxlf90** depend on the invocation command that you specify. For the **f95**, **xlf95** or **xlf95_r** command, the default suboptions are **signedzero** and **autodealloc**. For all other invocation commands, the defaults are **nosignedzero** and **noautodealloc**.

Arguments

signedzero | **nosignedzero**

Determines how the **SIGN(A,B)** function handles signed real 0.0.If you specify the **-qxlf90=signedzero** compiler option, **SIGN(A,B)** returns -|A| when B=-0.0. This behavior conforms to the Fortran 95 standard and is consistent with the IEEE standard for binary floating-point arithmetic. Note that for the **REAL(16)** data type, XL Fortran never treats zero as negative zero.

This suboption also determines whether a minus sign is printed in the following cases:

- For a negative zero in formatted output. Again, note that for the **REAL(16)** data type, XL Fortran never treats zero as negative zero.
- For negative values that have an output form of zero (that is, where trailing non-zero digits are truncated from the output so that the resulting output looks like zero). Note that in this case, the **signedzero** suboption does affect the **REAL(16)** data type; non-zero negative values that have an output form of zero will be printed with a minus sign.

autodealloc | **noautodealloc**

Determines whether the compiler deallocates allocatable objects that are declared locally without either the **SAVE** or the **STATIC** attribute and have a status of currently allocated when the subprogram terminates. This behavior conforms with the Fortran 95 standard. If you are certain that you are deallocating all local allocatable objects explicitly, you may wish to turn off this suboption to avoid possible performance degradation.

Examples

Consider the following program:

```
PROGRAM TESTSIGN
REAL X, Y, Z
X=1.0
Y=-0.0
Z=SIGN(X,Y)
PRINT *,Z
END PROGRAM TESTSIGN
```

The output from this example depends on the invocation command and the **-qxlf90** suboption that you specify. For example:

Invocation Command/xlf90 Suboption	Output
xlf95	-1.0
xlf95 -qxlf90=signedzero	-1.0
xlf95 -qxlf90=nosignedzero	1.0
xlf90	1.0
xlf	1.0

Related information

See the **SIGN** information in the *Intrinsic Procedures* section and the *Arrays Concepts* section of the *XL Fortran Language Reference*.

-qxlines option

Syntax

```
-qxlines | -qnoxlines
XLINES |  NOXLINES
```

Specifies whether fixed source form lines with a X in column 1 are compiled or treated as comments. This option is similar to the recognition of the character 'd' in column 1 as a conditional compilation (debug) character. The **-D** option recognizes the character 'x' in column 1 as a conditional compilation character when this compiler option is enabled. The 'x' in column 1 is interpreted as a blank, and the line is handled as source code.

Defaults

This option is set to **-qnoxlines** by default, and lines with the character 'x' in column 1 in fixed source form are treated as comment lines. While the **-qxlines** option is independent of **-D**, all rules for debug lines that apply to using 'd' as the conditional compilation character also apply to the conditional compilation character 'x'. The **-qxlines** compiler option is only applicable to fixed source form.

The conditional compilation characters 'x' and 'd' may be mixed both within a fixed source form program and within a continued source line. If a conditional compilation line is continued onto the next line, all the continuation lines must have 'x' or 'd' in column 1. If the initial line of a continued compilation statement is not a debugging line that begins with either 'x' or 'd' in column 1, subsequent continuation lines may be designated as debug lines as long as the statement is syntactically correct.

The OMP conditional compilation characters '!$', 'C$', and '*$' may be mixed with the conditional characters 'x' and 'd' both in fixed source form and within a continued source line. The rules for OMP conditional characters will still apply in this instance.

Examples

An example of a base case of -qxlines:

```
      C2345678901234567890
             program p
             i=3 ; j=4 ; k=5
      X      print *,i,j
      X    +        ,k
             end program p

     <output>: 3 4 5     (if -qxlines is on)
               no output (if -qxlines is off)
```

In this example, conditional compilation characters 'x' and 'd' are mixed, with 'x' on the initial line:

```
C2345678901234567890
       program p
       i=3 ; j=4 ; k=5
X      print *,i,
D    +         j,
X    +         k
       end program p

<output>: 3 4 5 (if both -qxlines and -qdlines are on)
          3 5   (if only -qxlines is turned on)
```

Here, conditional compilation characters 'x' and 'd' are mixed, with 'd' on the initial line:

```
C2345678901234567890
       program p
       i=3 ; j=4 ; k=5
D      print *,i,
X    +         j,
D    +         k
       end program p

<output>: 3 4 5 (if both -qxlines and -qdlines are on)
          3 5   (if only -qdlines is turned on)
```

In this example, the initial line is not a debug line, but the continuation line is interpreted as such, since it has an 'x' in column 1:

```
C2345678901234567890
       program p
       i=3 ; j=4 ; k=5
       print *,i
X    +        ,j
X    +        ,k
       end program p

<output>: 3 4 5 (if -qxlines is on)
          3     (if -qxlines is off)
```

Related information

See "-D option" on page 69 and *Conditional Compilation* in the *Language Elements* section of the *XL Fortran Language Reference*.

-qxref option

Syntax

```
-qxref[=full] | -qnoxref
XREF[(FULL)] | NOXREF
```

Determines whether to produce the cross-reference component of the attribute and cross-reference section of the listing.

If you specify only **-qxref**, only identifiers that are used are reported. If you specify **-qxref=full**, the listing contains information about all identifiers that appear in the program, whether they are used or not.

If **-qxref** is specified after **-qxref=full**, the full cross-reference listing is still produced.

You can use the cross-reference listing during debugging to locate problems such as using a variable before defining it or entering the wrong name for a variable.

Related information

See "Options that control listings and messages" on page 49 and "Attribute and cross-reference section" on page 254.

-qzerosize option

Syntax

-qzerosize | -qnozerosize
ZEROSIZE | NOZEROSIZE

Improves performance of FORTRAN 77 and some Fortran 90 and Fortran 95 programs by preventing checking for zero-sized character strings and arrays.

For Fortran 90 and Fortran 95 programs that might process such objects, use **-qzerosize**. For FORTRAN 77 programs, where zero-sized objects are not allowed, or for Fortran 90 and Fortran 95 programs that do not use them, compiling with **-qnozerosize** can improve the performance of some array or character-string operations.

Defaults

The default setting depends on which command invokes the compiler: **-qzerosize** for the **xlf90**, **xlf90_r**, **xlf95**, **xlf95_r**, **f90**, and **f95** commands and **-qnozerosize** for the **xlf**, **xlf_r**, and **f77**/**fort77** commands (for compatibility with FORTRAN 77).

Rules

Run-time checking performed by the **-C** option takes slightly longer when **-qzerosize** is in effect.

-S option

Syntax

```
-S
```

Produces one or more **.s** files that show equivalent assembler source for each Fortran source file.

Rules

When this option is specified, the compiler produces the assembler source files as output instead of an object or an executable file.

Restrictions

The generated assembler files do not include all the data that is included in a **.o** file by **-qipa** or **-g**.

Examples

```
xlf95 -O3 -qhot -S test.f               # Produces test.s
```

Related information

The "-o option" on page 80 can be used to specify a name for the resulting assembler source file.

For information about the assembler-language format, see the *Assembler Language Reference*.

-t option

Syntax

-tcomponents

Applies the prefix specified by the **-B** option to the designated components. *components* can be one or more of **a**, **F**, **c**, **h**, **I**, **b**, **z**, **l**, or **d** with no separators, corresponding to the assembler, the C preprocessor, the compiler, the array language optimizer, the interprocedural analysis (IPA) tool/loop optimizer, the code generator, the binder, the linker, and the **-S** disassembler, respectively.

Rules

If **-t** is not specified, any **-B** prefix is applied to all components.

Component	-t Mnemonic	Standard Program Name
assembler	a	as
C preprocessor	F	cpp
compiler front end	c	xlfentry
array language optimizer	h	xlfhot
IPA/loop optimizer	I	ipa
code generator	b	xlfcode
binder	z	bolt
linker	l	ld
disassembler	d	dis

Related information

See “-B option” on page 66 (which includes an example).

-U option

Syntax

```
-U
MIXED | NOMIXED
```

Makes the compiler sensitive to the case of letters in names.

You can use this option when writing mixed-language programs, because Fortran names are all lowercase by default, while names in C and other languages may be mixed-case.

Rules

If **-U** is specified, case is significant in names. For example, the names `Abc` and `ABC` refer to different objects.

The option changes the link names used to resolve calls between compilation units. It also affects the names of modules and thus the names of their **.mod** files.

Defaults

By default, the compiler interprets all names as if they were in lowercase. For example, `Abc` and `ABC` are both interpreted as `abc` and so refer to the same object.

Restrictions

The names of intrinsics must be all in lowercase when **-U** is in effect. Otherwise, the compiler may accept the names without errors, but the compiler considers them to be the names of external procedures, rather than intrinsics.

Related information

This is the short form of **-qmixed**. See "-qmixed option" on page 162.

-u option

Syntax

```
-u
UNDEF | NOUNDEF
```

Specifies that no implicit typing of variable names is permitted. It has the same effect as using the **IMPLICIT NONE** statement in each scope that allows implicit statements.

Defaults

By default, implicit typing is allowed.

Related information

See **IMPLICIT** in the *XL Fortran Language Reference*.

This is the short form of **-qundef**. See "-qundef option" on page 216.

-v option

Syntax

```
-v
```

Generates information on the progress of the compilation.

Rules

As the compiler executes commands to perform different compilation steps, this option displays a simulation of the commands it calls and the system argument lists it passes.

For a particular compilation, examining the output that this option produces can help you determine:

- What files are involved
- What options are in effect for each step
- How far a compilation gets when it fails

Related information

"-# option" on page 64 is similar to **-v**, but it does not actually execute any of the compilation steps.

-V option

Syntax

```
-V
```

This option is the same as **-v** except that you can cut and paste directly from the display to create a command.

-W option

Syntax

-Wcomponent,options

Passes the listed options to a component that is executed during compilation. *component* is one of **a**, **F**, **c**, **h**, **I**, **b**, **z**, **l**, or **d**, corresponding to the assembler, the C preprocessor, the compiler, the array language optimizer, the interprocedural analysis (IPA) tool/loop optimizer, the code generator, the binder, the linker, and the **-S** disassembler, respectively.

Component	-W Mnemonic	Standard Program Name
assembler	a	as
C preprocessor	F	cpp
compiler front end	c	xlfentry
array language optimizer	h	xlfhot
IPA/loop optimizer	I	ipa
code generator	b	xlfcode
binder	z	bolt
linker	l	ld
disassembler	d	dis

In the string following the **-W** option, use a comma as the separator for each option, and do not include any spaces. For example:

```
-Wcomponent,option_1[,option_2,...,option_n]
```

Background information

The primary purpose of this option is to construct sequences of compiler options to pass to one of the optimizing preprocessors. It can also be used to fine-tune the link-edit step by passing parameters to the **ld** command.

Defaults

You do not need the **-W** option to pass most options to the linker: unrecognized command-line options, except **-q** options, are passed to it automatically. Only linker options with the same letters as compiler options, such as **-v** or **-S**, strictly require **-W** (or the **ldopts** stanza in the configuration file).

If you need to include a character that is special to the shell in the option string, precede the character with a backslash.

Examples

See "Passing command-line options to the ″ld″ or ″as″ commands" on page 22.

You can use \, to embed a literal comma in the string supplied to the **-W** option.

In the following example, the \, embeds a literal comma in the **-WF** string and causes three arguments, rather than four, to be supplied to the C preprocessor.

```
$ xlf -qfree=f90  '-WF,-Dint1=1,-Dint2=2,-Dlist=3\,4'  a.F
$ cat a.F
print *, int1
print *, int2
print *, list
end
```

The output from the program will be:

```
$ ./a.out
 1
 2
 3 4
```

-w option

Syntax

```
-w
```

A synonym for the "-qflag option" on page 124. It sets **-qflag=e:e**, suppressing warning and informational messages and also messages generated by language-level checking.

-y option

Syntax

```
-y{n | m | p | z}
IEEE(Near | Minus | Plus | Zero)
```

Specifies the rounding mode for the compiler to use when evaluating constant floating-point expressions at compile time. It is equivalent to the **-qieee** option.

Arguments

n Round to nearest.

m Round toward minus infinity.

p Round toward plus infinity.

z Round toward zero.

Related information

See "-O option" on page 78 and "-qfloat option" on page 125.

-y is the short form of "-qieee option" on page 135.

Chapter 6. Using XL Fortran in a 64-Bit Environment

The 64-bit environment addresses an increasing demand for larger storage requirements and greater processing power. The Linux operating system provides an environment that allows you to develop and execute programs that exploit 64-bit processors through the use of 64-bit address space and 64-bit integers.

To support larger executables that can be fit within a 64-bit address space, a separate, 64-bit object form is used to meet the requirements of 64-bit executables. The linker binds 64-bit objects to create 64-bit executables. Note that objects that are bound together must all be of the same object format. The following scenarios are not permitted and will fail to load, or execute, or both:

- A 64-bit object or executable that has references to symbols from a 32-bit library or shared library
- A 32-bit object or executable that has references to symbols from a 64-bit library or shared library
- A 64-bit executable that attempts to explicitly load a 32-bit module
- A 32-bit executable that attempts to explicitly load a 64-bit module
- Attempts to run 64-bit applications on 32-bit platforms

On both 64-bit and 32-bit platforms, 32-bit executables will continue to run as they currently do on a 32-bit platform. On 32-bit platforms, 64-bit executables can be generated by specifying the **-q64** option.

The XL Fortran compiler mainly provides 64-bit mode support through the compiler option **-q64** in conjunction with the compiler option **-qarch**. This combination determines the bit mode and instruction set for the target architecture. The **-q32** and **-q64** options take precedence over the setting of the **-qarch** option. The **-q64** option will win over a 32-bit mode only **-qarch** setting, and the compiler will upgrade the **-qarch** setting to something that will handle 64-bit mode. Conflicts between the **-q32** and **-q64** options are resolved by the "last option wins" rule. Setting **-qarch=com** will ensure future compatibility for applications in 32–bit mode. For 64-bit mode applications, use **-qarch=ppc64** to achieve the same effect for all present or future supported 64-bit mode systems. **-qarch** settings that target a specific architecture, like the **rs64b**, **rs64c**, **pwr3**, **pwr4**, **pwr5**, **pwr5x**, **ppc970**, and **auto** settings will be more system-dependent.

Compiler options for the 64-Bit environment

The **-q32**, **-q64**, and **-qwarn64** compiler options are primarily for developers who are targetting 64-bit platforms. They enable you to do the following:

- Develop applications for the 64-bit environment
- Help migrate source code from the 32-bit environment to a 64-bit environment

Chapter 7. Problem determination and debugging

This section describes some methods you can use for locating and fixing problems in compiling or executing your programs.

Understanding XL Fortran error messages

Most information about potential or actual problems comes through messages from the compiler or application program. These messages are written to the standard error output stream.

Error severity

Compilation errors can have the following severity levels, which are displayed as part of some error messages:

U An unrecoverable error. Compilation failed because of an internal compiler error.

S A severe error. Compilation failed due to one of the following:
- An unrecoverable program error has been detected. Processing of the source file stops, and XL Fortran does not produce an object file. You can usually correct this error by fixing any program errors that were reported during compilation.
- Conditions exist that the compiler could not correct. An object file is produced; however, you should not attempt to run the program.
- An internal compiler table has overflowed. Processing of the program stops, and XL Fortran does not produce an object file.
- An include file does not exist. Processing of the program stops, and XL Fortran does not produce an object file.

E An error that the compiler can correct. The program should run correctly.

W Warning message. It does not signify an error but may indicate some unexpected condition.

L Warning message that was generated by one of the compiler options that check for conformance to various language levels. It may indicate a language feature that you should avoid if you are concerned about portability.

I Informational message. It does not indicate any error, just something that you should be aware of to avoid unexpected behavior or to improve performance.

Notes:
1. The message levels **S** and **U** indicate a compilation failure.
2. The message levels **I**, **L**, **W**, and **E** indicate that compilation was successful.

By default, the compiler stops without producing output files if it encounters a severe error (severity S). You can make the compiler stop for less severe errors by specifying a different severity with the **-qhalt** option. For example, with **-qhalt=e**, the compiler stops if it encounters any errors of severity E or higher severity. This technique can reduce the amount of compilation time that is needed to check the syntactic and semantic validity of a program. You can limit low-severity messages

without stopping the compiler by using the **-qflag** option. If you simply want to prevent specific messages from going to the output stream, see "-qsuppress option" on page 208.

Compiler return code

The compiler return codes and their respective meanings are as follows:

0 The compiler did not encounter any errors severe enough to make it stop processing a compilation unit.

1 The compiler encountered an error of severity E or *halt_severity* (whichever is lower). Depending on the level of *halt_severity*, the compiler might have continued processing the compilation units with errors.

40 An option error.

41 A configuration file error.

250 An out-of-memory error. The compiler cannot allocate any more memory for its use.

251 A signal received error. An unrecoverable error or interrupt signal is received.

252 A file-not-found error.

253 An input/output error. Cannot read or write files.

254 A fork error. Cannot create a new process.

255 An error while executing a process.

Run-time return code

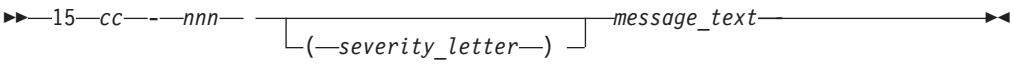
If an XLF-compiled program ends abnormally, the return code to the operating system is 1.

If the program ends normally, the return code is 0 (by default) or is **MOD**(*digit_string*,256) if the program ends because of a **STOP** *digit_string* statement.

Understanding XL Fortran messages

In addition to the diagnostic message issued, the source line and a pointer to the position in the source line at which the error was detected are printed or displayed if you specify the **-qsource** compiler option. If **-qnosource** is in effect, the file name, the line number, and the column position of the error are displayed with the message.

The format of an XL Fortran diagnostic message is:



where:

15 Indicates an XL Fortran message

cc Is the component number, as follows:

- **00** Indicates a code generation or optimization message
- **01** Indicates an XL Fortran common message
- **11-20** Indicates a Fortran-specific message
- **25** Indicates a run-time message from an XL Fortran application program

85	Indicates a loop-transformation message
86	Indicates an interprocedural analysis (IPA) message
nnn	Is the message number
severity_letter	Indicates how serious the problem is, as described in the preceding section
'*message text*'	Is the text describing the error

Limiting the number of compile-time messages

If the compiler issues many low-severity (**I** or **W**) messages concerning problems you are aware of or do not care about, use the **-qflag** option or its short form **-w** to limit messages to high-severity ones:

```
# E, S, and U messages go in listing; U messages are displayed on screen.
xlf95 -qflag=e:u program.f

# E, S, and U messages go in listing and are displayed on screen.

xlf95 -w program.f
```

Selecting the language for messages

By default, XL Fortran comes with messages in U.S. English only. You can also order translated message catalogs:

- Compiler messages in Japanese
- Run-time messages in Japanese

If compile-time messages are appearing in U.S. English when they should be in another language, verify that the correct message catalogs are installed and that the **LANG**, **LC_MESSAGES**, and/or **LC_ALL** environment variables are set accordingly.

If a run-time message appears in the wrong language, also ensure that your program calls the **setlocale** routine.

Related information: See "Environment variables for national language support" on page 8 and "Selecting the language for run-time messages" on page 29.

To determine which XL Fortran message catalogs are installed, use the following commands to list them:

```
rpm -ql xlf.cmp        # compile-time messages
rpm -ql xlf.msg.rte    # run-time messages
rpm -ql xlsmp.msg.rte  # SMP run-time messages
```

The file names of the message catalogs are the same for all supported international languages, but they are placed in different directories.

Note: When you run an XL Fortran program on a system without the XL Fortran message catalogs, run-time error messages (mostly for I/O problems) are not displayed correctly; the program prints the message number but not the associated text. To prevent this problem, copy the XL Fortran message catalogs from **/opt/ibmcmp/msg** to a directory that is part of the **NLSPATH** environment-variable setting on the execution system.

Fixing installation or system environment problems

If individual users or all users on a particular machine have difficulty running the compiler, there may be a problem in the system environment. Here are some common problems and solutions:

---

xlf90: not found
xlf90_r: not found
xlf95: not found
xlf95_r: not found
xlf: not found
xlf_r: not found
f77: not found
fort77: not found
f90: not found
f95: not found
Symptom: The shell cannot locate the command to execute the compiler.
Solution: Make sure that your **PATH** environment variable includes the directory **/opt/ibmcmp/xlf/10.1/bin**. If the compiler is properly installed, the commands you need to execute it are in this directory.

Could not load program *program*
Error was: not enough space
Symptom: The system cannot execute the compiler or an application program at all.
Solution: Set the storage limits for stack and data to "unlimited" for users who experience this problem. For example, you can set both your hard and soft limits with these **bash** commands:

```
ulimit -s unlimited
ulimit -d unlimited
```

Or, you may find it more convenient to edit the file **/etc/security/limits.conf** to give all users unlimited stack and data segments (by entering -1 for these fields).

If the storage problem is in an XLF-compiled program, using the **-qsave** or **-qsmallstack** option might prevent the program from exceeding the stack limit.
Explanation: The compiler allocates large internal data areas that may exceed the storage limits for a user. XLF-compiled programs place more data on the stack by default than in previous versions, also possibly exceeding the storage limit. Because it is difficult to determine precise values for the necessary limits, we recommend making them unlimited.

Could not load program *program*
Could not load library *library_name***.so**
Error was: no such file or directory
Solution: Make sure the XL Fortran libraries are installed in **/opt/ibmcmp/xlf/10.1/lib** and **/opt/ibmcmp/xlf/10.1/lib64**, or set the **LD_LIBRARY_PATH** and **LD_RUN_PATH** environment variables to include the directory where **libxlf90.so** is installed if it is in a different directory. See "Setting library search paths" on page 9 for details of this environment variable.

Symptom: Messages from the compiler or an XL Fortran application program are displayed in the wrong language.
Solution: Set the appropriate national language environment. You can set the national language for each user with the command **env**. Alternatively, each user can set one or more of the environment variables **LANG**, **NLSPATH**, **LC_MESSAGES**, **LC_TIME**, and **LC_ALL**. If you are not familiar with the purposes of these variables, "Environment variables for national language support" on page 8 provides details.

Symptom: A compilation fails with an I/O error.
Solution: Increase the size of the **/tmp** filesystem, or set the environment variable **TMPDIR** to the path of a filesystem that has more free space.
Explanation: The object file may have grown too large for the filesystem that holds it. The cause could be a very large compilation unit or initialization of all or part of a large array in a declaration.

Symptom: There are too many individual makefiles and compilation scripts to easily maintain or track.
Solution: Add stanzas to the configuration file, and create links to the compiler by using the names of these stanzas. By running the compiler with different command names, you can provide consistent groups of compiler options and other configuration settings to many users.

Fixing compile-time problems

The following sections discuss common problems you might encounter while compiling and how to avoid them.

Duplicating extensions from other systems

Some ported programs may cause compilation problems because they rely on extensions that exist on other systems. XL Fortran supports many extensions like these, but some require compiler options to turn them on. See "Options for compatibility" on page 51 for a list of these options and *Porting programs to XL Fortran* in the *XL Fortran Optimization and Programming Guide* for a general discussion of porting.

Isolating problems with individual compilation units

If you find that a particular compilation unit requires specific option settings to compile properly, you may find it more convenient to apply the settings in the source file through an **@PROCESS** directive. Depending on the arrangement of your files, this approach may be simpler than recompiling different files with different command-line options.

Compiling with thread-safe commands

Thread-safe invocation commands, like **xlf_r** or **xlf90_r**, for example, use different search paths and call different modules than the non thread-safe invocations. Your programs should account for the different usages. Programs that compile and run successfully for one environment may produce unexpected results when compiled and run for a different use. The configuration file, **xlf.cfg**, shows the paths, libraries, and so on for each invocation command. (See "Customizing the configuration file" on page 10 for a sample configuration file and an explanation of its contents.)

Running out of machine resources

If the operating system runs low on resources (page space or disk space) while one of the compiler components is running, you should receive one of the following messages:

```
1501-229 Compilation ended because of lack of space.
1517-011 Compilation ended.  No more system resources available.

1501-053 (S) Too much initialized data.
1501-511. Compilation failed for file [filename].
```

You may need to increase the system page space and recompile your program. See the man page information **man 8 mkswap swapon** for more information about page space.

If your program produces a large object file, for example, by initializing all or part of a large array, you may need to do one of the following:

- Increase the size of the filesystem that holds the **/tmp** directory.
- Set the **TMPDIR** environment variable to a filesystem with a lot of free space.
- For very large arrays, initialize the array at run time rather than statically (at compile time).

Fixing link-time problems

After the XL Fortran compiler processes the source files, the linker links the resulting object files together. Any messages issued at this stage come from the **ld** command. A frequently encountered error and its solution are listed here for your convenience:

filename.o: In function 'main':
filename.o(.text+0x14): undefined reference to 'p'
filename.o(.text+0x14): relocation truncated to fit: R_PPC_REL24 p

Symptom: A program cannot be linked because of unresolved references.

Explanation: Either needed object files or libraries are not being used during linking, there is an error in the specification of one or more external names, or there is an error in the specification of one or more procedure interfaces.

Solution: You may need to do one or more of the following actions:

- Compile again with the **-Wl,-M** option to create a file that contains information about undefined symbols.
- Make sure that if you use the **-U** option, all intrinsic names are in lowercase.

Fixing run-time problems

XL Fortran issues error messages during the running of a program in either of the following cases:

- XL Fortran detects an input/output error. "Setting run-time options" on page 29 explains how to control these kinds of messages.
- XL Fortran detects an exception error, and the default exception handler is installed (through the **-qsigtrap** option or a call to **SIGNAL**). To get a more descriptive message than `Core dumped`, you may need to run the program from within **gdb**.

  The causes for run-time exceptions are listed in "XL Fortran run-time exceptions" on page 38.

You can investigate errors that occur during the execution of a program by using a symbolic debugger, such as **gdb**.

Duplicating extensions from other systems

Some ported programs may not run correctly if they rely on extensions that are found on other systems. XL Fortran supports many such extensions, but you need to turn on compiler options to use some of them. See "Options for compatibility" on page 51 for a list of these options and *Porting programs to XL Fortran*in the *XL Fortran Optimization and Programming Guide* for a general discussion of porting.

Mismatched sizes or types for arguments

Arguments of different sizes or types might produce incorrect execution and results. To do the type-checking during the early stages of compilation, specify interface blocks for the procedures that are called within a program.

Working around problems when optimizing

If you find that a program produces incorrect results when it is optimized and if you can isolate the problem to a particular variable, you might be able to work around the problem temporarily by declaring the variable as **VOLATILE**. This prevents some optimizations that affect the variable. (See **VOLATILE** in the *XL Fortran Language Reference*.) Because this is only a temporary solution, you should continue debugging your code until you resolve your problem, and then remove the **VOLATILE** keyword. If you are confident that the source code and program design are correct and you continue to have problems, contact your support organization to help resolve the problem.

Input/Output errors

If the error detected is an input/output error and you have specified **IOSTAT** on the input/output statement in error, the **IOSTAT** variable is assigned a value according to *Conditions and IOSTAT Values* in the *XL Fortran Language Reference*.

If you have installed the XL Fortran run-time message catalog on the system on which the program is executing, a message number and message text are issued to the terminal (standard error) for certain I/O errors. If you have specified **IOMSG** on the input/output statement, the **IOMSG** variable is assigned the error message text if an error is detected, or the content of **IOMSG** variable is not changed. If this catalog is not installed on the system, only the message number appears. Some of the settings in "Setting run-time options" on page 29 allow you to turn some of these error messages on and off.

If a program fails while writing a large data file, you may need to increase the maximum file size limit for your user ID. You can do this through a shell command, such as **ulimit** in **bash**.

Tracebacks and core dumps

If a run-time exception occurs and an appropriate exception handler is installed, a message and a traceback listing are displayed. Depending on the handler, a core file might be produced as well. You can then use a debugger to examine the location of the exception.

To produce a traceback listing without ending the program, call the **xl__trbk** procedure:

```
IF (X .GT. Y) THEN    ! X > Y indicates that something is wrong.
  PRINT *, 'Error - X should not be greater than Y'
  CALL XL__TRBK       ! Generate a traceback listing.
END IF
```

See *Installing an exception handler* in the *XL Fortran Optimization and Programming Guide* for instructions about exception handlers and "XL Fortran run-time exceptions" on page 38 for information about the causes of run-time exceptions.

Debugging a Fortran 90 or Fortran 95 program

You can use **dbx** and other symbolic debuggers to debug your programs. For instructions on using your chosen debugger, consult the online help within the debugger or its documentation.

Always specify the **-g** option when compiling programs for debugging.

Related information:

- "Options for error checking and debugging" on page 46

Chapter 8. Understanding XL Fortran compiler listings

Diagnostic information is placed in the output listing produced by the **-qlist**, **-qsource**, **-qxref**, **-qattr**, **-qreport**, and **-qlistopt** compiler options. The **-S** option generates an assembler listing in a separate file.

To locate the cause of a problem with the help of a listing, you can refer to the following:

- The source section (to see any compilation errors in the context of the source program)
- The attribute and cross-reference section (to find data objects that are misnamed or used without being declared or to find mismatched parameters)
- The transformation and object sections (to see if the generated code is similar to what you expect)

A heading identifies each major section of the listing. A string of greater than symbols precedes the section heading so that you can easily locate its beginning:

```
>>>>> section name
```

You can select which sections appear in the listing by specifying compiler options.

Related information: See "Options that control listings and messages" on page 49.

Header section

The listing file has a header section that contains the following items:

- A compiler identifier that consists of the following:
  - Compiler name
  - Version number
  - Release number
  - Modification number
  - Fix number
- Source file name
- Date of compilation
- Time of compilation

The header section is always present in a listing; it is the first line and appears only once. The following sections are repeated for each compilation unit when more than one compilation unit is present.

Options section

The options section is always present in a listing. There is a separate section for each compilation unit. It indicates the specified options that are in effect for the compilation unit. This information is useful when you have conflicting options. If you specify the **-qlistopt** compiler option, this section lists the settings for all options.

Source section

The source section contains the input source lines with a line number and, optionally, a file number. The file number indicates the source file (or include file) from which the source line originated. All main file source lines (those that are not from an include file) do not have the file number printed. Each include file has a file number associated with it, and source lines from include files have that file number printed. The file number appears on the left, the line number appears to its right, and the text of the source line is to the right of the line number. XL Fortran numbers lines relative to each file. The source lines and the numbers that are associated with them appear only if the **-qsource** compiler option is in effect. You can selectively print parts of the source by using the **@PROCESS** directives **SOURCE** and **NOSOURCE** throughout the program.

Error messages

If the **-qsource** option is in effect, the error messages are interspersed with the source listing. The error messages that are generated during the compilation process contain the following:

- The source line
- A line of indicators that point to the columns that are in error
- The error message, which consists of the following:
  - The 4-digit component number
  - The number of the error message
  - The severity level of the message
  - The text that describes the error

For example:

```
         2 |          equivalence (i,j,i)
      .................................a.
a - 1514-117: (E) Same name appears more than once in an
equivalence group.
```

If the **-qnosource** option is in effect, the error messages are all that appear in the source section, and an error message contains:

- The file name in quotation marks
- The line number and column position of the error
- The error message, which consists of the following:
  - The 4-digit component number
  - The number of the error message
  - The severity level of the message
  - The text that describes the error

For example:

```
"doc.f", line 6.11: 1513-039 (S) Number of arguments is not
permitted for INTRINSIC function abs.
```

Transformation report section

If the **-qreport** option is in effect, a transformation report listing shows how XL Fortran optimized the program. This section displays pseudo-Fortran code that corresponds to the original source code, so that you can see parallelization and loop transformations that the **-qhot** and/or **-qsmp** options have generated.

Sample Report

The following report was created for the program **t.f** using the

```
xlf -qhot -qreport t.f
```

command.

Program t.f:

```
integer a(100, 100)
integer i,j

do i = 1 , 100
  do j = 1, 100
    a(i,j) = j
  end do
end do
end
```

Transformation Report:

```
>>>>> SOURCE SECTION <<<<<
** _main   === End of Compilation 1 ===

>>>>> LOOP TRANSFORMATION SECTION <<<<<


                PROGRAM _main ()
     4|           IF (.FALSE.) GOTO lab_9
                  @LoopIV0 = 0
       Id=1       DO @LoopIV0 = @LoopIV0, 99
     5|             IF (.FALSE.) GOTO lab_11
                    @LoopIV1 = 0
       Id=2         DO @LoopIV1 = @LoopIV1, 99
                      ! DIR_INDEPENDENT loopId = 0
     6|               a((@LoopIV1 + 1),(@LoopIV0 + 1)) = (@LoopIV0 + 1)
     7|             ENDDO
                    lab_11
     8|           ENDDO
                  lab_9
     9|         END PROGRAM _main


Source        Source        Loop Id       Action / Information
File          Line

----------    ----------    ----------    -------------------------------------
         0             4             1    Loop interchanging applied to loop nest.

>>>>> FILE TABLE SECTION <<<<<
```

Attribute and cross-reference section

This section provides information about the entities that are used in the compilation unit. It is present if the **-qxref** or **-qattr** compiler option is in effect. Depending on the options in effect, this section contains all or part of the following information about the entities that are used in the compilation unit:

- Names of the entities
- Attributes of the entities (if **-qattr** is in effect). Attribute information may include any or all of the following details:
  - The type
  - The class of the name
  - The relative address of the name
  - Alignment
  - Dimensions
  - For an array, whether it is allocatable
  - Whether it is a pointer, target, or integer pointer
  - Whether it is a parameter
  - Whether it is volatile
  - For a dummy argument, its intent, whether it is value, and whether it is optional
  - Private, public, protected, module
- Coordinates to indicate where you have defined, referenced, or modified the entities. If you declared the entity, the coordinates are marked with a `$`. If you initialized the entity, the coordinates are marked with a `*`. If you both declared and initialized the entity at the same place, the coordinates are marked with a `&`. If the entity is set, the coordinates are marked with a `@`. If the entity is referenced, the coordinates are not marked.

Class is one of the following:

- Automatic
- BSS (uninitialized static internal)
- Common
- Common block
- Construct name
- Controlled (for an allocatable object)
- Controlled automatic (for an automatic object)
- Defined assignment
- Defined operator
- Derived type definition
- Entry
- External subprogram
- Function
- Generic name
- Internal subprogram
- Intrinsic
- Module
- Module function
- Module subroutine
- Namelist
- Pointee
- Private component
- Program
- Reference parameter
- Renames
- Static
- Subroutine

- Use associated
- Value parameter

If you specify the **full** suboption with **-qxref** or **-qattr**, XL Fortran reports all entities in the compilation unit. If you do not specify this suboption, only the entities you actually use appear.

Object section

XL Fortran produces this section only when the **-qlist** compiler option is in effect. It contains the object code listing, which shows the source line number, the instruction offset in hexadecimal notation, the assembler mnemonic of the instruction, and the hexadecimal value of the instruction. On the right side, it also shows the cycle time of the instruction and the intermediate language of the compiler. Finally, the total cycle time (straight-line execution time) and the total number of machine instructions that are produced are displayed. There is a separate section for each compilation unit.

File table section

This section contains a table that shows the file number and file name for each main source file and include file used. It also lists the line number of the main source file at which the include file is referenced. This section is always present.

Compilation unit epilogue Section

This is the last section of the listing for each compilation unit. It contains the diagnostics summary and indicates whether the unit was compiled successfully. This section is not present in the listing if the file contains only one compilation unit.

Compilation epilogue Section

The compilation epilogue section occurs only once at the end of the listing. At completion of the compilation, XL Fortran presents a summary of the compilation: number of source records that were read, compilation start time, compilation end time, total compilation time, total CPU time, and virtual CPU time. This section is always present in a listing.

Appendix A. XL Fortran technical information

This section contains details about XL Fortran that advanced programmers may need to diagnose unusual problems, run the compiler in a specialized environment, or do other things that a casual programmer is rarely concerned with.

The compiler phases

The typical compiler invocation command executes some or all of the following programs in sequence. For link-time optimizations, some of the phases will be executed more than once during a compilation. As each program runs, the results are sent to the next step in the sequence.

1. A preprocessor
2. The compiler, which consists of the following phases:
   a. Front-end parsing and semantic analysis
   b. Loop transformations
   c. Interprocedural analysis
   d. Optimization
   e. Register allocation
   f. Final assembly
3. The assembler (for any **.s** files)
4. The linker **ld**

External Names in XL Fortran Libraries

To minimize naming conflicts between user-defined names and the names that are defined in the run-time libraries, the names of input/output routines in the run-time libraries are prefixed with an underscore(_), or _xl.

The XL Fortran run-time environment

Object code that the XL Fortran compiler produces often invokes compiler-supplied subprograms at run time to handle certain complex tasks. These subprograms are collected into several libraries.

The function of the XL Fortran Run-Time Environment may be divided into these main categories:

- Support for Fortran I/O operations
- Mathematical calculation
- Operating-system services
- Support for SMP parallelization

The XL Fortran Run-Time Environment also produces run-time diagnostic messages in the national language appropriate for your system. Unless you bind statically, you cannot run object code produced by the XL Fortran compiler without the XL Fortran Run-Time Environment.

The XL Fortran Run-Time Environment is upward-compatible. Programs that are compiled and linked with a given level of the run-time environment and a given level of the operating system require the same or higher levels of both the run-time environment and the operating system to run.

External names in the run-time environment

Run-time subprograms are collected into libraries. By default, the compiler invocation command also invokes the linker and gives it the names of the libraries that contain run-time subprograms called by Fortran object code.

The names of these run-time subprograms are external symbols. When object code that is produced by the XL Fortran compiler calls a run-time subprogram, the **.o** object code file contains an external symbol reference to the name of the subprogram. A library contains an external symbol definition for the subprogram. The linker resolves the run-time subprogram call with the subprogram definition.

You should avoid using names in your XL Fortran program that conflict with names of run-time subprograms. Conflict can arise under two conditions:

- The name of a subroutine, function, or common block that is defined in a Fortran program has the same name as a library subprogram.
- The Fortran program calls a subroutine or function with the same name as a library subprogram but does not supply a definition for the called subroutine or function.

Technical details of the -qfloat=hsflt option

The **-qfloat=hsflt** option is unsafe for optimized programs that compute floating-point values that are outside the range of representation of single precision, not just outside the range of the result type. The range of representation includes both the precision and the exponent range.

Even when you follow the rules that are stated in the preceding paragraph and in "-qfloat option" on page 125, programs that are sensitive to precision differences might not produce expected results. Because **-qfloat=hsflt** is not compliant with IEEE, programs will not always run as expected.

For example, in the following program, `X.EQ.Y` may be true or may be false:

```
REAL X, Y, A(2)
DOUBLE PRECISION Z
LOGICAL SAME

READ *, Z
X = Z
Y = Z
IF (X.EQ.Y) SAME = .TRUE.
! ...
! ... Calculations that do not change X or Y
! ...
CALL SUB(X)         ! X is stored in memory with truncated fraction.
IF (X.EQ.Y) THEN    ! Result might be different than before.
...

A(1) = Z
X = Z
A(2) = 1.           ! A(1) is stored in memory with truncated fraction.
IF (A(1).EQ.X) THEN ! Result might be different than expected.
...
```

If the value of `Z` has fractional bits that are outside the precision of a single-precision variable, these bits may be preserved in some cases and lost in others. This makes the exact results unpredictable when the double-precision value

of Z is assigned to single-precision variables. For example, passing the variable as a dummy argument causes its value to be stored in memory with a fraction that is truncated rather than rounded.

Implementation details for -qautodbl promotion and padding

The following sections provide additional details about how the **-qautodbl** option works, to allow you to predict what happens during promotion and padding.

Terminology

The *storage relationship* between two data objects determines the relative starting addresses and the relative sizes of the objects. The **-qautodbl** option tries to preserve this relationship as much as possible.

Data objects can also have a *value relationship*, which determines how changes to one object affect another. For example, a program might store a value into one variable, and then read the value through a different storage-associated variable. With **-qautodbl** in effect, the representation of one or both variables might be different, so the value relationship is not always preserved.

An object that is affected by this option may be:

- *Promoted*, meaning that it is converted to a higher-precision data type. Usually, the resulting object is twice as large as it would be by default. Promotion applies to constants, variables, derived-type components, arrays, and functions (which include intrinsic functions) of the appropriate types.

  Note: **BYTE**, **INTEGER**, **LOGICAL**, and **CHARACTER** objects are never promoted.
- *Padded*, meaning that the object keeps its original type but is followed by undefined storage space. Padding applies to **BYTE**, **INTEGER**, **LOGICAL**, and nonpromoted **REAL** and **COMPLEX** objects that may share storage space with promoted items. For safety, **POINTER**s, **TARGET**s, actual and dummy arguments, members of **COMMON** blocks, structures, pointee arrays, and pointee **COMPLEX** objects are always padded appropriately depending on the **-qautodbl** suboption. This is true whether or not they share storage with promoted objects.

  Space added for padding ensures that the storage-sharing relationship that existed before conversion is maintained. For example, if array elements **I(20)** and **R(10)** start at the same address by default and if the elements of **R** are promoted and become twice as large, the elements of **I** are padded so that **I(20)** and **R(10)** still start at the same address.

  Except for unformatted I/O statements, which read and write any padding that is present within structures, I/O statements do not process padding.

  Note: The compiler does not pad **CHARACTER** objects.

Examples of storage relationships for -qautodbl suboptions

The examples in this section illustrate storage-sharing relationships between the following types of entities:

- **REAL(4)**
- **REAL(8)**
- **REAL(16)**
- **COMPLEX(4)**
- **COMPLEX(8)**
- **COMPLEX(16)**
- **INTEGER(8)**
- **INTEGER(4)**
- **CHARACTER(16)**.

Note: In the diagrams, solid lines represent the actual data, and dashed lines represent padding.

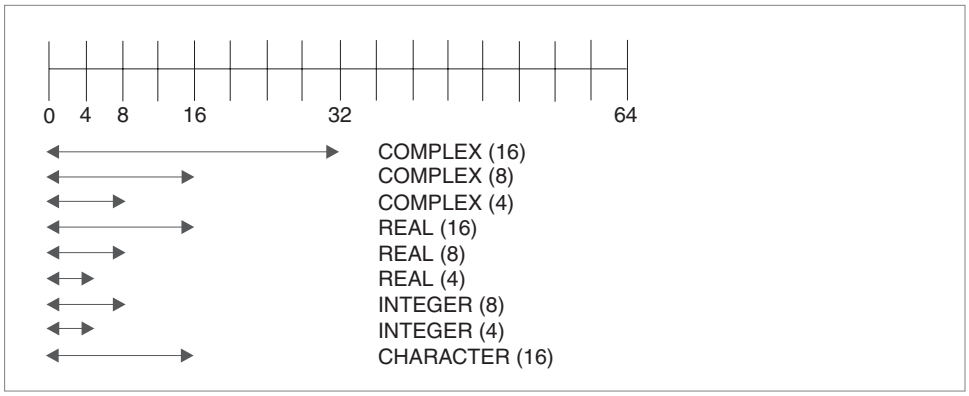


Figure 1. Storage relationships without the -qautodbl option

The figure above illustrates the default storage-sharing relationship of the compiler.

```
@process autodbl(none)
      block data
      complex(4) x8      /(1.123456789e0,2.123456789e0)/
      real(16) r16(2)    /1.123q0,2.123q0/
      integer(8) i8(2)   /1000,2000/
      character*5 c(2)  /"abcde","12345"/
      common /named/ x8,r16,i8,c
      end

      subroutine s()
         complex(4) x8
         real(16) r16(2)
         integer(8) i8(2)
         character*5 c(2)
         common /named/ x8,r16,i8,c
!          x8    = (1.123456e0,2.123456e0)      ! promotion did not occur
!         r16(1) = 1.123q0                      ! no padding
!         r16(2) = 2.123q0                      ! no padding
!          i8(1) = 1000                         ! no padding
!          i8(2) = 2000                         ! no padding
!           c(1) = "abcde"                      ! no padding
!           c(2) = "12345"                      ! no padding
      end subroutine s
```

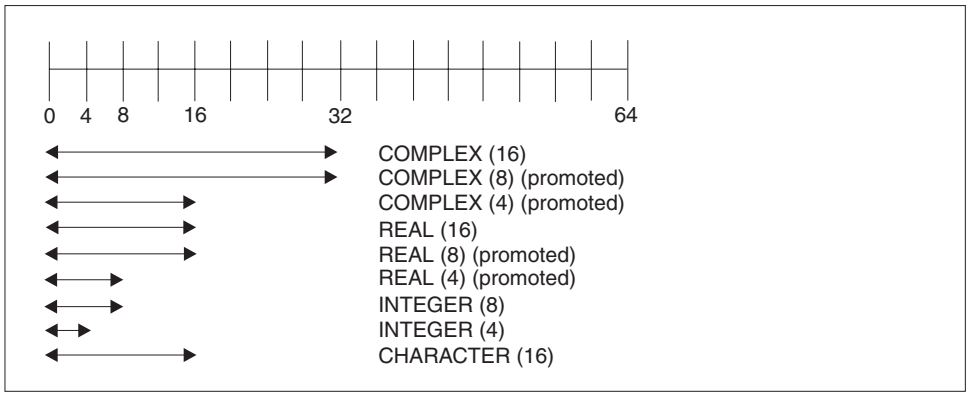


Figure 2. Storage relationships with -qautodbl=dbl

```
@process autodbl(dbl)
      block data
      complex(4) x8
      real(16) r16(2)    /1.123q0,2.123q0/
      real(8) r8
      real(4) r4         /1.123456789e0/
      integer(8) i8(2)   /1000,2000/
      character*5 c(2)  /"abcde","12345"/
      equivalence (x8,r8)
      common /named/ r16,i8,c,r4
!     Storage relationship between r8 and x8 is preserved.
!     Data values are NOT preserved between r8 and x8.
      end

      subroutine s()
         real(16) r16(2)
         real(8) r4
         integer(8) i8(2)
         character*5 c(2)
         common /named/ r16,i8,c,r4
!         r16(1) = 1.123q0                        ! no padding
!         r16(2) = 2.123q0                        ! no padding
!          r4    = 1.123456789d0                  ! promotion occurred
!          i8(1) = 1000                           ! no padding
!          i8(2) = 2000                           ! no padding
!           c(1) = "abcde"                        ! no padding
!           c(2) = "12345"                        ! no padding
      end subroutine s
```

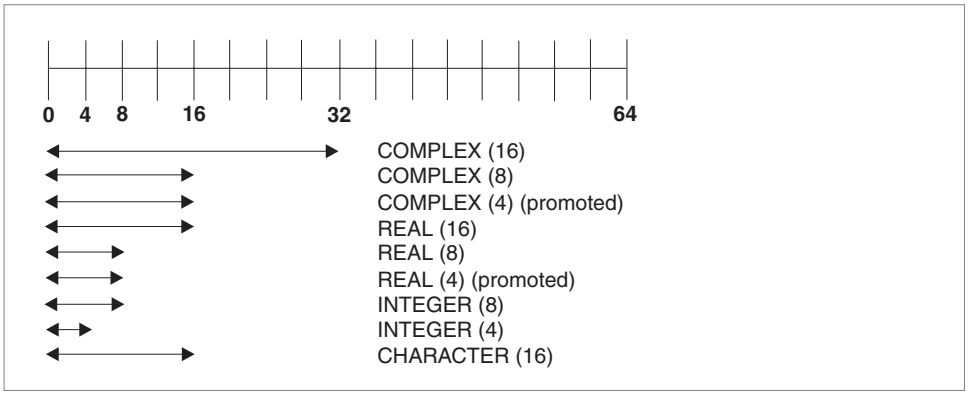


Figure 3. Storage relationships with -qautobl=dbl4

```
@process autodbl(dbl4)
      complex(8) x16    /(1.123456789d0,2.123456789d0)/
      complex(4) x8
      real(4) r4(2)
      equivalence (x16,x8,r4)
!     Storage relationship between r4 and x8 is preserved.
!     Data values between r4 and x8 are preserved.
!     x16   = (1.123456789d0,2.123456789d0)      ! promotion did not occur
!     x8    = (1.123456789d0,2.123456789d0)      ! promotion occurred
!     r4(1) = 1.123456789d0                      ! promotion occurred
!     r4(2) = 2.123456789d0                      ! promotion occurred
      end
```

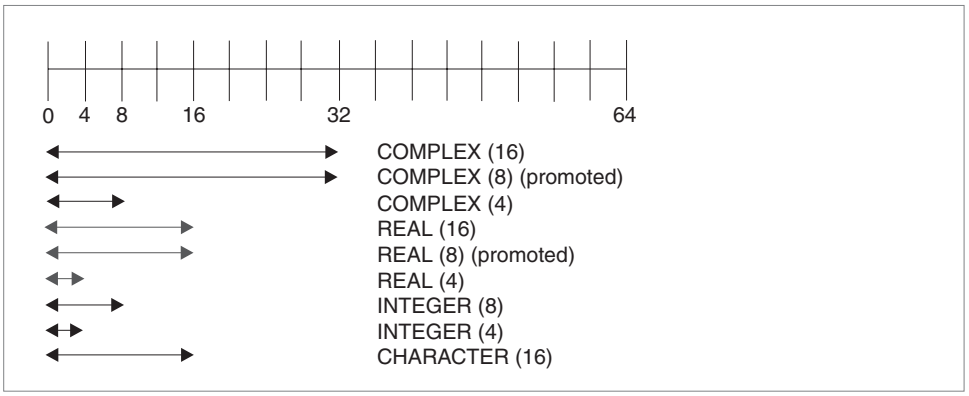


Figure 4. Storage relationships with -qautodbl=dbl8

```
@process autodbl(dbl8)
      complex(8) x16    /(1.12345678912345678d0,2.12345678912345678d0)/
      complex(4) x8
      real(8) r8(2)
      equivalence (x16,x8,r8)
!     Storage relationship between r8 and x16 is preserved.
!     Data values between r8 and x16 are preserved.
!     x16   = (1.12345678912345678q0,2.12345678912345678q0)
!                                                ! promotion occurred
!     x8    = upper 8 bytes of r8(1)             ! promotion did not occur
!     r8(1) = 1.12345678912345678q0              ! promotion occurred
!     r8(2) = 2.12345678912345678q0              ! promotion occurred
      end
```

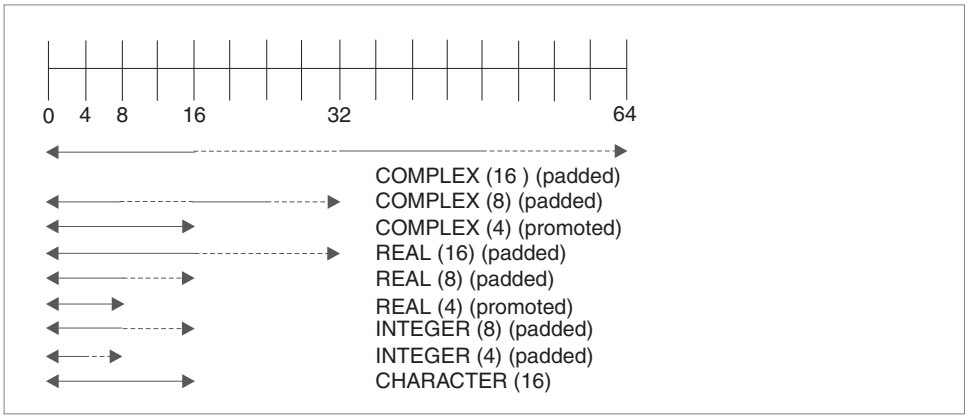


Figure 5. Storage relationships with -qautodbl=dblpad4

In the figure above, the dashed lines represent the padding.

```
@process autodbl(dblpad4)
      complex(8) x16  /(1.123456789d0,2.123456789d0)/
      complex(4) x8
      real(4) r4(2)
      integer(8) i8(2)
      equivalence(x16,x8,r4,i8)
!     Storage relationship among all entities is preserved.
!     Date values between x8 and r4 are preserved.
!     x16   = (1.123456789d0,2.123456789d0)      ! padding occurred
!     x8    = (upper 8 bytes of x16, 8 byte pad) ! promotion occurred
!     r4(1) = real(x8)                           ! promotion occurred
!     r4(2) = imag(x8)                           ! promotion occurred
!     i8(1) = real(x16)                          ! padding occurred
!     i8(2) = imag(x16)                          ! padding occurred
      end
```

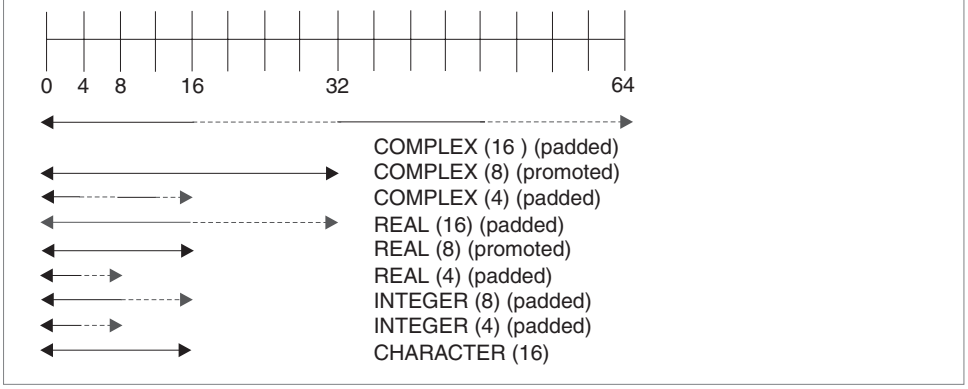


Figure 6. Storage relationships with -qautodbl=dblpad8

In the figure above, the dashed lines represent the padding.

```
@process autodbl(dblpad8)
      complex(8) x16    /(1.12345678912345678d0,2.12345678912345678d0)/
      complex(4) x8
      real(8) r8(2)
      integer(8) i8(2)
      byte b(16)
      equivalence (x16,x8,r8,i8,b)
!     Storage relationship among all entities is preserved.
```

```
!     Data values between r8 and x16 are preserved.
!     Data values between i8 and b are preserved.
!     x16 = (1.123456789123456789q0,2.123456789123456789q0)
!                                              ! promotion occurred
!     x8 = upper 8 bytes of r8(1)              ! padding occurred
!     r8(1) = real(x16)                        ! promotion occurred
!     r8(2) = imag(x16)                        ! promotion occurred
!     i8(1) = upper 8 bytes of real(x16)       ! padding occurred
!     i8(2) = upper 8 bytes of imag(x16)       ! padding occurred
!     b(1:8)= i8(1)                            ! padding occurred
!     b(9:16)= i8(2)                           ! padding occurred
      end
```

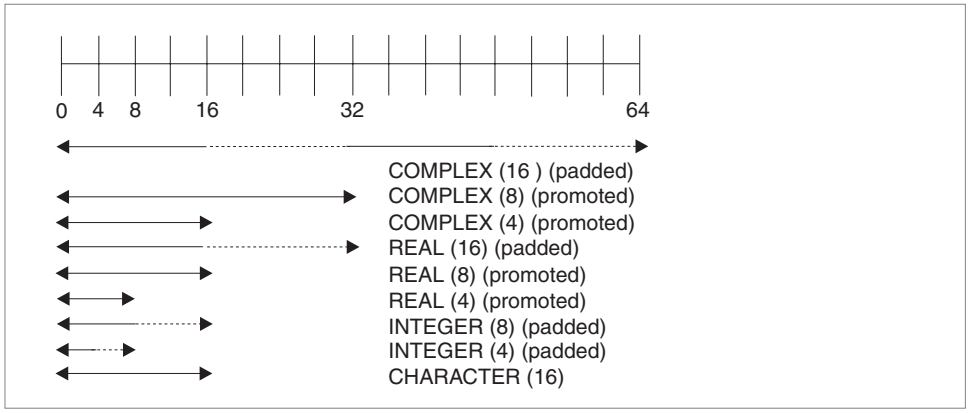


Figure 7. Storage relationships with -qautodbl=dblpad

In the figure above, the dashed lines represent the padding.

```
@process autodbl(dblpad)
      block data
      complex(4) x8      /(1.123456789e0,2.123456789e0)/
      real(16) r16(2)    /1.123q0,2.123q0/
      integer(8) i8(2)   /1000,2000/
      character*5 c(2)   /"abcde","12345"/
      common /named/ x8,r16,i8,c
      end
      subroutine s()
         complex(8) x8
         real(16) r16(4)
         integer(8) i8(4)
         character*5 c(2)
         common /named/ x8,r16,i8,c
!          x8    = (1.123456789d0,2.123456789d0)   !  promotion occurred
!         r16(1) = 1.123q0                         !  padding occurred
!         r16(3) = 2.123q0                         !  padding occurred
!          i8(1) = 1000                            !  padding occurred
!          i8(3) = 2000                            !  padding occurred
!           c(1) = "abcde"                         !  no padding occurred
!           c(2) = "12345"                         !  no padding occurred
      end subroutine s
```

Appendix B. XL Fortran internal limits

Language Feature	Limit
Maximum number of iterations performed by **DO** loops with loop control with index variable of type INTEGER(n) for *n* = 1, 2 or 4	(2**31)-1
Maximum number of iterations performed by **DO** loops with loop control with index variable of type INTEGER(8)	(2**63)-1
Maximum character format field width	(2**31)-1
Maximum length of a format specification	(2**31)-1
Maximum length of Hollerith and character constant edit descriptors	(2**31)-1
Maximum length of a fixed source form statement	34 000
Maximum length of a free source form statement	34 000
Maximum number of continuation lines	n/a **1**
Maximum number of nested **INCLUDE** lines	64
Maximum number of nested interface blocks	1 024
Maximum number of statement numbers in a computed **GOTO**	999
Maximum number of times a format code can be repeated	(2**31)-1
Allowable record numbers and record lengths for input/output files in 32-bit mode	The record number can be up to (2**63)-1. The maximum record length is (2**31)-1 bytes.
Allowable record numbers and record lengths for input/output files in 64-bit mode	The record number can be up to (2**63)-1, and the record length can be up to (2**63)-1 bytes. However, for unformatted sequential files, you must use the **uwidth=64** run-time option for the record length to be greater than (2**31)-1 and up to (2**63)-1. If you use the default **uwidth=32** run-time option, the maximum length of a record in an unformatted sequential file is (2**31)-1 bytes.
Allowable bound range of an array dimension	The bound of an array dimension can be positive, negative, or zero within the range -(2**31) to 2**31-1 in 32-bit mode, or -(2**63) to 2**63-1 in 64-bit mode.
Allowable external unit numbers	0 to (2**31)-1 **2**
Maximum numeric format field width	2 000
Maximum number of concurrent open files	1 024 **3**

1 You can have as many continuation lines as you need to create a statement with a maximum of 34 000 bytes.

2 The value must be representable in an **INTEGER(4)** object, even if specified by an **INTEGER(8)** variable.
3 In practice, this value is somewhat lower because of files that the run-time system may open, such as the preconnected units 0, 5, and 6.

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Glossary

This glossary defines terms that are commonly used in this document. It includes definitions developed by the American National Standards Institute (ANSI) and entries from the *IBM Dictionary of Computing*.

A

active processor. See *online processor*.

actual argument. An expression, variable, procedure, or alternate return specifier that is specified in a procedure reference.

alias. A single piece of storage that can be accessed through more than a single name. Each name is an alias for that storage.

alphabetic character. A letter or other symbol, excluding digits, used in a language. Usually the uppercase and lowercase letters A through Z plus other special symbols (such as $ and _) allowed by a particular language.

alphanumeric. Pertaining to a character set that contains letters, digits, and usually other characters, such as punctuation marks and mathematical symbols.

American National Standard Code for Information Interchange. See *ASCII.*

argument. An expression that is passed to a function or subroutine. See also *actual argument*, *dummy argument*.

argument association. The relationship between an actual argument and a dummy argument during the invocation of a procedure.

arithmetic constant. A constant of type integer, real, or complex.

arithmetic expression. One or more arithmetic operators and arithmetic primaries, the evaluation of which produces a numeric value. An arithmetic expression can be an unsigned arithmetic constant, the name of an arithmetic constant, or a reference to an arithmetic variable, function reference, or a combination of such primaries formed by using arithmetic operators and parentheses.

arithmetic operator. A symbol that directs the performance of an arithmetic operation. The intrinsic arithmetic operators are:

```
+      addition
-      subtraction
*      multiplication
/      division
**     exponentiation
```

array. An entity that contains an ordered group of scalar data. All objects in an array have the same data type and type parameters.

array declarator. The part of a statement that describes an array used in a program unit. It indicates the name of the array, the number of dimensions it contains, and the size of each dimension.

array element. A single data item in an array, identified by the array name and one or more subscripts. See also *subscript*.

array name. The name of an ordered set of data items.

array section. A subobject that is an array and is not a structure component.

ASCII. The standard code, using a coded character set consisting of 7-bit coded characters (8-bits including parity check), that is used for information interchange among data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters. See also *Unicode*.

asynchronous. Pertaining to events that are not synchronized in time or do not occur in regular or predictable time intervals.

assignment statement. An executable statement that defines or redefines a variable based on the result of expression evaluation.

associate name. The name by which a selector of an **ASSOCIATE** construct is known within the construct.

attribute. A property of a data object that may be specified in a type declaration statement, attribute specification statement, or through a default setting.

automatic parallelization. The process by which the compiler attempts to parallelize both explicitly coded **DO** loops and **DO** loops generated by the compiler for array language.

B

binary constant. A constant that is made of one or more binary digits (0 and 1).

bind. To relate an identifier to another object in a program; for example, to relate an identifier to a value, an address or another identifier, or to associate formal parameters and actual parameters.

blank common. An unnamed common block.

block data subprogram. A subprogram headed by a **BLOCK DATA** statement and used to initialize variables in named common blocks.

bss storage. Uninitialized static storage.

busy-wait. The state in which a thread keeps executing in a tight loop looking for more work once it has completed all of its work and there is no new work to do.

byte constant. A named constant that is of type byte.

byte type. A data type representing a one-byte storage area that can be used wherever a **LOGICAL(1)**, **CHARACTER(1)**, or **INTEGER(1)** can be used.

C

character constant. A string of one or more alphabetic characters enclosed in apostrophes or double quotation marks.

character expression. A character object, a character-valued function reference, or a sequence of them separated by the concatenation operator, with optional parentheses.

character operator. A symbol that represents an operation, such as concatenation (//), to be performed on character data.

character set. All the valid characters for a programming language or for a computer system.

character string. A sequence of consecutive characters.

character substring. A contiguous portion of a character string.

character type. A data type that consists of alphanumeric characters. See also *data type*.

chunk. A subset of consecutive loop iterations.

collating sequence. The sequence in which the characters are ordered for the purpose of sorting, merging, comparing, and processing indexed data sequentially.

comment. A language construct for the inclusion of text in a program that has no effect on the execution of the program.

common block. A storage area that may be referred to by a calling program and one or more subprograms.

compile. To translate a source program into an executable program (an object program).

compiler comment directive. A line in source code that is not a Fortran statement but is recognized and acted on by the compiler.

compiler directive. Source code that controls what XL Fortran does rather than what the user program does.

complex constant. An ordered pair of real or integer constants separated by a comma and enclosed in parentheses. The first constant of the pair is the real part of the complex number; the second is the imaginary part.

complex number. A number consisting of an ordered pair of real numbers, expressible in the form **a+bi**, where **a** and **b** are real numbers and **i** squared equals -1.

complex type. A data type that represents the values of complex numbers. The value is expressed as an ordered pair of real data items separated by a comma and enclosed in parentheses. The first item represents the real part of the complex number; the second represents the imaginary part.

conform. To adhere to a prevailing standard. An executable program conforms to the Fortran 95 Standard if it uses only those forms and relationships described therein and if the executable program has an interpretation according to the Fortran 95 Standard. A program unit conforms to the Fortran 95 Standard if it can be included in an executable program in a manner that allows the executable program to be standard-conforming. A processor conforms to the standard if it executes standard-conforming programs in a manner that fulfills the interpretations prescribed in the standard.

connected unit. In XL Fortran, a unit that is connected to a file in one of three ways: explicitly via the **OPEN** statement to a named file, implicitly, or by preconnection.

constant. A data object with a value that does not change. The four classes of constants specify numbers (arithmetic), truth values (logical), character data (character), and typeless data (hexadecimal, octal, and binary). See also *variable*.

construct. A sequence of statements starting with a **SELECT CASE**, **DO**, **IF**, or **WHERE** statement, for example, and ending with the corresponding terminal statement.

continuation line. A line that continues a statement beyond its initial line.

control statement. A statement that is used to alter the continuous sequential invocation of statements; a

control statement may be a conditional statement, such as **IF**, or an imperative statement, such as **STOP**.

D

data object. A variable, constant, or subobject of a constant.

data striping. Spreading data across multiple storage devices so that I/O operations can be performed in parallel for better performance. Also known as *disk striping*.

data transfer statement. A **READ**, **WRITE**, or **PRINT** statement.

data type. The properties and internal representation that characterize data and functions. The intrinsic types are integer, real, complex, logical, and character. See also *intrinsic*.

debug line. Allowed only for fixed source form, a line containing source code that is to be used for debugging. Debug lines are defined by a `D` or `X` in column 1. The handling of debug lines is controlled by the **-qdlines** and **-qxlines** compiler options.

default initialization. The initialization of an object with a value specified as part of a derived type definition.

definable variable. A variable whose value can be changed by the appearance of its name or designator on the left of an assignment statement.

delimiters. A pair of parentheses or slashes (or both) used to enclose syntactic lists.

denormalized number. An IEEE number with a very small absolute value and lowered precision. A denormalized number is represented by a zero exponent and a non-zero fraction.

derived type. A type whose data have components, each of which is either of intrinsic type or of another derived type.

digit. A character that represents a nonnegative integer. For example, any of the numerals from 0 through 9.

directive. A type of comment that provides instructions and information to the compiler.

disk striping. See *data striping*.

DO loop. A range of statements invoked repetitively by a **DO** statement.

DO variable. A variable, specified in a **DO** statement, that is initialized or incremented prior to each occurrence of the statement or statements within a **DO** loop. It is used to control the number of times the statements within the range are executed.

DOUBLE PRECISION constant. A constant of type real with twice the precision of the default real precision.

dummy argument. An entity whose name appears in the parenthesized list following the procedure name in a **FUNCTION**, **SUBROUTINE**, **ENTRY**, or statement function statement.

dynamic dimensioning. The process of re-evaluating the bounds of an array each time the array is referenced.

dynamic extent. For a directive, the lexical extent of the directive and all subprograms called from within the lexical extent.

E

edit descriptor. An abbreviated keyword that controls the formatting of integer, real, or complex data.

elemental. Pertaining to an intrinsic operation, procedure or assignment that is applied independently to elements of an array or corresponding elements of a set of conformable arrays and scalars.

embedded blank. A blank that is surrounded by any other characters.

entity. A general term for any of the following: a program unit, procedure, operator, interface block, common block, external unit, statement function, type, named variable, expression, component of a structure, named constant, statement label, construct, or namelist group.

environment variable. A variable that describes the operating environment of the process.

executable program. A program that can be executed as a self-contained procedure. It consists of a main program and, optionally, modules, subprograms and non-Fortran external procedures.

executable statement. A statement that causes an action to be taken by the program; for example, to perform a calculation, test conditions, or alter normal sequential execution.

explicit initialization. The initialization of an object with a value in a data statement initial value list, block data program unit, type declaration statement, or array constructor.

explicit interface. For a procedure referenced in a scoping unit, the property of being an internal procedure, module procedure, intrinsic procedure, external procedure that has an interface block, recursive

procedure reference in its own scoping unit, or dummy procedure that has an interface block.

expression. A sequence of operands, operators, and parentheses. It may be a variable, a constant, or a function reference, or it may represent a computation.

extended-precision constant. A processor approximation to the value of a real number that occupies 16 consecutive bytes of storage.

external file. A sequence of records on an input/output device. See also *internal file*.

external name. The name of a common block, subroutine, or other global procedure, which the linker uses to resolve references from one compilation unit to another.

external procedure. A procedure that is defined by an external subprogram or by a means other than Fortran.

F

field. An area in a record used to contain a particular category of data.

file. A sequence of records. See also *external file*, *internal file*.

file index. See *i-node*.

floating-point number. A real number represented by a pair of distinct numerals. The real number is the product of the fractional part, one of the numerals, and a value obtained by raising the implicit floating-point base to a power indicated by the second numeral.

format. (1) A defined arrangement of such things as characters, fields, and lines, usually used for displays, printouts, or files. (2) To arrange such things as characters, fields, and lines.

formatted data. Data that is transferred between main storage and an input/output device according to a specified format. See also *list-directed* and *unformatted record*.

function. A procedure that returns the value of a single variable or an object and usually has a single exit. See also *intrinsic procedure*, *subprogram*.

G

generic identifier. A lexical token that appears in an **INTERFACE** statement and is associated with all the procedures in an interface block.

H

hard limit. A system resource limit that can only be raised or lowered by using root authority, or cannot be altered because it is inherent in the system or operating environments's implementation. See also *soft limit*.

hexadecimal. Pertaining to a system of numbers to the base sixteen; hexadecimal digits range from 0 (zero) through 9 (nine) and A (ten) through F (fifteen).

hexadecimal constant. A constant, usually starting with special characters, that contains only hexadecimal digits.

high order transformations. A type of optimization that restructures loops and array language.

Hollerith constant. A string of any characters capable of representation by XL Fortran and preceded with *n***H**, where *n* is the number of characters in the string.

host. A main program or subprogram that contains an internal procedure is called the host of the internal procedure. A module that contains a module procedure is called the host of the module procedure.

host association. The process by which an internal subprogram, module subprogram, or derived-type definition accesses the entities of its host.

I

IPA. Interprocedural analysis, a type of optimization that allows optimizations to be performed across procedure boundaries and across calls to procedures in separate source files.

implicit interface. A procedure referenced in a scoping unit other than its own is said to have an implicit interface if the procedure is an external procedure that does not have an interface block, a dummy procedure that does not have an interface block, or a statement function.

implied DO. An indexing specification (similar to a **DO** statement, but without specifying the word **DO**) with a list of data elements, rather than a set of statements, as its range.

infinity. An IEEE number (positive or negative) created by overflow or division by zero. Infinity is represented by an exponent where all the bits are 1's, and a zero fraction.

i-node. The internal structure that describes the individual files in the operating system. There is at least one i-node for each file. An i-node contains the node, type, owner, and location of a file. A table of i-nodes is stored near the beginning of a file system. Also known as *file index*.

input/output (I/O). Pertaining to either input or output, or both.

input/output list. A list of variables in an input or output statement specifying the data to be read or written. An output list can also contain a constant, an expression involving operators or function references, or an expression enclosed in parentheses.

integer constant. An optionally signed digit string that contains no decimal point.

interface block. A sequence of statements from an **INTERFACE** statement to its corresponding **END INTERFACE** statement.

interface body. A sequence of statements in an interface block from a **FUNCTION** or **SUBROUTINE** statement to its corresponding **END** statement.

interference. A situation in which two iterations within a **DO** loop have dependencies upon one another.

internal file. A sequence of records in internal storage. See also *external file*.

interprocedural analysis. See *IPA*.

intrinsic. Pertaining to types, operations, assignment statements, and procedures that are defined by Fortran language standards and can be used in any scoping unit without further definition or specification.

intrinsic module. A module that is provided by the compiler and is available to any program.

intrinsic procedure. A procedure that is provided by the compiler and is available to any program.

K

keyword. (1) A statement keyword is a word that is part of the syntax of a statement (or directive) and may be used to identify the statement. (2) An argument keyword specifies the name of a dummy argument

kind type parameter. A parameter whose values label the available kinds of an intrinsic type.

L

lexical extent. All of the code that appears directly within a directive construct.

lexical token. A sequence of characters with an indivisible interpretation.

link-edit. To create a loadable computer program by means of a linker.

linker. A program that resolves cross-references between separately compiled or assembled object modules and then assigns final addresses to create a single relocatable load module. If a single object module is linked, the linker simply makes it relocatable.

list-directed. A predefined input/output format that depends on the type, type parameters, and values of the entities in the data list.

literal. A symbol or a quantity in a source program that is itself data, rather than a reference to data.

literal constant. A lexical token that directly represents a scalar value of intrinsic type.

load balancing. An optimization strategy that aims at evenly distributing the work load among processors.

logical constant. A constant with a value of either `true` or `false` (or T or F).

logical operator. A symbol that represents an operation on logical expressions:

```
.NOT.    (logical negation)
.AND.    (logical conjunction)
.OR.     (logical union)
.EQV.    (logical equivalence)
.NEQV.   (logical nonequivalence)
.XOR.    (logical exclusive disjunction)
```

loop. A statement block that executes repeatedly.

M

_main. The default name given to a main program by the compiler if the main program was not named by the programmer.

main program. The first program unit to receive control when a program is run. See also *subprogram*.

master thread. The head process of a group of threads.

module. A program unit that contains or accesses definitions to be accessed by other program units.

mutex. A primitive object that provides mutual exclusion between threads. A mutex is used cooperatively between threads to ensure that only one of the cooperating threads is allowed to access shared data or run certain application code at a time.

N

NaN (not-a-number). A symbolic entity encoded in floating-point format that does not correspond to a number. See also *quiet NaN*, *signalling NaN*.

name. A lexical token consisting of a letter followed by up to 249 alphanumeric characters (letters, digits, and underscores). Note that in FORTRAN 77, this was called a symbolic name.

named common. A separate, named common block consisting of variables.

namelist group name. The first parameter in the NAMELIST statement that names a list of names to be used in READ, WRITE, and PRINT statements.

negative zero. An IEEE representation where the exponent and fraction are both zero, but the sign bit is 1. Negative zero is treated as equal to positive zero.

nest. To incorporate a structure or structures of some kind into a structure of the same kind. For example, to nest one loop (the nested loop) within another loop (the nesting loop); to nest one subroutine (the nested subroutine) within another subroutine (the nesting subroutine).

nonexecutable statement. A statement that describes the characteristics of a program unit, data, editing information, or statement functions, but does not cause any action to be taken by the program.

nonexisting file. A file that does not physically exist on any accessible storage medium.

normal. A floating point number that is not denormal, infinity, or NaN.

not-a-number. See *NaN*.

numeric constant. A constant that expresses an integer, real, complex, or byte number.

numeric storage unit. The space occupied by a nonpointer scalar object of type default integer, default real, or default logical.

O

octal. Pertaining to a system of numbers to the base eight; the octal digits range from 0 (zero) through 7 (seven).

octal constant. A constant that is made of octal digits.

one-trip DO-loop. A **DO** loop that is executed at least once, if reached, even if the iteration count is equal to 0. (This type of loop is from FORTRAN 66.)

online processor. In a multiprocessor machine, a processor that has been activated (brought online). The number of online processors is less than or equal to the number of physical processors actually installed in the machine. Also known as *active processor*.

operator. A specification of a particular computation involving one or two operands.

P

pad. To fill unused positions in a field or character string with dummy data, usually zeros or blanks.

paging space. Disk storage for information that is resident in virtual memory but is not currently being accessed.

PDF. See *profile-directed feedback*.

pointee array. An explicit-shape or assumed-size array that is declared in an integer **POINTER** statement or other specification statement.

pointer. A variable that has the **POINTER** attribute. A pointer must not be referenced or defined unless it is pointer associated with a target. If it is an array, it does not have a shape unless it is pointer-associated.

preconnected file. A file that is connected to a unit at the beginning of execution of the executable program. Standard error, standard input, and standard output are preconnected files (units 0, 5 and 6, respectively).

predefined convention. The implied type and length specification of a data object, based on the initial character of its name when no explicit specification is given. The initial characters I through N imply type integer of length 4; the initial characters A through H, O through Z, $, and _ imply type real of length 4.

present. A dummy argument is present in an instance of a subprogram if it is associated with an actual argument and the actual argument is a dummy argument that is present in the invoking procedure or is not a dummy argument of the invoking procedure.

primary. The simplest form of an expression: an object, array constructor, structure constructor, function reference, or expression enclosed in parentheses.

procedure. A computation that may be invoked during program execution. It may be a function or a subroutine. It may be an intrinsic procedure, an external procedure, a module procedure, an internal procedure, a dummy procedure, or a statement function. A subprogram may define more than one procedure if it contains **ENTRY** statements.

profile-directed feedback (PDF). A type of optimization that uses information collected during application execution to improve performance of conditional branches and in frequently executed sections of code.

program unit. A main program or subprogram.

pure. An attribute of a procedure that indicates there are no side effects.

Q

quiet NaN. A NaN (not-a-number) value that does not signal an exception. The intent of a quiet NaN is to propagate a NaN result through subsequent computations. See also *NaN*, *signalling NaN*.

R

random access. An access method in which records can be read from, written to, or removed from a file in any order. See also *sequential access*.

rank. The number of dimensions of an array.

real constant. A string of decimal digits that expresses a real number. A real constant must contain a decimal point, a decimal exponent, or both.

record. A sequence of values that is treated as a whole within a file.

relational expression. An expression that consists of an arithmetic or character expression, followed by a relational operator, followed by another arithmetic or character expression.

relational operator. The words or symbols used to express a relational condition or a relational expression:

```
.GT.        greater than
.GE.        greater than or equal to
.LT.        less than
.LE.        less than or equal to
.EQ.        equal to
.NE.        not equal to
```

result variable. The variable that returns the value of a function.

return specifier. An argument specified for a statement, such as CALL, that indicates to which statement label control should return, depending on the action specified by the subroutine in the RETURN statement.

S

scalar. (1) A single datum that is not an array. (2) Not having the property of being an array.

scale factor. A number indicating the location of the decimal point in a real number (and, on input, if there is no exponent, the magnitude of the number).

scope. That part of an executable program within which a lexical token has a single interpretation.

scope attribute. That part of an executable program within which a lexical token has a single interpretation of a particular named property or entity.

scoping unit. (1) A derived-type definition. (2) An interface body, excluding any derived-type definitions and interface bodies contained within it. (3) A program unit or subprogram, excluding derived-type definitions, interface bodies, and subprograms contained within it.

selector. The object that is associated with the associate name in an **ASSOCIATE** construct.

semantics. The relationships of characters or groups of characters to their meanings, independent of the manner of their interpretation and use. See also *syntax*.

sequential access. An access method in which records are read from, written to, or removed from a file based on the logical order of the records in the file. See also *random access*.

signaling NaN. A NaN (not-a-number) value that signals an invalid operation exception whenever it appears as an operand. The intent of the signaling NaN is to catch program errors, such as using an uninitialized variable. See also *NaN*, *quiet NaN*.

sleep. The state in which a thread completely suspends execution until another thread signals it that there is work to do.

SMP. See *symmetric multiprocessing*.

soft limit. A system resource limit that is currently in effect for a process. The value of a soft limit can be raised or lowered by a process, without requiring root authority. The soft limit for a resource cannot be raised above the setting of the hard limit. See also *hard limit*.

spill space. The stack space reserved in each subprogram in case there are too many variables to hold in registers and the program needs temporary storage for register contents.

specification statement. A statement that provides information about the data used in the source program. The statement could also supply information to allocate data storage.

stanza. A group of lines in a file that together have a common function or define a part of the system. Stanzas are usually separated by blank lines or colons, and each stanza has a name.

statement. A language construct that represents a step in a sequence of actions or a set of declarations. Statements fall into two broad classes: executable and nonexecutable.

statement function. A name, followed by a list of dummy arguments, that is equated with an intrinsic or derived-type expression, and that can be used as a substitute for the expression throughout the program.

statement label. A number from one through five digits that is used to identify a statement. Statement

labels can be used to transfer control, to define the range of a **DO**, or to refer to a **FORMAT** statement.

storage association. The relationship between two storage sequences if a storage unit of one is the same as a storage unit of the other.

structure. A scalar data object of derived type.

structure component. The part of a data object of derived-type corresponding to a component of its type.

subobject. A portion of a named data object that may be referenced or defined independently of other portions. It can be an array element, array section, structure component, or substring.

subprogram. A function subprogram or a subroutine subprogram. Note that in FORTRAN 77, a block data program unit was called a subprogram. See also *main program*.

subroutine. A procedure that is invoked by a **CALL** statement or defined assignment statement.

subscript. A subscript quantity or set of subscript quantities enclosed in parentheses and used with an array name to identify a particular array element.

substring. A contiguous portion of a scalar character string. (Although an array section can specify a substring selector, the result is not a substring.)

symmetric multiprocessing (SMP). A system in which functionally-identical multiple processors are used in parallel, providing simple and efficient load-balancing.

synchronous. Pertaining to an operation that occurs regularly or predictably with regard to the occurrence of a specified event in another process.

syntax. The rules for the construction of a statement. See also *semantics*.

T

target. A named data object specified to have the **TARGET** attribute, a data object created by an **ALLOCATE** statement for a pointer, or a subobject of such an object.

thread. A stream of computer instructions that is in control of a process. A multithread process begins with one stream of instructions (one thread) and may later create other instruction streams to perform tasks.

thread visible variable. A variable that can be accessed by more than one thread.

time slice. An interval of time on the processing unit allocated for use in performing a task. After the interval has expired, processing unit time is allocated to another task, so a task cannot monopolize processing unit time beyond a fixed limit.

token. In a programming language, a character string, in a particular format, that has some defined significance.

trigger constant. A sequence of characters that identifies comment lines as compiler comment directives.

type declaration statement. A statement that specifies the type, length, and attributes of an object or function. Objects can be assigned initial values.

U

unformatted record. A record that is transmitted unchanged between internal and external storage.

Unicode. A universal character encoding standard that supports the interchange, processing, and display of text that is written in any of the languages of the modern world. It also supports many classical and historical texts in a number of languages. The Unicode standard has a 16-bit international character set defined by ISO 10646. See also *ASCII*.

unit. A means of referring to a file to use in input/output statements. A unit can be connected or not connected to a file. If connected, it refers to a file. The connection is symmetric: that is, if a unit is connected to a file, the file is connected to the unit.

unsafe option. Any option that could result in undesirable results if used in the incorrect context. Other options may result in very small variations from the default result, which is usually acceptable. Typically, using an unsafe option is an assertion that your code is not subject to the conditions that make the option unsafe.

use association. The association of names in different scoping units specified by a **USE** statement.

V

variable. A data object whose value can be defined and redefined during the execution of an executable program. It may be a named data object, array element, array section, structure component, or substring. Note that in FORTRAN 77, a variable was always scalar and named.

X

XPG4. X/Open Common Applications Environment (CAE) Portability Guide Issue 4; a document which defines the interfaces of the X/Open Common Applications Environment that is a superset of

POSIX.1-1990, POSIX.2-1992, and POSIX.2a-1992 containing extensions to POSIX standards from XPG3.

Z

zero-length character. A character object that has a length of 0 and is always defined.

zero-sized array. An array that has a lower bound that is greater than its corresponding upper bound. The array is always defined.

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