

IBM XL Fortran Enterprise Edition for AIX, V11.1



Compiler Reference

IBM XL Fortran Enterprise Edition for AIX, V11.1



Compiler Reference

Note!

Before using this information and the product it supports, be sure to read the general information under “Notices” on page 353.

First Edition

This edition applies to IBM XL Fortran Enterprise Edition for AIX, V11.1 (Program number 5724-S72) 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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About this document

This document describes the IBM® XL Fortran Enterprise Edition for AIX®, V11.1 compiler and explains how to set up the compilation environment and how to compile, link, and run programs written 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 AIX 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*.
- 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: *AIX Commands Reference, Volumes 1 - 6* and the AIX information center.

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, “Summary of compiler options by functional category” organizes 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. Chapter 6, “Detailed descriptions of the

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

- Chapter 7, “Using XL Fortran in a 64-Bit Environment” discusses application development for the 64-bit environment.
- Chapter 8, “Problem determination and debugging” through Chapter 10, “Fortran-Related AIX commands” address debugging, understanding compiler listings, and Fortran-related AIX commands.
- 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
<i>italics</i>	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 <i>trigger_constant</i> in fixed source form is 4 for directives that are continued on one or more lines.
<u>underlining</u>	The default setting of a parameter of a compiler option or directive.	nomaf <u>maf</u>
monospace	Examples of program code, command strings, or user-defined names.	Also, specify the following runtime options before running the program, with a command similar to the following: export XLFRT0PTS="err_recovery=no: langlv1=90std"
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 specify -O3 , the compiler assumes -qhot=level=0 . To prevent all HOT optimizations with -O3 , you must specify -qnohot .

Syntax diagrams

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

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.
The **▶**— symbol indicates the beginning of a command, directive, or statement.
The —**▶** symbol indicates that the command, directive, or statement syntax is continued on the next line.

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

The — \blacktriangleleft symbol indicates the end of a command, directive, or statement.

Fragments, which are diagrams of syntactical units other than complete commands, directives, or statements, start with the \mid — symbol and end with the — \mid symbol.

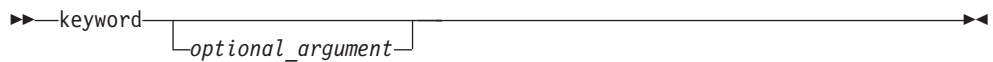
IBM XL Fortran extensions are marked by a number in the syntax diagram with an explanatory note immediately following the diagram.

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.

- Required items are shown on the horizontal line (the main path):

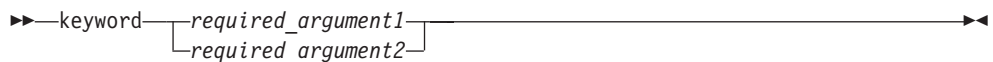


- Optional items are shown below the main path:



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 make more than one choice from the stacked items or repeat an item. The separator character, if it is other than a blank, is also indicated:



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

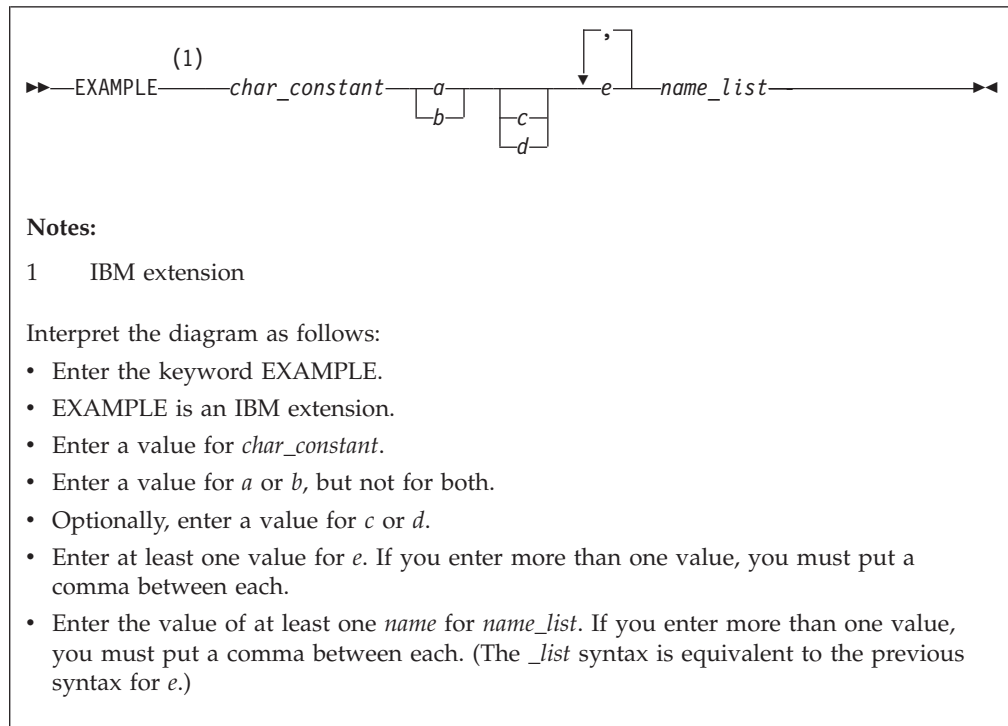


- Keywords are shown in nonitalic letters and should be entered exactly as shown.

- Variables are shown in italicized lowercase letters. They represent user-supplied names or values. If a variable or user-specified name ends in *_list*, you can provide a list of these terms separated by commas.
- If punctuation marks, parentheses, arithmetic operators, or other such symbols are shown, you must enter them as part of the syntax.

Sample syntax diagram

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



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`, `xlF90_r7`, `xlF95`, `xlF95_r`, `xlF95_r7`, `xlF`, `xlF_r`, `xlF_r7`, `xlF2003`, `xlF2003_r`, `f2003`, `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 23.

Some sample programs from this document and some other programs that illustrate ideas presented in this document are in the directory `/usr/lpp/xlf/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: `/usr/lpp/xlf/`

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/usr/lpp/xlf/`

Notes on the terminology used

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

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

Related information

The following sections provide information on documentation related to XL Fortran:

- “IBM XL Fortran publications”
- “Standards and specifications documents” on page xiii
- “Other IBM publications” on page xiii

IBM XL Fortran publications

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 XL Fortran 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 Enterprise Edition for AIX, V11.1 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 online information center are provided in the *IBM XL Fortran Enterprise Edition for AIX, V11.1 Installation Guide*. The information center is also viewable on the Web at <http://publib.boulder.ibm.com/infocenter/comphelp/v9v111/index.jsp>.

- PDF documents

PDF documents are located by default in the `/usr/lpp/xlf/doc/LANG/pdf/` directory, where *LANG* is one of `en_US` or `ja_JP`. The PDF files are also available on the Web at <http://www.ibm.com/software/awdtools/fortran/xlfortran/library>.

The following files comprise the full set of XL Fortran product manuals:

Table 2. XL Fortran PDF files

Document title	PDF file name	Description
<i>IBM XL Fortran Enterprise Edition for AIX, V11.1 Installation Guide</i> , GC23-5834-00	install.pdf	Contains information for installing XL Fortran and configuring your environment for basic compilation and program execution.
<i>Getting Started with IBM XL Fortran Enterprise Edition for AIX, V11.1</i> , GC23-5835-00	getstart.pdf	Contains an introduction to the XL Fortran product, with information on setting up and configuring your environment, compiling and linking programs, and troubleshooting compilation errors.
<i>IBM XL Fortran Enterprise Edition for AIX, V11.1 Compiler Reference</i> , SC23-5833-00	cr.pdf	Contains information about the various compiler options and environment variables.
<i>IBM XL Fortran Enterprise Edition for AIX, V11.1 Language Reference</i> , SC23-5832-00	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.
<i>IBM XL Fortran Enterprise Edition for AIX, V11.1 Optimization and Programming Guide</i> , SC23-5836-00	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.

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

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

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

Standards and specifications documents

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

- *American National Standard Programming Language FORTRAN, ANSI X3.9-1978.*
- *American National Standard Programming Language Fortran 90, ANSI X3.198-1992.*
- *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 - Part 1: Base language, ISO/IEC 1539-1:2004. (This document uses its informal name, Fortran 2003.)*
- *Information technology - Programming languages - Fortran - Enhanced data type facilities, ISO/IEC JTC1/SC22/WG5 N1379.*
- *Information technology - Programming languages - Fortran - Floating-point exception handling, 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, available at <http://www.openmp.org>*

Other IBM publications

- *AIX Commands Reference, Volumes 1 - 6, SC23-4888*
- *AIX Technical Reference: Base Operating System and Extensions, Volumes 1 & 2, SC23-4913*
- *AIX National Language Support Guide and Reference, SC23-4902*
- *AIX General Programming Concepts: Writing and Debugging Programs, SC23-4896*
- *AIX Assembler Language Reference, SC23-4923*

All AIX documentation is available at <http://publib.boulder.ibm.com/infocenter/pseries/v5r3/index.jsp>.

- *ESSL for AIX V4.2 Guide and Reference, SA22-7904, available at <http://publib.boulder.ibm.com/infocenter/clresctr/index.jsp>*

Technical support

Additional technical support is available from the XL Fortran Support page at <http://www.ibm.com/software/awdtools/fortran/xlfortran/support>. This page provides a portal with search capabilities to a large selection of technical support FAQs and other support documents.

If you cannot find what you need, you can send e-mail to 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 Enterprise Edition for AIX, V11.1 is an optimizing, standards-based, command-line compiler for the AIX 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 AIX 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 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 V11.1 compiler is supported on the Version 5.2, or higher, AIX operating system. See the *IBM XL Fortran Enterprise Edition for AIX, V11.1 Installation Guide* and README file for a list of requirements.

The compiler, its generated object programs, and runtime library should run on all RISC System/6000® (RS/6000®) or pSeries® systems with the required software, disk space, and virtual storage.

The POWER3™, POWER4™, POWER5™, POWER5+™, or POWER6™ processor is a type of PowerPC. In this document, any statement or reference to the PowerPC also applies to the POWER3, POWER4, POWER5, POWER5+, or POWER6 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 and Fortran 2003 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, partial Fortran 2003 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 `xl`, `xl_r`, `xl_r7`, `f77`, and `fort77` commands provide maximum compatibility with existing FORTRAN 77 programs. The default options provided with the `f90`, `xl_f90`, `xl_f90_r`, and `xl_f90_r7` commands give access to the full range of Fortran 90 language features. The default options provided with the `f95`, `xl_f95`, `xl_f95_r`, and `xl_f95_r7` commands give access to the full range of Fortran 95 language features. The default options provided with the `f2003`, `xl_f2003`, and `xl_f2003_r` commands give access to the full range of Fortran 2003 language features.

Additionally, you can name your source files with extensions such as `.f77`, `.f90`, `.f95`, or `.f03` and use the generic compiler invocations such as `xl` or `xl_r` to automatically select language-level appropriate defaults.

To protect your investments in FORTRAN 77 object code, you can link Fortran 90 and Fortran 95 programs with existing FORTRAN 77 object modules and libraries. See “Linking new objects with existing ones” on page 39 for details.

Source-code conformance checking

To help you find anything in your programs that might cause problems when you port to or from different FORTRAN 77, Fortran 90, Fortran 95, or Fortran 2003 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 American National Standard FORTRAN 77 (`-qlanglvl=77std` option), full American National Standard Fortran 90 (`-qlanglvl=90std` option), full Fortran 95 standard (`-qlanglvl=95std` option), and full Fortran 2003 Standard (`-qlanglvl=2003std` 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 `xl f`, `xl f_r`, `xl f_r7`, `xl f90`, `xl f90_r`, `xl f90_r7`, `xl f95`, `xl f95_r`, `xl f95_r7`, `f95`, `xl f2003`, `xl f2003_r`, `f2003`, `f77`, or `fort77` command. The `xl f`, `xl f_r`, `xl f_r7`, and `f77` commands maintain maximum compatibility with the behavior and I/O formats of XL Fortran Version 2. The `xl f90`, `xl f90_r`, `xl f90_r7`, and `f90` commands provide more Fortran 90 conformance and some implementation choices for efficiency and usability. The `f95`, `xl f95`, `xl f95_r`, and `xl f95_r7` commands provide more Fortran 95 conformance and some implementation choices for efficiency and usability. The `xl f2003`, `xl f2003_r`, and `f2003` commands provide more Fortran 2003 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 `xl f_r`, `xl f_r7`, `xl f90_r`, `xl f90_r7`, `xl f95_r`, `xl f95_r7`, and `xl f2003_r` commands and the set of `xl f`, `xl f90`, `f90`, `xl f95`, `f95`, `xl f2003`, `f2003`, `f77`, and `fort77` commands is that the first set links and binds the object files to the thread-safe components (libraries, `crt0_r.o`, 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:

```
xl f -F/etc/xl f.cfg.53:xl f_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 edit the default configuration file or use a customized configuration file instead of creating many separate aliases or shell scripts.

Related information:

- “Using custom compiler configuration files” on page 11
- “Compiling XL Fortran programs” on page 23
- Chapter 5, “Summary of compiler options by functional category,” on page 57 and Chapter 6, “Detailed descriptions of the XL Fortran compiler options,” on page 73
- “Understanding XL Fortran messages” on page 318

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 “Listings, messages, and compiler information” on page 63 and Chapter 9, “Understanding XL Fortran compiler listings,” on page 335.

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

Symbolic debugger support

You can use `dbx` 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 **README**, and follow any directions it gives. It contains information that you should know and possibly distribute to other people who use XL Fortran. (README files are located by default in the XL Fortran directory and in the root directory of the installation media.)
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. Read the *AIX Installation and migration* to understand the full procedure for installing optional software from the distribution medium. This document provides good step-by-step instructions that should answer all your questions and should help you to solve any installation problems.

If you are already experienced with AIX software installation, you can use the **installp** or **smit installp** 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 under **/usr** contain XL Fortran components:

- **/usr/bin** contains the compiler invocation commands.
- **/usr/lib** contains the libraries.
- **/usr/lpp/xf** contains executables and files that the compiler needs.
- **/usr/include** contains the include files, some of which contain definitions that XL Fortran uses.
- **/usr/lib/nls/msg** contains the message catalog files that XL Fortran uses.
- **/usr/lpp/xlfrtemsg** contains the default message catalog files that are used by XL Fortran programs.
- **/usr/share/man/cat1** contains the compiler man pages.

You must copy the **/etc/xf.cfg.nn** (where *nn* indicates which OS version the configuration file is for) file from the server to the client. The **/etc** 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. If you are not sure which shell is in use, a quick way to find out is to issue an **echo \$0**. This provides a different result in each shell:

```
$ sh
$ echo $0
sh
$ ksh
$ echo $0
ksh
$ csh
% echo $0
No file for $0.
%
```

The Bourne shell path is **/bin/sh**, the Korn shell path is **/bin/ksh**, and the C shell path is **/bin/csh**.

To set the environment variables so that everyone on the system has access to them, set the variables in the file **/etc/profile** (for the Bourne or the Korn shell), or set the variables in the file **/etc/csh.login** or in the file **/etc/csh.cshrc** (for the C shell). To set them for a specific user only, add the appropriate commands to the appropriate **.profile** or **.cshrc** file in the user's home directory. The variables are set the next time the user logs on.

For more information about setting environment variables, see the *AIX Commands Reference, Volumes 1 - 6*.

The following examples show how to set environment variables from various shells.

From the Bourne or Korn shell:

```
NLSPATH=/usr/lib/nls/msg/%L/%N:/usr/lib/nls/msg/prime/%N
LANG=en_US
TMPDIR=/home/joe/temp
export LANG NLSPATH TMPDIR
```

From the C shell:

```
setenv LANG en_US
setenv NLSPATH /usr/lib/nls/msg/%L/%N:/usr/lib/nls/msg/prime/%N
setenv TMPDIR /home/joe/temp
```

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 **ksh** 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 with the **IBM_eucJP** code page, use the following commands from the Bourne or Korn shell:

```
LANG=ja_JP
NLSPATH=/usr/lib/nls/msg/%L/%N:/usr/lib/nls/msg/prime/%N
export LANG NLSPATH
```

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 runtime messages” on page 44.

See *AIX General Programming Concepts: Writing and Debugging Programs* for more information about National Language Support environment variables and locale concepts.

LIBPATH: Setting library search paths

Under normal circumstances, you only need **LIBPATH** if shared libraries are located in different directories at run time from those that they are in at compile time. To use **LIBPATH**, set it at run time to the names of any directories that contain required user libraries, plus **/usr/lib**:

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

# When the libraries are in the same directories as at compile
# time, the program finds them.
a.out

# If libmylib1.a and libmylib2.a are moved to /usr/lib/mydir3,
# you must set the LIBPATH variable:
export LIBPATH=/usr/lib/mydir3:/usr/lib
a.out
```

When running the compiler, ensure that the library **libxlf90.a** is in **/usr/lib** or is in a directory named in the **LIBPATH** setting. Otherwise, you cannot run the compiler, because it is dynamically linked with the **libxlf90.a** library.

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 runtime 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 runtime 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.

Using custom compiler configuration files

XL Fortran generates a default configuration file `/etc/xlf.cfg.nm` at installation time, where *nm* indicates which OS version the configuration file is for. The configuration file specifies information that the compiler uses when you invoke it.

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

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

You have several options for customizing configuration files:

- You can directly edit the default configuration file. In this case, the customized options will apply for all users for all compilations. The disadvantage of this option is that you will need to reapply your customizations to the new default configuration file that is provided every time you install a compiler update. Also, if you upgrade the operating system, you must change the symbolic links to the configuration file in `/etc/` to point to the correct version of the configuration file.
- You can use the default configuration file as the basis of customized copies that you specify at compile time with the `-F` option. In this case, the custom file overrides the default file on a per-compilation basis. Again, the disadvantage of this option is that you will need to reapply your customizations to the new default configuration file that is provided every time you install a compiler update.
- You can create custom, or user-defined, configuration files that are specified at compile time with the `XLF_USR_CONFIG` environment variable. In this case, the custom user-defined files complement, rather than override, the default configuration file, and they can be specified on a per-compilation or global basis. The advantage of this option is that you do not need to modify your existing,

custom configuration files when a new system configuration file is installed during an update installation. Procedures for creating custom, user-defined configuration files are provided below.

Related information:

- “-F” on page 92

Creating custom configuration files

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

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

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

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

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

Figure 1. Sample configuration file

In this example:

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

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

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

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

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

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

DEFLT:
     options=<C>
```

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

Figure 3. Default configuration file xlf.cfg

Overriding the default order of attribute values

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

Table 3. Assignment operators and attribute ordering

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

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

```

xlf_prepend: use=xlf
             options=-<B1>

xlf_replace: use=xlf
             options=-<B2>

xlf_append: use=xlf
            options+=<B3>

DEFLT: use=DEFLT
       options=-<D>

```

Figure 4. Custom user-defined configuration file `/etc/userconfig2`

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

1. stanza `xlf` uses `B`, `D`, and `C`
2. stanza `xlf_prepend` uses `B1`, `B`, `D`, and `C`
3. stanza `xlf_replace` uses `B2`
4. stanza `xlf_append` uses `B`, `D`, `C`, and `B3`

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

```

xlf:
  use=xlf
  options==-Isome_include_path
  options+=some options

```

Figure 6. Using additional assignment operations

Examples of stanzas in custom configuration files

DEFLT: use=DEFLT options = -g	This example specifies that the <code>-g</code> option is to be used in all compilations.
xlf: use=xlf options+==-qlist xlf_r: use=xlf_r options+==-qlist	This example specifies that <code>-qlist</code> be used for any compilation invoked by the <code>xlf</code> and <code>xlf_r</code> commands. This <code>-qlist</code> specification overrides the default setting of <code>-qlist</code> specified in the system configuration file.
DEFLT: use=DEFLT libraries=-L/home/user/lib,-lmylib	This example specifies that all compilations should link with <code>/home/user/lib/libmylib.a</code> .

Editing the default configuration file

The configuration file specifies information that the compiler uses when you invoke it. XL Fortran provides the configuration files `/etc/xlf.cfg.mm`, for the AIX versions that the compiler supports. *mm* indicates which operating system version the configuration file is for. For example, `/etc/xlf.cfg.52` is the configuration file for AIX version 5.2 and by default, the compiler will use this file on AIX version 5.2.

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 /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 configuration file and then move or copy your makefiles to another system, you will also need to copy the changed configuration file.
3. Installing a compiler update or program temporary fix (PTF) or an upgrade may overwrite the configuration files under the `/etc/` directory. The installation will save the old version of the configuration files under the `/lpp/save.config/` directory. You will need to compare the saved files and the newly installed files to determine if you need to recover configuration data.
4. If you upgrade the operating system and if you made modifications in the configuration file for the lower operating system version, you will need to compare the configuration file for the lower OS version with the configuration file for the higher OS version after the upgrade to determine if you need to recover configuration data. For more information on operating system migration, please refer to the *Operating system migration* section in the *XL Fortran Installation Guide*.
5. 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.
6. The `xlF_r`, `xlF90_r`, `xlF95_r`, and `xlF2003_r` stanzas support the operating system default thread interface: that is, the POSIX1003.1-1996 standard for AIX Version 5.2 and higher levels of the AIX operating system.
7. If you are mixing Message-Passing Interface (MPI) and threaded programming, use the appropriate stanza in the `xlF.cfg` file to link in the proper libraries and to set the correct default behavior:
 - `mpxlF_r` Specifies `xlF_r` behavior when mixing MPI and threaded programming. You access this stanza by specifying the `mpxlF_r` command.
 - `mpxlF_r7` Specifies `xlF_r7` behavior when mixing MPI and threaded programming. You access this stanza by specifying the `mpxlF_r` command with the `-d7` option. The level of POSIX pthreads API support is Draft 7.
 - `mpxlF90_r` Specifies `xlF90_r` behavior when mixing MPI and threaded programming. You access this stanza by specifying the `mpxlF90_r` command.
 - `mpxlF90_r7` Specifies `xlF90_r7` behavior when mixing MPI and threaded programming. You access this stanza by specifying the `mpxlF90_r` command with the `-d7` option. The level of POSIX pthreads API support is Draft 7.
 - `mpxlF95_r` Specifies `xlF95_r` behavior when mixing MPI and threaded programming. You access this stanza by specifying the `mpxlF95_r` command.
 - `mpxlF95_r7` Specifies `xlF95_r7` behavior when mixing MPI and threaded programming. You access this stanza by specifying the

mpxlf2003_r **mpxlf95_r** command with the **-d7** option. The level of POSIX pthreads API support is Draft 7.

mpxlf2003_r Specifies **xf2003_r** behavior when mixing MPI and threaded programming. You access this stanza by specifying the **mpxlf2003_r** command.

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.
cpp	The absolute path name of the C preprocessor, which is automatically called for files ending with a specific suffix (usually .F).
xf	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.
xfopt	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	<p>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.</p> <p>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.</p>
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 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” on page 265.
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.
proflibs	-L options, which are separated by commas, that specify the path where the linker searches for additional libraries for profiled programs.
smplibraries	Specifies the libraries that are used to link programs that you compiled with the -qsmpl 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” on page 92 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:

```
ls1pp -h "*xlf*"
```

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

To check the level of the compiler executable itself, issue the command:

```
what /usr/lpp/xlf/bin/xlffentry
```

If the compiler is installed in a different directory, use the appropriate path name for the `xlffentry` file.

You can also use the `-qversion` compiler option to display the version, release, and level of the compiler and its components.

Upgrading to XL Fortran V11.1

Here is some advice to help make the transition from an earlier version of the XL Fortran compiler as fast and simple as possible.

Things to note in XL Fortran V11.1

Because XL Fortran V11.1 is highly compatible with XL Fortran Versions 10 through 3 inclusive, most of the advice in this section applies to upgrades from Version 2, or earlier levels of XL Fortran.

- The `f90`, `xlf90`, `xlf90_r`, and `xlf90_r7` commands provide Fortran 90 conformance, and the `f95`, `xlf95`, `xlf95_r`, and `xlf95_r7` commands provide Fortran 95 conformance. However, these commands may cause some problems with existing FORTRAN 77 programs. The `xlf`, `xlf_r`, `xlf_r7`, `f77`, and `fort77` commands avoid some of these problems by keeping the old behavior wherever possible.

- Fortran 90 introduced the idea of kind parameters for types. Except for the types complex and character, XL Fortran uses numeric kind parameters that correspond to the lengths of the types. For the type complex, the kind parameter is equal to the length of the real portion, which is half of the overall length. For the type character, the kind parameter is equal to the number of bytes that are required to represent each character, and this value is 1. A FORTRAN 77 declaration that is written using the * extension for length specifiers can now be rewritten with a kind parameter:

```

INTEGER*4 X ! F77 notation with extension.
INTEGER(4) X ! F90 standard notation.
COMPLEX*8 Y ! *n becomes (n) for all types except
COMPLEX(4) Y ! COMPLEX, where the value is halved.

```

This new form is the one we use consistently throughout the XL Fortran manuals.

Because the values of kind parameters may be different for different compilers, you may want to use named constants, placed in an include file or a module, to represent the kind parameters used in your programs. The **SELECTED_CHAR_KIND**, **SELECTED_INT_KIND** and **SELECTED_REAL_KIND** intrinsic functions also let you determine kind values in a portable way.

- Fortran 90 introduced a standardized free source form for source code, which is different from the XL Fortran Version 2 free source form. The **-qfree** and **-k** options now use the Fortran 90 free source form; the Version 2 free source form is available through the option **-qfree=ibm**.
- The library that provides Fortran 90, Fortran 95, and Fortran 2003 support is **libxlf90.a**, located in **/usr/lib**. A **libxlf.a** library of stub routines is provided in **/usr/lib**, but it is only used for linking existing Version 1 or 2 object files or running existing executables. When a Version 1 or Version 2 object file calls entry points in **libxlf.a**, those entry points then call equivalent entry points in **libxlf90.a**. If you recompile such object files, the result could be improved I/O performance, because the entry points in **libxlf90.a** are called directly.

Avoiding or fixing upgrade problems

Although XL Fortran is generally backward-compatible with FORTRAN 77 programs, there are some changes in XL Fortran and the Fortran 90, Fortran 95, and Fortran 2003 languages that you should be aware of.

To preserve the behavior of existing compilation environments, the **xlf** and **f77** commands both work as they did in earlier XL Fortran versions wherever possible. As you write entirely new Fortran 90, Fortran 95, or Fortran 2003 programs or adapt old programs to avoid potential problems, you can begin using the **xlf90**, **xlf95**, and **xlf2003** commands, which use Fortran 90, Fortran 95, and Fortran 2003 conventions for source-code format.

Note that in the following table, you can substitute **xlf_r** or **xlf_r7** for **xlf**, **xlf90_r** or **xlf90_r7** for **xlf90**, and **xlf95_r** or **xlf95_r7** for **xlf95**, or **xlf2003_r** for **xlf2003**.

Table 4. Potential problems migrating programs to XL Fortran V11.1. The column on the right shows which problems you can avoid by using the **xlf** or **f77** command.

Potential Problem	Solution or Workaround	xlf Avoids?
Compilation Problems		

Table 4. Potential problems migrating programs to XL Fortran V11.1 (continued). The column on the right shows which problems you can avoid by using the `xlf` or `f77` command.

Potential Problem	Solution or Workaround	xlf Avoids?
New intrinsic procedure names may conflict with external procedure names. The intrinsic procedure is called instead of the external procedure.	Use the <code>-qextern</code> option, or insert <code>EXTERNAL</code> statements to avoid the ambiguity. Consider switching to the Fortran 90 or Fortran 95 procedure if it does what you want.	
The <code>.XOR.</code> intrinsic operator is not recognized.	Use the option <code>-qxlf77=intxor.</code>	✓
Zero-sized objects are not allowed by the compiler.	Use the <code>xlf90</code> or <code>xlf95</code> command, or use the <code>-qzerosize</code> option with the <code>xlf</code> or <code>f77</code> command.	
Performance / Optimization Problems		
Existing programs or programs linked with older XL Fortran object files run more slowly or do not show expected performance improvements on new hardware.	Recompile everything.	
Programs compiled with <code>-O3</code> or <code>-qhot</code> optimization behave differently from those unoptimized (different results, exceptions, or compilation messages).	Try adding the <code>-qstrict</code> option.	
The option combination <code>-O</code> and <code>-1</code> cannot be abbreviated <code>-O1</code> , to avoid misunderstandings. (There are <code>-O2</code> , <code>-O3</code> , <code>-O4</code> , and <code>-O5</code> optimization levels, but there is no <code>-O1</code> .)	Specify <code>-O</code> and <code>-1</code> as separate options.	
Programs that use integer <code>POINTERS</code> produce incorrect results when optimized.	Specify the option <code>-qalias=intptr</code> with the <code>xlf90</code> or <code>xlf95</code> command, or use the <code>xlf</code> command.	✓
Runtime problems		
Programs that read to the end of the file and then try to append records without first executing a <code>BACKSPACE</code> statement do not work correctly. The write requests generate error messages.	To compile existing programs, specify the option <code>-qxlf77=softeof</code> with the <code>xlf90</code> or <code>xlf95</code> command, or use the <code>xlf</code> command. For new programs, add the <code>BACKSPACE</code> statement before writing past the endfile record.	✓
Uninitialized variables are not necessarily set to zero, and programs that ran before may exceed the user stack limit. The reason is that the default storage class is now <code>AUTOMATIC</code> , rather than <code>STATIC</code> (an implementation choice allowed by the language).	Ensure that you explicitly initialize your variables, use the <code>-qsave</code> option with the <code>xlf90</code> or <code>xlf95</code> command, or add <code>SAVE</code> statements where needed in the source.	✓

Table 4. Potential problems migrating programs to XL Fortran V11.1 (continued). The column on the right shows which problems you can avoid by using the **xl**f or **f77** command.

Potential Problem	Solution or Workaround	xl
Writing data to some files opened without a POSITION= specifier overwrites the files, instead of appending the data.	Use the option -qposition=appendold , or add POSITION= specifiers where needed.	✓
Newly compiled programs are unable to read existing data files containing NAMELIST data. The reason is that the Fortran 90 and Fortran 95 standards define a namelist format that is different from that used on AIX in the past.	Set the environment variable XLFRTEOPTS to the string namelist=old . The programs that produced the old NAMELIST data must be recompiled.	
Some I/O statements and edit descriptors accept or produce slightly different input and output. For example, real output now has a leading zero when appropriate. The changes to I/O formats are intended to be more usable and typical of industry practice, so you should try to use the defaults for any new data you produce.	When you need to maintain compatibility with existing data files, compile with the xl f command. If the incompatibility is due to a single specific I/O change, see if the -qxl f77 option has a suboption for backward compatibility. If so, you can switch to the xl f90 or xl f95 command and use the -qxl f77 option on programs that use the old data files.	✓
Numeric results and I/O output are not always exactly identical with XL Fortran Version 2. Certain implementation details of I/O, such as spacing in list-directed output and the meanings of some IOSTAT values, have changed since XL Fortran Version 2. (This entry is similar to the previous one except that these differences have no backward-compatibility switches.)	You may need to generate existing data files again or to change any programs that depend on these details. When no backward-compatibility switch is provided by the -qxl f77 compiler option or XLFRTEOPTS runtime options, there is no way to get the old behavior back.	
SIGN(A,B) now returns $- A $ when B = -0.0 . Prior to XL Fortran Version 7.1, it returned $ A $.	This behavior conforms with the Fortran 95 standard and is consistent with the IEEE standard for binary floating-point arithmetic. It occurs because the -qxl f90= signedzero option is turned on. Turn it off, or specify a command that does not use this option by default.	✓

Table 4. Potential problems migrating programs to XL Fortran V11.1 (continued). The column on the right shows which problems you can avoid by using the `xlf` or `f77` command.

Potential Problem	Solution or Workaround	xlf Avoids?
A minus sign is printed for a negative zero in formatted output. A minus sign is printed for negative values that have an outputted form of zero (that is, in the case where trailing non-zero digits are truncated from the output so that the resulting output looks like zero). Prior to XL Fortran Version 7.1, minus signs were not printed in these situations.	This behavior conforms with the Fortran 95 standard and occurs because the <code>-qxlf90=signedzero</code> option is turned on. Turn it off, or specify a command that does not use this option by default.	✓
The handling of IEEE infinity and not-a-number (NaN) exceptional values has changed. By default, XL Fortran displays IEEE infinity and NaN exceptional values based on the command used to compile the source code. This can result in a mixture of IEEE exceptional value outputs if there are multiple object files that were compiled with different options.	XL Fortran allows control over the display of IEEE infinity and NaN exceptional values. To get the previous behavior, set the <code>XLFRTEOPTS</code> environment variable to the <code>naninfoutput=old</code> string.	✓

Related information:

- “Compiling for specific architectures” on page 33
- “Setting runtime options” on page 44
- “-qalias” on page 112
- “-qextern” on page 155
- “-qposition” on page 231
- “-qsave” on page 242
- “-qxlf77” on page 289

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 AIX 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. Before using the compiler for a specialized purpose, such as porting or performance tuning, look at the categories of options in Chapter 5, “Summary of compiler options by functional category,” on page 57 to see if XL Fortran already provides a solution.
3. To learn more about writing and optimizing XL Fortran programs, refer to the *XL Fortran Language Reference* and *XL Fortran Optimization and Programming Guide*.

`libxlf90.a` is provided for both threaded and non-threaded applications. XL Fortran determines at run time whether your application is threaded.

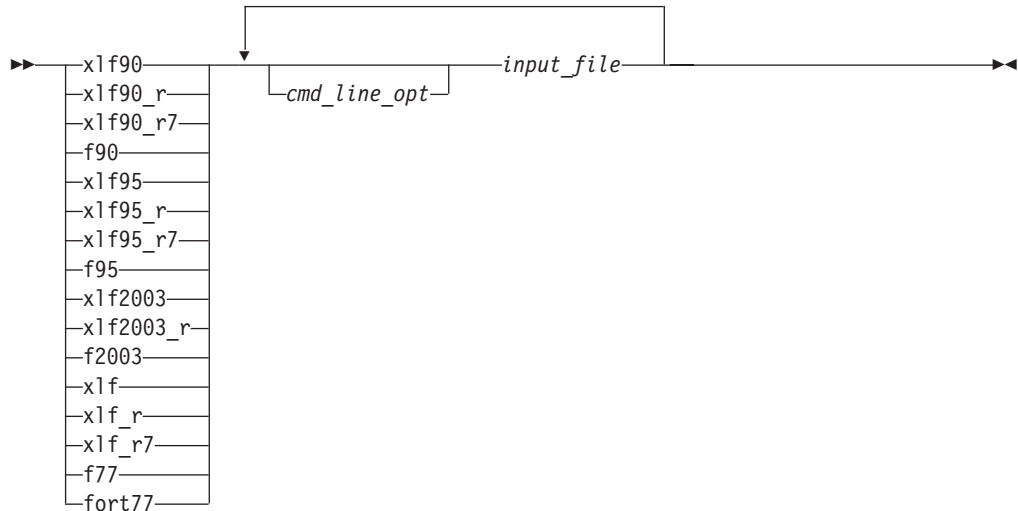
Editing XL Fortran source files

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`, `.f95`, or `.f03` 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`, `xlf90_r7`, `f90`, `xlf95`, `xlf95_r`, `xlf95_r7`, `f95`, `xlf2003`, `xlf2003_r`, `f2003`, `xlf`, `xlf_r`, `xlf_r7`, `f77`, or `fort77` 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/xlf.cfg.nn` where *nn* represents the operating system level).

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`, `xlf_r7`, `xlf90_r`, `xlf90_r7`, `xlf95_r`, `xlf95_r7`, and `xlf2003_r`, commands use the thread-safe components (libraries, `crt0_r.o`, and so on) to link and bind object files.

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

Table 5. XL Fortran Invocation commands

Driver Invocation	Path or Location	Chief Functionality	Linked Libraries
<code>xlf90</code> , <code>f90</code>	<code>/usr/bin</code>	Fortran 90	<code>libxlf90.a</code>
<code>f90</code>	<code>/usr/bin</code>	Fortran 90	<code>libxlf90.a</code>
<code>xlf90_r</code>	<code>/usr/bin</code>	Threadsafe Fortran 90, operating system default POSIX pthreads API	<code>libxlf90.a</code>
<code>xlf90_r7</code>	<code>/usr/bin</code>	Threadsafe Fortran 90, Draft 7 POSIX pthreads API	<code>libxlf90.a</code>
<code>xlf95</code> , <code>f95</code>	<code>/usr/bin</code>	Fortran 95	<code>libxlf90.a</code>
<code>f95</code>	<code>/usr/bin</code>	Fortran 95	<code>libxlf90.a</code>
<code>xlf95_r</code>	<code>/usr/bin</code>	Threadsafe Fortran 95, operating system default POSIX pthreads API	<code>libxlf90.a</code>
<code>xlf95_r7</code>	<code>/usr/bin</code>	Threadsafe Fortran 95, Draft 7 POSIX pthreads API	<code>libxlf90.a</code>
<code>xlf2003</code>	<code>/usr/bin</code>	Fortran 2003	<code>libxlf90.a</code>
<code>xlf2003_r</code>	<code>/usr/bin</code>	Threadsafe Fortran 2003, operating system default POSIX pthreads API	<code>libxlf90.a</code>
<code>f2003</code>	<code>/usr/bin</code>	Fortran 2003	<code>libxlf90.a</code>

Table 5. XL Fortran Invocation commands (continued)

Driver Invocation	Path or Location	Chief Functionality	Linked Libraries
xlf	/usr/bin	FORTRAN 77	libxlf90.a
xlf_r	/usr/bin	Threadsafe FORTRAN 77, operating system default POSIX pthreads API	libxlf90.a
xlf_r7	/usr/bin	Threadsafe FORTRAN 77, Draft 7 POSIX pthreads API	libxlf90.a
f77 or fort77	/usr/bin	FORTRAN 77	libxlf90.a

The invocation commands have the following implications for directive triggers:

- For **f77**, **fort77**, **f90**, **f95**, **f2003**, **xlf**, **xlf90**, **xlf95**, and **xlf2003**, 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.a**, in addition to **libxlf90.a**. It will be installed as **/usr/lib/libxlf90_t.a** 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.a** when an application is threaded, you can use **libxlf90_t.a** in multithreaded applications where there is only one Fortran thread.

When you bind a multithreaded executable with multiple Fortran threads, **-lxlf90** should appear instead of **-lxlf90_t** in the command line. Note that using the **xlf_r**, **xlf_r7**, **xlf90_r**, **xlf90_r7**, **xlf95_r**, **xlf95_r7**, or **xlf2003_r** invocation command ensures the proper linking.

Compiling XL Fortran Version 2 programs

xlf maintains, wherever possible, compatibility with existing programs by using the same I/O formats as earlier versions of XL Fortran and some implementation behavior compatible with FORTRAN 77.

f77 is identical to **xlf** (assuming that the configuration file has not been customized).

You may find that you need to continue using these commands for compatibility with existing makefiles and build environments. However, be aware that programs that you compile with these commands may not conform to the Fortran 90 or Fortran 95 standard in subtle ways.

Compiling Fortran 90 or Fortran 95 programs

The `f90`, `xl f90`, `xl f90_r`, and `xl f90_r7` commands make your programs conform more closely to the Fortran 90 standard than do the `xl f`, `xl f_r`, `xl f_r7`, and `f77/fort77` commands. The `f95`, `xl f95`, `xl f95_r`, and `xl f95_r7` commands make your programs conform more closely to the Fortran 95 standard than do the `xl f`, `xl f_r`, `xl f_r7`, and `f77/fort77` commands. `f90`, `xl f90`, `xl f90_r`, `xl f90_r7`, `f95`, `xl f95`, `xl f95_r`, and `xl f95_r7` 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`, `xl f90`, `xl f90_r`, and `xl f90_r7` commands and the set of `f95`, `xl f95`, `xl f95_r`, and `xl f95_r7` commands. We recommend that you switch to the Fortran 95 formats for data files whenever possible.

By default, the `f90`, `xl f90`, `xl f90_r`, and `xl f90_r7` commands do not conform completely to the Fortran 90 standard. Also, by default, the `f95`, `xl f95`, `xl f95_r`, and `xl f95_r7` 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:rndsngl:nofold -qnoswapomp
-qlanglvl=90std
-qlanglvl=95std
```

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

```
export XLF RTEOPTS="err_recovery=no:langlvl=90std"
export XLF RTEOPTS="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 Fortran 2003 programs

The `f2003`, `xl f2003`, and `xl f2003_r` commands make your programs conform more closely to the Fortran 2003 Standard than do the `xl f`, `xl f_r`, or `xl f_r7` commands. The Fortran 2003 commands accept free source form by default. I/O formats for the Fortran 2003 commands are the same as for the `f95`, `xl f95`, `xl f95_r`, and `xl f95_r7` commands. The Fortran 2003 commands format infinity and NaN floating-point values differently from previous commands.

By default, the `f2003`, `xl f2003`, and `xl f2003_r` commands do not conform completely to the Fortran 2003 standard. If you need full compliance, compile with the following additional compiler suboptions:

```
-qlanglvl=2003std -qnodirective -qnoescape -qextname -qfloat=nomaf:rndsngl:nofold
-qnoswapomp -qstrictieemod
```

Also specify the following runtime options:

```
XLF RTEOPTS="err_recovery=no:langlvl=2003std:iostat_end=2003std:internal_nldelim=2003std"
```

Compiling XL Fortran SMP programs

You can use the `xl f_r`, `xl f_r7`, `xl f90_r`, `xl f90_r7`, `xl f95_r`, `xl f95_r7` or `xl f2003_r` command to compile XL Fortran SMP programs. The `xl f_r` and `xl f_r7` commands

are similar to the `xlf` command; the `xlf90_r` and `xlf90_r7` commands are similar to the `xlf90` command; the `xlf95_r` and `xlf95_r7` commands are similar to the `xlf95` command; the `xlf2003_r` command is similar to the `xlf2003` command. The main difference is that the thread-safe components (libraries, `crt0_r.o`, and so on) are used to link and bind the object files if you specify the `xlf_r`, `xlf_r7`, `xlf90_r`, `xlf90_r7`, `xlf95_r`, `xlf95_r7`, or `xlf2003_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.

Levels of POSIX pthreads API support

On AIX Version 5.2 and higher, XL Fortran supports 64-bit thread programming with the 1003.1-1996 (POSIX) standard pthreads API. It also supports 32-bit programming with both the Draft 7 and the 1003.1-1996 standard APIs.

You can use invocation commands (which use corresponding stanzas in the `xlf.cfg.nm` configuration file) to compile and then link your programs with either the 1003.1-1996 standard or the Draft 7 interface libraries.

- To compile and then link your program with the 1003.1-1996 standard interface libraries, use the `xlf_r`, `xlf90_r`, `xlf95_r`, or `xlf2003_r` command. For example, you could specify:

```
xlf95_r test.f
```

- To compile and then link your program with the Draft 7 interface libraries, use the `xlf_r7`, `xlf90_r7`, or `xlf95_r7` command. For example, you could specify:

```
xlf95_r7 test.f
```

Apart from the level of thread support, the `xlf_r7`, `xlf90_r7`, and `xlf95_r7` commands and the corresponding stanzas in the `xlf.cfg.nm` configuration file provide the same support as the `xlf_r`, `xlf90_r`, and `xlf95_r` commands and the corresponding stanzas.

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`, `.f03`, 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 33.

The `fsuffix` and `cppsuffix` attributes in “Editing the default configuration file” on page 14 and the “`-qsuffix`” on page 265 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 “Linking” on page 68 and “Linking XL Fortran programs” on page 35.

The `osuffix` attribute, which is described in “Editing the default configuration file” on page 14 and the “`-qsuffix`” on page 265, 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 “Editing the default configuration file” on page 14 and the “`-qsuffix`” on page 265, lets you select a different suffix.

Archive or Library Files (.a suffix)

The compiler sends any specified library files (`.a` files) to the linker at link time. There are also AIX and XL Fortran library files in the `/usr/lib` directory that are linked in automatically.

Related information: See “`-l`” on page 98, “`-L`” on page 97, and “`LIBPATH:` Setting library search paths” on page 10.

Shared Object 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.

Related information: See “`-brtl`” on page 85 and “`-bdynamic`, `-bshared`, and `-bstatic`” on page 79.

Configuration Files (.cfg,*nm* 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/xlf.cfg.nm`.

Related information: See “Using custom compiler configuration files” on page 11 and “-F” on page 92 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” on page 95, “-qmoddir” on page 212, and “Displaying information inside binary files (what)” on page 342.

Profile Data Files

The **-qpdf1** option produces runtime 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 “-qpdf1, -qpdf2” on page 221.

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” on page 103 for information on selecting a different name and “-c” on page 89 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” on page 89 and “Linking XL Fortran programs” on page 35. For information on renaming the object file, see “-o” on page 103.

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” on page 302 and “Linking XL Fortran programs” on page 35. For information on renaming the assembler source file, see “-o” on page 103.

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 “Listings, messages, and compiler information” on page 63.

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`” on page 212.

cpp-Preprocessed Source Files: *Ffilename.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 33 and “`-d`” on page 91.

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 “`-qpdf1`, `-qpdf2`” on page 221.

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 Chapter 6, “Detailed descriptions of the XL Fortran compiler options,” on page 73 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
```

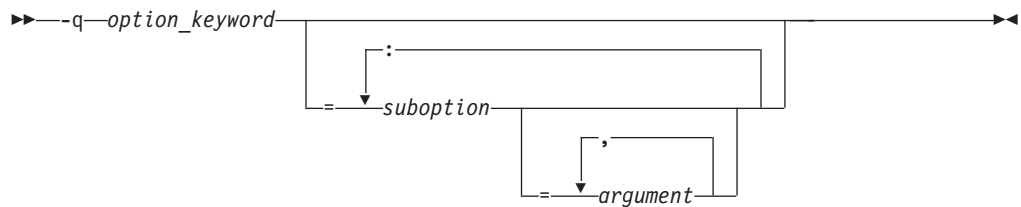
(There are some exceptions, such as **-pg**, which is a single option and not the same as **-p -g**.)

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:



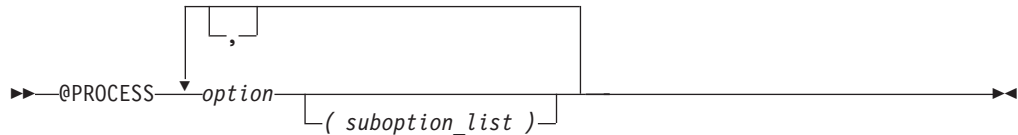
This format is more restrictive about the placement of blanks; you must separate individual **-q** options by blanks, and there must be no blank between a **-q** option and a following argument string. Unlike the names of flag options, **-q** option names are not case-sensitive except that the **q** 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 -03 -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 -berok file.f # -berok is passed to ld
```

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

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

In this example, the **ld** option **-berok** 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/xlf.cfg.nn**, 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/xlf.cfg.53**:

```
asopt = "w"
ldopt = "m"
```

and issue this command:


```
xlf95 -wm -Wa,-x -Wl,-s produces_warnings.s uses_many_symbols.f
```

the file **produces_warnings.s** is assembled with the options **-w** and **-x** (issue warnings and produce cross-reference), and the object files are linked with the options **-m** and **-s** (write list of object files and strip final executable file).

Related information: See “-W” on page 309 and “Using custom compiler configuration files” on page 11.

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” on page 119 and also **-O4** and **-O5** under the “-O” on page 100.

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. If you are also using one of the optimizing preprocessors, **cpp** is called before any of the other preprocessors.

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 **Ffilename.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:

- “-d” on page 91
- “-t” on page 303
- “-W” on page 309
- “Using custom compiler configuration files” on page 11

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 **AIXV4**, you can define that symbol to **cpp** by compiling with a command like:

```
xlf95 conditional.F -WF,-DAIXV4
```

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 **/usr/ccs/lib/cpp**. This is the standard **cpp**. It is **ISO C** compliant and therefore recognizes trigraph sequences.

On the AIX operating system, **cpp** has the option **-qlanglvl=classic**. Therefore, compile the trigraph example by using the following command:

```
xlf95 tst.F -d -v -WF,-qlanglvl=classic
```

This invokes **cpp tst.F -qlanglvl=classic**.

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 42 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.

Linking 32-bit SMP object files using the `ld` command

To use the `ld` command to link an SMP program, follow these guidelines:

- Do not use the `-e` flag to change the default starting point of the executable output file (`__start`). If you use other starting points, your results will be unpredictable.
- Specify the following options and files with the `ld` command:
 - `-bh:4`, `-bpT:0x10000000`, `-bpD:0x20000000`.
 - `-lxl` before any other libraries or files on the command line if you are linking any object files compiled by XL Fortran Version 2.
 - The object file that contains the system startup routine:
 - `crt0_r.o` for a program that was not profiled.
 - `mcrt0_r.o` for a program that was profiled with the `-p` option.
 - `gcrt0_r.o` for a program that was profiled with the `-pg` option.
 - Link with the startup files in `/usr/lib`.
 - Compiler and system libraries, in the following order:
 - For POSIX pthreads Draft 7 support:
`-lxlfpthrds_compat`, `-lxl90`, `-lxlopt`, `-lxlf`, `-lxlsmp`, `-lpthreads_compat`, `-lpthreads`, `-lm`, `-lc`
 - For POSIX pthreads 1003.1-1996 standard support:
`-lxl90`, `-lxlopt`, `-lxlf`, `-lxlsmp`, `-lpthreads`, `-lm`, `-lc`
 - You only need to specify `-lxlsmp` if you are compiling with `-qsmp`.
 - If you use the `-qautodbl` option, specify some extra libraries that are listed in “`-qautodbl`” on page 125.
 - If you use the `-qpdf1` compiler option, specify `-lxlopt`.
 - If you use the `-qhot=vector` suboption, specify `-lxlopt`.

On AIX Version 5.2 and higher, the default POSIX pthreads API is the 1003.1-1996 standard. If you had a program called `mytest` and you wanted to obtain access to the functions in the 1003.1-1996 standard POSIX pthreads API on AIX Version 5.2, you would link with the `libpthread.a` library, using something similar to the following command:

```
ld -bh:4 -bpT:0x10000000 -bpD:0x20000000 /lib/crt0_r.o mytest.o -lxl90
-lxlopt -lxlf -lxlsmp -lpthreads -lm -lc -o mytest
```

The 1003.1-1996 standard is not fully compatible with Draft 7. If you have programs that require the Draft 7 interface, link your programs with the `libpthread_compat.a` and `libxlfpthrds_compat.a` libraries (which provide compatibility support) followed by the `libpthread.a` library. For example, if you have a program called `mytest` that was written to use the Draft 7 interface, on AIX Version 5.2, you would use something similar to the following command:

```
ld -bh:4 -bpT:0x10000000 -bpD:0x20000000 /lib/crt0_r.o mytest.o
-lx1fpthrs_compat -lx1f90 -lx1opt -lx1f -lx1smp
-lpthreads_compat -lpthreads -lm -lc -o mytest
```

The configuration file `/etc/xlf.cfg` lists these default libraries and linker options. By doing a sample compilation with the `-#` option, you can see exactly how the compiler would run the linker.

See the *AIX Commands Reference, Volumes 1 - 6* for a description of the linker options.

Linking 64-bit SMP object files using the `ld` command

To use the `ld` command to link a 64-bit SMP program, follow these guidelines:

- Do not use the `-e` flag to change the default starting point of the executable output file (`__start`). If you use other starting points, your results will be unpredictable.
- Specify the following options and files with the `ld` command:
 - On AIX 5.2, `-bh:4`, `-bpT:0x10000000`, `-bpD:0x20000000`, `-b64`
 - On AIX 5.2 and above, `-bh:4`, `-bpT:0x100000000`, `-bpD:0x110000000`, `-b64`
 - The object file that contains the system startup routine:
 - `crt0_64.o` for a program that was not profiled.
 - `mcrt0_64.o` for a program that was profiled with the `-p` option.
 - `gcrt0_64.o` for a program that was profiled with the `-pg` option.
 - Link with the startup files in `/usr/lib`.
 - Compiler and system libraries:
 - `-lx1f90`, `-lx1smp`, `-lm`, `-lc`, and `-lpthreads`, in that order (you only need `-lx1smp` if you compile with the `-qsmp` option).
 - If you use the `-qautodbl` option, specify one of the libraries that are listed in the suboptions of “`-qautodbl`” on page 125.
 - If you use the `-qpdf1` compiler option, specify `-lx1opt`.
 - If you use the `-qhot=vector` suboption, specify `-lx1opt`.

For example, to link the object files `smpfile1.o` and `smpfile2.o` on AIX 5.2, you could specify the following:

```
ld -bh:4 -bpT:0x10000000 -bpD:0x20000000 -b64 /lib/crt0_64.o -lx1f90
-lx1smp -lm -lc -lpthreads smpfile1.o smpfile2.o
```

The configuration file `/etc/xlf.cfg` lists these default libraries and linker options. By doing a sample compilation with the `-#` option, you can see exactly how the compiler would run the linker.

See the *AIX Commands Reference, Volumes 1 - 6* for a description of the linker options.

Linking 32-bit non-SMP object files using the `ld` command

To use the `ld` command to link non-SMP object files in a 32-bit environment, follow these guidelines:

- Do not use the `-e` flag to change the default starting point of the executable output file (`__start`). If you use other starting points, your results will be unpredictable.
- Specify the following options and files with the `ld` command:
 - `-bh:4`, `-bpT:0x10000000`, `-bpD:0x20000000`.
 - `-lx1f` before any other libraries or files on the command line if any object files compiled by XL Fortran Version 2 are being linked.
 - The object file that contains the system startup routine:

- **crt0.o** for a program that was not profiled.
- **mcrt0.o** for a program that was profiled with the **-p** option.
- **gcrt0.o** for a program that was profiled with the **-pg** option.
- Link with the startup files in **/usr/lib**.
- Compiler and system libraries:
 - **-lxf90**, **-lm**, and **-lc** in that order.
 - If you use the **-qautodbl** option, specify some extra libraries that are listed in “-qautodbl” on page 125.
 - If you use the **-qpdf1** compiler option, specify **-lxlopt**.
 - If you use the **-qhot=vector** suboption, specify **-lxlopt**.

For example, to link the object files `file1.o` and `file2.o`, you could specify the following:

```
ld -bh:4 -bpT:0x10000000 -bpD:0x20000000 /lib/crt0.o -lxf90 -lm -lc
file1.o file2.o
```

The configuration file `/etc/xf.cfg` lists these default libraries and linker options. By doing a sample compilation with the **-#** option, you can see exactly how the compiler would run the linker.

See the *AIX Commands Reference, Volumes 1 - 6* for a description of the linker options.

Linking 64-bit non-SMP object files using the `ld` command

To use the `ld` command to link non-SMP object files in a 64-bit environment, follow these guidelines:

- Do not use the **-e** flag to change the default starting point of the executable output file (`__start`). If you use other starting points, your results will be unpredictable.
- Specify the following options and files with the `ld` command:
 - On AIX 5.2, **-bh:4**, **-bpT:0x10000000**, **-bpD:0x20000000**, **-b64**.
 - On AIX 5.2 and above, **-bh:4**, **-bpT:0x10000000**, **-bpD:0x110000000**, **-b64**
 - The object file that contains the system startup routine:
 - **crt0_64.o** for a program that was not profiled.
 - **mcrt0_64.o** for a program that was profiled with the **-p** option.
 - **gcrt0_64.o** for a program that was profiled with the **-pg** option.
 - Link with the startup files in **/usr/lib**.
 - Compiler and system libraries:
 - **-lxf90**, **-lm**, and **-lc** in that order.
 - If you use the **-qautodbl** option, specify some extra libraries that are listed in “-qautodbl” on page 125.
 - If you use the **-qpdf1** compiler option, specify **-lxlopt**.
 - If you use the **-qhot=vector** suboption, specify **-lxlopt**.

For example, to link the object files `file1.o` and `file2.o` on AIX 5.2, you could specify the following:

```
ld -bh:4 -bpT:0x10000000 -bpD:0x20000000 -b64 /lib/crt0_64.o -lxf90 -lm
-lc file1.o file2.o
```

The configuration file `/etc/xf.cfg` lists these default libraries and linker options. By doing a sample compilation with the **-#** option, you can see exactly how the compiler would run the linker.

See the *AIX Commands Reference, Volumes 1 - 6* for a description of the linker options.

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 -bhalt:2 -K -r file.f # xlf95 passes all these options to ld
```

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

Checking for interface errors at link time

If you specify the **-qextchk** compiler option, the linker may refuse to link object files containing mismatching procedure interfaces or common block definitions, allowing you to find these errors at link time, instead of trying to debug incorrect results.

If the linking problem can be isolated to a few names that do not resolve, perhaps because of uppercase letters in C names or trailing underscores added by the **-qextname** option, you can use the **-brename** linker option to change just those names:

```
xlf95 -brename:Old_Link_Name,new_link_name fort_prog.o c_prog.o
```

Related information: See “-qextchk” on page 154, “-U” on page 305, and “-qextname” on page 156.

Linking new objects with existing ones

If you have **.o** or other object files that you compiled with an earlier version of XL Fortran, you can link them with object files that you compile with XL Fortran V11.1, subject to the following notes. The main XL Fortran library is **libxlf90.a**, but calls to older entry points in **libxlf.a** are still possible; the calls are passed to the new entry points in the main libraries, which makes the resulting programs slower than if everything is recompiled.

Notes:

1. You must explicitly specify the XL Fortran **libxlf.a** library as part of the link step, preferably by including the option **-lxl**.
2. For safety, always put **-lxl** as the first option after the compiler command so that the library is linked before any user object files. Doing so ensures that the new I/O routines override any existing ones in statically linked object files.
3. When you relink old object files, the I/O routines in the resulting program differ in some ways from the behavior of XL Fortran Version 2. To make the resulting program work as you expect, you may need to change some of the runtime settings in “Setting runtime options” on page 44 (particularly the **namelist** setting) or to recompile the source files with the “-qxlf77” on page 289. Some changed I/O details cannot be switched to the old behavior at all.
4. You cannot link files that you compiled with the XL Fortran Version 4 level of IPA with files that you compiled with the XL Fortran Version 6 level or later of IPA.
5. You cannot link 64-bit objects compiled with XL Fortran version 7.1.0.1, or lower. The object format has changed on AIX Version 5.2.
6. You cannot link **pdf** files that you created with **-qpdf1** and Version 5.2.0 or earlier levels of XL Fortran with **pdf** files that you created with **-qpdf1** and XL Fortran Version 7.1 or higher. However, you can link object files that you created with **-qpdf2** and XL Fortran Version 7.1 or higher with object files that you created with **-qpdf2** and earlier levels of XL Fortran.

Relinking an existing executable file

Because the linker accepts executable files as input, you can link an existing executable file with updated object files. You cannot, however, relink executable files that were previously linked using the **-qipa** option.

If you have a program consisting of several source files and only make localized changes to some of the source files, you do not necessarily have to compile each file again. Instead, you can include the executable file as the last input file when compiling the changed files:

```
xlf95 -omansion front_door.f entry_hall.f parlor.f sitting_room.f \  
    master_bath.f kitchen.f dining_room.f pantry.f utility_room.f  
  
vi kitchen.f # Fix problem in OVEN subroutine  
  
xlf95 -o newmansion kitchen.f mansion
```

Limiting the number of files to compile and link the second time reduces the compile time, disk activity, and memory use.

Note: If this type of linking is done incorrectly, it can result in interface errors and other problems. Therefore, you should not try it unless you are experienced with linking.

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” on page 41). 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.

You can use **-b** linker options on the compiler command line to create statically linked object files:

```
xlf95 -bnso -bI:/usr/lib/syscalls.exp file1.f file2.f
```

You must also specify **-bI:/usr/lib/threads.exp** when you are statically linking with the **xlf_r**, **xlf_r7**, **xlf90_r**, **xlf90_r7**, **xlf95_r**, **xlf95_r7**, or **xlf2003_r** command.

If you are using Asynchronous I/O, you must also specify **-bI:/usr/lib/aio.exp**. The **-bns** option places the library procedures that your program references into the program's object file. Files with a suffix of **.exp** specify the names of system routines that must be imported to your program from the system.

An alternative that requires less disk space is to link any XL Fortran libraries statically but to leave references to other system libraries dynamic. This example statically links just the XL Fortran libraries:

```
# Build a temporary object from the Fortran library:
ld -r -o libtmp.o -bns -lxl90
# Build the application with this object on the command line:
xlf95 -o appl appl1.o appl2.o libtmp.o
```

Avoiding naming conflicts during linking

If you define an external subroutine, external function, or common block with the same name as a runtime 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. Many naming conflicts only apply to statically linked programs.
- Order the names of libraries and object files on the command line so that the one that should take precedence comes first. For example, to make names in **libxl90.a** take precedence over duplicate names in an object file, specify **-lxl90** first on the command line.

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.

If different versions of a routine occur in more than one library or object file, be careful to use the specific version that you want. Specify the file with the correct version as the first file on the command line or in the configuration file. If the file is a library, specify the appropriate **-l** option first on the command line. This technique does not apply to references between routines that are in the same shared library or to routines that are explicitly imported from one shared library to another.

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 runtime 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.

Running previously compiled programs

Statically linked programs that you compiled with levels of XL Fortran prior to V11.1 should continue to run with no change in performance or behavior. They may not run on a system with a level of the operating system different from the system on which they were compiled.

If you have dynamically linked programs compiled by XL Fortran Versions 2 through V11.1, you can run them on systems with the XL Fortran V11.1 libraries. The programs will use the current compiler data formats and I/O behavior, which are somewhat different from those of XL Fortran Version 2.

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 runtime message catalogs. Alternatively, you can link dynamically and copy the program as well as the XL Fortran libraries if needed and optionally the runtime message catalogs. For non-SMP programs, **libxlf90.a** is usually the only XL Fortran library needed. For SMP programs, you will usually need at least the **libxlf90.a** and **libxlsmp.a** libraries. **libxlf.a** is only needed if the program has any XL Fortran Version 1 or 2 object files linked in. **libxlfpm*.a** and **libxlfpad.a** are only needed if the program is compiled with the **-qautodbl** option. If your application has dependencies on **libhmd.a**, refer to "Using debug memory routines for XL Fortran" on page 328 for more details on library dependencies.

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 40.

POSIX Pthreads binary compatibility

The XL Fortran compiler and runtime library provide binary compatibility in the following areas:

- Executable file binary compatibility. If you created an executable file that had dependencies on the pthreads Draft 7 API (for example, you used XL Fortran Version 5.2.0 or AIX Version 4.2.1), you can upgrade your system to use XL Fortran V11.1 or AIX Version 5.2 and run your executable file without first recompiling and relinking your program.
- Object file or archive library binary compatibility. If you created an object file or archive library that had dependencies on the Draft 7 pthreads API, you can continue to use that object file or archive library with the Draft 7 interface if you move from AIX Version 4.2.1 to AIX Version 5.2. For example, if you have a source file called **test.f** that uses a shared or static archive library called **libmy_utility.a** (which was created with the Draft 7 interface), you would enter something similar to the following command on AIX Version 5.2:

```
xlf95_r7 test.f -lmy_utility -o a.out
```

You do not need to regenerate **libmy_utility.a** before using it on AIX Version 5.2.

There are, however, restrictions on binary compatibility. XL Fortran supports combinations of Draft 7 and 1003.1-1996 standard object files in some instances. For example, if you used XL Fortran Version 5.2.0 to create a library, that library uses the Draft 7 pthreads API. An application that you build with that library can use either the Draft 7 pthreads API or the 1003.1-1996 standard pthreads API as long as the portions of the complete application built with the Draft 7 pthreads API do not share any pthreads data objects (such as mutexes or condition variables) with the portions built with the 1003.1-1996 standard pthreads API. If any such objects need to be used across portions of an application that are compiled with different levels of the pthreads API, the final application needs to use either the Draft 7 pthreads API or the 1003.1-1996 standard pthreads API across the entire application. You can do this in one of two ways:

- Build the application by using the **xlf_r7**, **xlf90_r7**, or **xlf95_r7** command, so that it uses the Draft 7 pthreads API.
- Build both the library and the rest of the application by using the **xlf_r**, **xlf90_r**, **xlf95_r**, or **xlf2003_r** command.

Runtime libraries for POSIX pthreads support

There are three runtime libraries that are connected with POSIX thread support. The **libxlf90.a** library is the Fortran runtime library that supports both non-threaded and threaded applications. The **libxlsmp.a** library is the SMP runtime library.

The following libraries are used:

`/lib/libxf90.a` Provides 1003.1-1996 standard 32-bit and 64-bit support.

`/lib/libxlsmp.a` Provides 1003.1-1996 standard 32-bit and 64-bit support.

`/lib/libxlpthrds_compat.a` Provides Draft 7 32-bit support.

XL Fortran supplies the following directories for `.mod` files:

`/usr/lpp/xf/include_d7` Provides Draft 7 32-bit support.

`/usr/lpp/xf/include` Provides 1003.1-1996 standard 32-bit and 64-bit support.

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

Cmd.	Libraries Used	Include Files Used	POSIX Pthreads API Level Supported
xlf90_r xlf95_r xlf2003_r xlf_r	/lib/libxf90.a /lib/libxlsmp.a /lib/libpthreads.a	/usr/lpp/xf/include	1003.1-1996 standard
xlf90_r7 xlf95_r7 xlf_r7	/lib/libxf90.a /lib/libxlsmp.a /lib/libxlpthrds_compat.a /lib/libpthreads.a	/usr/lpp/xf/include_d7	Draft 7

Selecting the language for runtime messages

To select a language for runtime 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 runtime 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.

The C library routine `setlocale` is defined in the *AIX Technical Reference: Base Operating System and Extensions, Volumes 1 & 2*.

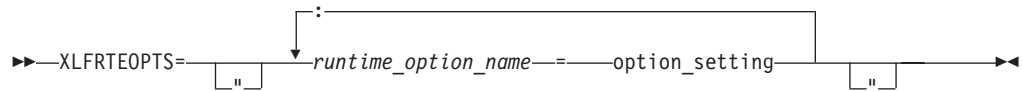
Setting runtime options

Internal switches in an XL Fortran program control runtime behavior, similar to the way compiler options control compile-time behavior. You can set the runtime options through either environment variables or a procedure call within the

program. You can specify XL Fortran runtime 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 **ksh** 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 runtime error message.
- A **DEALLOCATE** statement needs to issue a runtime 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 runtime options with the **XLFRTEOPTS** environment variable or the **SETRTEOPTS** procedure:

aggressive_array_io={yes | no}

Controls whether or not the XL Fortran run time will take advantage of descriptor information when deciding to apply slower or faster algorithms to do array I/O operations. Descriptor information that specifies an array or array section as contiguous can be used to apply the faster algorithms which would otherwise be unsafe if the array or array section was not contiguous. The default is to perform aggressive array I/O operations.

Code executing under the current XL Fortran runtime but compiled with older XL Fortran compilers can cause the aggressive array I/O operations to be unsafe if the older compilers did not set the XL Fortran descriptor information correctly. This can be a problem with code built with old XL Fortran compilers no longer in service or built with XL Fortran compilers not at the latest service levels. Older code should be recompiled, if possible, with the current compiler instead of relying on the use of this option.

buffering={**enable** | **disable_preconn** | **disable_all**}

Determines whether the XL Fortran runtime 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** runtime option to disable the buffering in the XL Fortran runtime 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, and tape drives). 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 runtime library maintains an I/O buffer for each connected logical unit. The current read-write file pointers that the runtime library maintains might not be synchronized with the read-write pointers of the corresponding files in the file system.
disable_preconn	The Fortran runtime 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 runtime 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 runtime 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.

cnvrr={yes | no}

If you set this runtime 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 | systemtime | alltime | total_usertime | total_systemtime | 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. (For a definition of user time, see the *AIX Performance Management*).

systemtime

Returns the system time of a process. (For a definition of system time, see the *AIX Performance Management*).

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_systemtime

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** runtime 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 runtime 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*.

errloc={yes | no}

Controls whether the file name and line number appear in runtime error messages when a runtime error condition occurs during I/O or an **ALLOCATE/DEALLOCATE** statement and an error message is issued. By default, the line number and file name appear prepended to the runtime error messages. If **errloc=no** is specified, runtime error messages are displayed without the source location information.

The **errloc** runtime option can be specified with the **SETRTEOPTS** procedure, as well.

erroeof={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 runtime 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.

errthrdnum={yes | no}

When **errthrdnum=yes** is in effect, the thread number of the executing OpenMP thread specified by the **omp_get_thread_num** routine is appended to any XL Fortran runtime error messages generated. For single-threaded programs, the thread number will be 0. If **errloc=yes** is specified, the thread number appears in front of the file name and line number information. If the **IOMSG=** specifier is present in an I/O statement, the thread number is prepended in the message assigned to the variable specified by this option in the same format as displayed on standard error.

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** runtime option results in a different **IOSTAT** value from extensions being returned for the end-of-file condition

```
export XLFRTTEOPTS=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*.

intrinths={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={90ext | 90std | 95std | 2003std | extended}

Determines the level of support for Fortran standards and extensions to the standards. The values of the suboptions are as follows:

90ext Currently, provides the same level of support as the **extended** suboption. **90ext** was the default suboption prior to XL Fortran Version 7.1. However, this suboption is now obsolete, and to avoid problems in the future, you should start using the **extended** suboption as soon as possible.

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** runtime option results in a runtime 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
...           ! conform 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 as of V11.1 (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 runtime 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 runtime error message is issued. However, if you specify **langlvl=90std**, a runtime 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, and tape drives)

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 (Version 1) **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-compliant new format in writing any new data files.

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

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

naninfoutput={2003std | old | default}

Controls whether the display of IEEE exceptional values conform to the Fortran 2003 standard or revert to the old XL Fortran behavior. This runtime option allows object files created with different compilation commands to output all IEEE exceptional values based on the old behavior, or the Fortran 2003 standard. The suboptions are:

default

Exceptional values output depends on how the program is compiled.

old

Exceptional values output conforms to the old XL Fortran behavior.

2003std

Exceptional values output conforms to the Fortran 2003 standard.

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** runtime 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** runtime 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.

ufmt_littleendian={*units_list*}

Specifies unit numbers of unformatted data files on which little-endian I/O is to be performed. The little-endian format data in the specified unformatted files is converted, on-the-fly, during the I/O operation to and from the big-endian format used on machines where XL Fortran applications are running.

This runtime option does not work with internal files; internal files are always **FORMATTED**. Units specified must be connected by an explicit or implicit **OPEN** for the **UNFORMATTED** form of I/O.

The syntax for this option is as follows:

```
ufmt_littleendian=units_list
```

where:

```
units_list = units | units_list, units
```

```
units = unit | unit- | -unit | unit1-unit2
```

The unit number must be an integer, whose value is in the range 1 through 2 147 483 647.

unit Specifies the number of the logical unit.

unit- Specifies the range of units, starting from unit number *unit* to the highest possible unit number

-unit Specifies the range of units, starting from unit number 1 to unit number *unit*.

unit1-unit2

Specifies the range of units, starting from unit number *unit1* to unit number *unit2*.

Notes:

1. The byte order of data of type **CHARACTER** is not swapped.
2. The compiler assumes that the internal representation of values of type **REAL*4** or **REAL*8** is IEEE floating-point format compliant. I/O may not work properly with an internal representation that is different.
3. The internal representation of values of type **REAL*16** is inconsistent among different vendors. The compiler treats the internal representation of values of type **REAL*16** to be the same as XL Fortran's. I/O may not work properly with an internal representation that is different.
4. Conversion of derived type data is not supported. The alignment of derived types is inconsistent among different vendors.
5. Discrepancies in implementations from different vendors may cause problems in exchanging the little-endian unformatted data files between XL Fortran applications running on AIX and Fortran applications running on little-endian systems. XL Fortran provides a number of options that help users port their programs to XL Fortran. If there are problems exchanging little-endian data files, check these options to see if they can help with the problem.

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 runtime 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 runtime 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 runtime option **uwidth** is only valid for 64-bit mode applications.

xrf_messages={yes | no}

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

The following examples set the **cnvrr** runtime option to **yes** and the **xrf_messages** option to **no**.

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

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

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

```
CALL setrteopts('xrf_messages=NO:cnvrr=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:

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

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`.

MALLOCALIGN=16

The `MALLOCALIGN=16` environment variable specifies that dynamic memory allocations return 16-byte aligned addresses. (See also the `-qipa=malloc16` option.)

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.)

XLF_USR_CONFIG

Use the `XLF_USR_CONFIG` environment variable to specify the location of a custom configuration file to be used by the compiler. The file name must be given with its absolute path. The compiler will first process the definitions in this file before processing those in the default system configuration file, or those in a customized file specified by the `-F` option; for more information, see “Using custom compiler configuration files” on page 11.

Other environment variables that affect runtime behavior

The `LIBPATH` 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 runtime options and cannot be set in either `XLFRTEOPTS` or `XLSMPOPTS`.

XL Fortran runtime exceptions

The following operations cause runtime exceptions in the form of `SIGTRAP` signals, which typically result in a “Trace/BPT trap” message:

- Fixed-point division by zero.
- 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 exceptions occur after you specify the appropriate **-qflttrap** suboptions at compile time.
- Floating-point operations that generate NaN values and loads of the NaN values after you specify the **-qfloat=nanq** option at compile time.
- Calls to the TRAP hardware-specific intrinsic procedure.

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. **dbx** provides a specific error message that describes the cause of the exception.

Related information:

- “-C” on page 88
- “-qflttrap” on page 167
- “-qsigtrap” on page 248

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. Summary of compiler options by functional category

The XL Fortran options available on the AIX platform are grouped into the following categories:

- Output control
- Input control
- Language element control
- Floating-point and integer control
- Error checking and debugging
- Listings, messages, and compiler information
- Optimization and tuning
- Object code control
- Linking
- Portability and migration
- Compiler customization
- Deprecated options

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

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.

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.

For detailed information about each compiler option, see Chapter 6, "Detailed descriptions of the XL Fortran compiler options," on page 73.

Output control

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

Table 6. Compiler output options

Option name	@PROCESS directive	Description
-c	None.	Prevents the completed object from being sent to the linker. With this option, the output is a .o file for each source file.

Table 6. Compiler output options (continued)

Option name	@PROCESS directive	Description
-d	None.	Causes preprocessed source files that are produced by cpp to be kept rather than deleted.
-o	None.	Specifies a name for the output object, assembler, or executable file.
-S	None.	Generates an assembler language file for each source file.
-qdescriptor	None.	Specifies the XL Fortran internal descriptor data structure format to use for non object-oriented entities in your compiled applications.
-qmoddir	None.	Specifies the location for any module (.mod) files that the compiler writes.

Input control

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

Table 7. Compiler input options

Option name	@PROCESS directive	Description
-I	None.	Adds a directory to the search path for include files and .mod files.
-qcclines	CCLINES	Determines whether the compiler recognizes conditional compilation lines in fixed source form and F90 free source form. IBM free source form is not supported with this option.
-qci	CI	Specifies the identification numbers (from 1 to 255) of the INCLUDE lines to process.
-qcr	None.	Controls how the compiler interprets the CR (carriage return) character.
-qdirective	DIRECTIVE	Specifies sequences of characters, known as trigger constants, that identify comment lines as compiler comment directives.
-qfixed	FIXED	Indicates that the input source program is in fixed source form and optionally specifies the maximum line length.
-qfree	FREE	Indicates that the source code is in free source form.
-qmixed, -U	MIXED	Makes the compiler sensitive to the case of letters in names.
-qsuffix	None.	Specifies the source-file suffix on the command line.
-qxlines	XLINES	Specifies whether fixed source form lines with a X in column 1 are compiled or treated as comments.

Language element control

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

Table 8. Language element control options

Option name	@PROCESS directive	Description
-D, -qdlines	DLINES	Specifies whether the compiler compiles fixed source form lines with a D in column 1 or treats them as comments.
-qinit	INIT	Makes the initial association status of pointers disassociated.
-qlanglvl	LANGLVL	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.
-qmbcs	MBCS	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.
-qnullterm	NULLTERM	Appends a null character to each character constant expression that is passed as a dummy argument, making it more convenient to pass strings to C functions.
-1, -qonetrip	ONETRIP	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.
-qposition	POSITION	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.
-qqcount	QCOUNT	Accepts the Q character-count edit descriptor (Q) as well as the extended-precision Q edit descriptor (Qw.d).
-qsaa	SAA	Checks for conformance to the SAA FORTRAN language definition. It identifies nonconforming source code and also options that allow such nonconformances.
-qsave	SAVE	Specifies the default storage class for local variables.

Table 8. Language element control options (continued)

Option name	@PROCESS directive	Description
-qsclk	None.	Specifies the resolution that the SYSTEM_CLOCK intrinsic procedure uses in a program.
-u	UNDEF	Specifies that no implicit typing of variable names is permitted.
-qxlF77	XLF77	Provides backward compatibility with XL Fortran Versions 1 and 2 aspects of language semantics and I/O data format that have changed.
-qxlF90	XLF90	Provides backward compatibility with XL Fortran for AIX Version 5 and the Fortran 90 standard for certain aspects of the Fortran language.
-qxlF2003	XLF2003	Provides the ability to use language features specific to the Fortran 2003 standard when compiling with compiler invocations that follow earlier Fortran standards, as well as the ability to disable these features when compiling with compiler invocations that follow the Fortran 2003 standard.

Floating-point and integer control

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

Table 9. Floating-point and integer control options

Option name	@PROCESS directive	Description
-qautodbl	AUTODBL	Provides an automatic means of converting single-precision floating-point calculations to double-precision and of converting double-precision calculations to extended-precision.
-qdpc	DPC	Increases the precision of real constants for maximum accuracy, when assigning real constants to DOUBLE PRECISION variables.
-qenum	None.	Specifies the range of the enumerator constant and enables storage size to be determined.
-qfloat	FLOAT	Selects different strategies for speeding up or improving the accuracy of floating-point calculations.

Table 9. Floating-point and integer control options (continued)

Option name	@PROCESS directive	Description
-qintsize	None.	Sets the size of default INTEGER and LOGICAL data entities that have no length or kind specified.
-qieee, -y	IEEE	Specifies the rounding mode that the compiler will use when it evaluates constant floating-point expressions at compile time.
-qintlog	INTLOG	Specifies that you can mix integer and logical data entities in expressions and statements.
-qintsize	INTSIZE	Sets the size of default INTEGER and LOGICAL data entities that have no length or kind specified.
-qrealsize	REALSIZE	Sets the default size of REAL , DOUBLE PRECISION , COMPLEX , and DOUBLE COMPLEX values.
-qstrictieeemod	STRICTIEEEMOD	Specifies whether the compiler will adhere to the Fortran 2003 IEEE arithmetic rules for the ieee_arithmetic and ieee_exceptions intrinsic modules.

Object code control

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

Table 10. Object code control options

Option name	@PROCESS directive	Description
-q32	None.	Enables 32-bit compilation mode (or, more briefly, 32-bit mode) support in a 64-bit environment.
-q64	None.	Indicates 64-bit compilation bit mode and, together with the -qarch option, determines the target machines on which the 64-bit executable will run.
-qinlglue	INLGLUE	When used with -O2 or higher optimization, inlines glue code that optimizes external function calls in your application.
-qpic	None.	Generates Position-Independent Code suitable for use in shared libraries.
-qsaveopt	None.	Saves the command-line options used for compiling a source file, the version and level of each compiler component invoked during compilation, and other information to the corresponding object file.

Table 10. Object code control options (continued)

Option name	@PROCESS directive	Description
-qbttable	None.	Controls the amount of debugging traceback information that is included in the object files.
-qthreaded	None.	Indicates to the compiler whether it must generate threadsafe code.

Error checking and debugging

The options in the following table allow you to detect and correct problems in your source code. In some cases, these options can alter your object code, increase your compile time, or introduce runtime checking that can slow down the execution of your application. The option descriptions indicate how extra checking can impact performance.

To control the amount and type of information you receive regarding the behavior and performance of your application, consult “Listings, messages, and compiler information” on page 63.

For information on debugging optimized code, see the *XL Fortran Optimization and Programming Guide*.

Table 11. Error checking and debugging options

Option name	@PROCESS directive	Description
-#	None.	Previews the compilation steps specified on the command line, without actually invoking any compiler components.
-C, -qcheck	CHECK	Checks each reference to an array element, array section, or character substring to ensure the reference stays within the defined bounds of the entity.
-g, -qdbg	DBG	Generates debug information for use by a symbolic debugger.
-qdpcl	None.	Generates symbols that tools based on the IBM Dynamic Probe Class Library (DPCL) can use to see the structure of an executable file.
-qextchk	EXTCHK	Generates information to perform type-checking at both compile and link time to ensure consistency between declarations and references.
-qflttrap	FLTTRAP	Determines what types of floating-point exception conditions to detect at run time.

Table 11. Error checking and debugging options (continued)

Option name	@PROCESS directive	Description
-qfullpath	FULLPATH	When used with the -g option, this option records the full, or absolute, path names of source and include files in object files compiled with debugging information, so that debugging tools can correctly locate the source files.
-qhalt	HALT	Stops compilation before producing any object, executable, or assembler source files if the maximum severity of compile-time messages equals or exceeds the severity you specify.
-qinit	INIT(F90PTR)	Makes the initial association status of pointers disassociated.
-qinitauto	INITAUTO	Initializes uninitialized automatic variables to a specific value, for debugging purposes.
-qkeepparm	None.	When used with -O2 or higher optimization, specifies whether function parameters are stored on the stack.
-qlinedebug	None.	Generates only line number and source file name information for a debugger.
-qobject	OBJECT	Specifies whether to produce an object file or to stop immediately after checking the syntax of the source files.
“-qoptdebug” on page 219	None.	When used with high levels of optimization, produces files containing optimized pseudocode that can be read by a debugger.
-qwarn64	None.	Displays informational messages identifying statements that may cause problems with 32-bit to 64-bit migration.
-qxflag=dvz	None.	Causes the compiler to generate code to detect floating-point divide-by-zero operations.

Listings, messages, and compiler information

The options in the following table allow you control over the listing file, as well as how and when to display compiler messages. You can use these options in conjunction with those described in “Error checking and debugging” on page 62 to provide a more robust overview of your application when checking for errors and unexpected behavior.

Table 12. Listings and messages options

Option name	@PROCESS directive	Description
-qattr	ATTR	Produces a compiler listing that includes the attribute component of the attribute and cross-reference section of the listing.
-qflag	FLAG	Limits the diagnostic messages to those of a specified severity level or higher.
-qlist	LIST	Produces a compiler listing file that includes an object listing.
-qlistopt	None.	Produces a compiler listing file that includes all options in effect at the time of compiler invocation.
-qphsinfo	PHSINFO	Reports the time taken in each compilation phase to standard output.
-qnoprint	None.	Prevents the compiler from creating the listing file, regardless of the settings of other listing options.
-qreport	None.	Produces listing files that show how sections of code have been optimized.
-qsource	SOURCE	Produces a compiler listing file that includes the source section of the listing and provides additional source information when printing error messages.
-qsuppress	None.	Prevents specific informational or warning messages from being displayed or added to the listing file, if one is generated.
-qversion	None.	Displays the version and release of the compiler being invoked.
-V	None.	The same as -v except that you can cut and paste directly from the display to create a command.
-v	None.	Reports the progress of compilation, by naming the programs being invoked and the options being specified to each program.
-w	None.	Suppresses informational, language-level and warning messages (equivalent to -qflag=e:e).
-qxref	XREF	Produces a compiler listing that includes the cross-reference component of the attribute and cross-reference section of the listing.

Optimization and tuning

You can control the optimization and tuning process, which can improve the performance of your application at run time, using the options in the following table. Remember that not all options benefit all applications. Trade-offs sometimes occur between an increase in compile time, a reduction in debugging capability, and the improvements that optimization can provide. In addition to the option descriptions in this section, consult the *XL Fortran Optimization and Programming Guide* for details on the optimization and tuning process as well as writing optimization friendly source code.

Some of the options in “Floating-point and integer control” on page 60 can also improve performance, but you must use them with care to ensure your application retains the floating point semantics it requires.

Table 13. Optimization and tuning options

Option name	@PROCESS directive	Description
-qalias	ALIAS(<i>argument_list</i>)	Indicates whether a program contains certain categories of aliasing or does not conform to Fortran standard aliasing rules. The compiler limits the scope of some optimizations when there is a possibility that different names are aliases for the same storage location..
-qarch	None.	Specifies the processor architecture, or family of architectures, where the code may run. This allows the compiler to take maximum advantage of the machine instructions specific to an architecture, or common to a family of architectures.
-qassert	ASSERT	Provides information about the characteristics of the files that can help to fine-tune optimizations..
-qcache	None.	When specified with -O4 , -O5 , or -qipa , specifies the cache configuration for a specific execution machine.
-qcompact	COMPACT	Avoids optimizations that increase code size.
-qdirectstorage	None.	Informs the compiler that a given compilation unit may reference write-through-enabled or cache-inhibited storage.
-qenablevmx	None.	Enables generation of vector instructions for processors that support them.
-qessl	None.	Allows the compiler to substitute the Engineering and Scientific Subroutine Library (ESSL) routines in place of Fortran 90 intrinsic procedures.

Table 13. Optimization and tuning options (continued)

Option name	@PROCESS directive	Description
-qfdpr	None.	Provides object files with information that the IBM Feedback Directed Program Restructuring (FDPR) performance-tuning utility needs to optimize the resulting executable file.
-qhot	HOT(<i>suboptions</i>)	Performs high-order loop analysis and transformations (HOT) during optimization.
-qipa	None.	Enables or customizes a class of optimizations known as interprocedural analysis (IPA).
-qlargepage	None.	Takes advantage of large pages provided on POWER4 and higher systems, for applications designed to execute in a large page memory environment.
-qlibansi	None.	Assumes that all functions with the name of an ANSI C library function are, in fact, the library functions and not a user function with different semantics.
-qlibessl	None.	Assumes that all functions with the name of an ESSL library function are, in fact, the library functions and not a user function with different semantics.
-qlibposix	None.	Assumes that all functions with the name of a POSIX 1003.1 library function are, in fact, the system functions and not a user function with different semantics.
-qmaxmem	MAXMEM	Limits the amount of memory that the compiler allocates while performing specific, memory-intensive optimizations to the specified number of kilobytes.
-qminimaltoc	None.	Minimizes the number of entries in the global entity table of contents (TOC).
-O	OPTIMIZE	Specifies whether to optimize code during compilation and, if so, at which level.
-p	None.	Prepares the object files produced by the compiler for profiling.
-qpdf1, -qpdf2	None.	Tunes optimizations through profile-directed feedback (PDF), where results from sample program execution are used to improve optimization near conditional branches and in frequently executed code sections.

Table 13. Optimization and tuning options (continued)

Option name	@PROCESS directive	Description
-qprefetch	None.	Inserts prefetch instructions automatically where there are opportunities to improve code performance.
-Q	None.	Specifies whether procedures are considered for inlining and/or the names of particular procedures that should or should not be considered for inlining.
-qshowpdf	None.	When used with -qpdf1 and a minimum optimization level of -O2 at compile and link steps, inserts additional profiling information into the compiled application to collect call and block counts for all procedures in the application.
-qsmallstack	None.	Minimizes stack usage where possible.
-qsmp	None.	Enables parallelization of program code.
-qstacktemp	None.	Determines where to allocate certain XL Fortran compiler temporaries at run time.
-qstrict	STRICT	Ensures that optimizations done by default at optimization levels -O3 and higher, and, optionally at -O2 , do not alter certain program semantics mostly related to strict IEEE floating-point conformance.
-qstrict_induction	None.	Prevents the compiler from performing induction (loop counter) variable optimizations. These optimizations may be unsafe (may alter the semantics of your program) when there are integer overflow operations involving the induction variables.
-qtune	TUNE	Tunes instruction selection, scheduling, and other architecture-dependent performance enhancements to run best on a specific hardware architecture.
-qunroll	UNROLL	Specifies whether unrolling DO loops is allowed in a program. Unrolling is allowed on outer and inner DO loops.
-qunwind	None.	Specifies that the compiler will preserve the default behavior for saves and restores to volatile registers during a procedure call.

Table 13. Optimization and tuning options (continued)

Option name	@PROCESS directive	Description
-qzerosize	None.	Prevents checking for zero-sized character strings and arrays in programs that might process such objects.

Linking

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

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

Related information: The “-qextchk” on page 154 option enables some extra consistency checking during linking.

Table 14. Linking options

Option name	@PROCESS directive	Description
-b64	None.	In 64-bit mode, instructs the linker to bind with 64-bit objects.
-bdynamic, -bshared, and -bstatic	None.	These options are toggles that are used to control the processing of -l options and the way that shared objects are processed.
-bhalt	None.	Specifies the maximum error level that is allowed before the linker (ld) command halts.
-bloodmap	None.	Saves a log of linker actions and messages in the specified file <i>name</i> .
-bmaxdata, -bmaxstack	None.	Specifies the maximum amount of space to reserve for the program data segment and stack segment for programs where the size of these regions is a constraint.
-brtl	None.	Controls runtime linking for the output file.
-L	None.	Searches the directory path for library files specified by the -l option.
-l	None.	Searches for the specified library file, <i>libkey.so</i> , and then <i>libkey.a</i> for dynamic linking, or just for <i>libkey.a</i> for static linking.

Portability and migration

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

Table 15. Portability and migration options

Option name	@PROCESS directive	Description
-qalign	ALIGN	Specifies the alignment of data objects in storage, which avoids performance problems with misaligned data.
-qctyplss	CTYPLSS	Specifies whether character constant expressions are allowed wherever typeless constants may be used.
-qddim	DDIM	Specifies that the bounds of pointer arrays are re-evaluated each time the arrays are referenced and removes some restrictions on the bounds expressions for pointer arrays.
-qdescriptor	None.	Specifies the XL Fortran internal descriptor data structure format to use for non object-oriented entities in your compiled applications.
-qescape	ESCAPE	Specifies how the backslash is treated in character strings, Hollerith constants, H edit descriptors, and character string edit descriptors.
-qextern	EXTERN	Allows user-written procedures to be called instead of XL Fortran intrinsics.
-qextname	EXTNAME	Adds an underscore to the names of all global entities.
-qlog4	LOG4	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.
-qmodule	None.	Specifies that the compiler should use the XL Fortran Version 8.1 naming convention for non-intrinsic module files.
-qport	PORT	Provides options to accommodate other Fortran language extensions when porting programs to XL Fortran.
-qswapomp	SWAPOMP	Specifies that the compiler should recognize and substitute OpenMP routines in XL Fortran programs.
-qvecnvoll	None.	Specifies whether to use volatile or non-volatile vector registers.

Table 15. Portability and migration options (continued)

Option name	@PROCESS directive	Description
-qxflag=oldtab	XFLAG(OLDTAB)	Interprets a tab in columns 1 to 5 as a single character (for fixed source form programs), for compatibility with XL Fortran Version 1.

Compiler customization

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

Table 16. Compiler customization options

Option name	@PROCESS directive	Description
-B	None.	Determines substitute path names for XL Fortran executables such as the compiler, assembler, linker, and preprocessor.
-F	None.	Specifies an alternative configuration file, which stanza to use within the configuration file, or both.
-NS, -qspillsize	SPILLSIZE	Specifies the size (in bytes) of the register spill space; the internal program storage areas used by the optimizer for register spills to storage.
-qalias_size	ALIAS_SIZE(<i>bytes</i>)	Specifies an appropriate initial size, in bytes, for the aliasing table. This option has effect only when optimization is enabled.
-t	None.	Applies the prefix specified by the -B option to the designated components.
-W	None.	Passes the listed options to a component that is executed during compilation.

Deprecated options

The compiler still accepts options listed in the following table. An asterisk marks options with functionality that the compiler supports under another name. Options without an asterisk can produce unexpected results and are not guaranteed to perform as previously documented. Use with discretion.

An option is 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.

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.

Table 17. *Deprecated options*

Option name	Replacement option
-P{v k}[!]	Obsolete. It is still accepted, but it has no effect. Invokes the selected optimizing preprocessor. Adding ! prevents the compilation step from following preprocessing. Note: The preprocessors are available as separate vendor-logo products.
-qcharlen= 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
-qarch= 601 603 604 pwr pwr2 p2sc pwr2s com	As of the V11.1 release of the compiler, these suboptions are no longer supported. If you would like similar floating-point behavior to that provided by these suboptions, use the -qfloat=nosingle:norndsngl option.
-q64=largetype or -q64=nolargetype	Obsolete.Replaced by -q64 .
-qhsflt -qnohsflt	Obsolete. Replaced by the hsflt and nohsflt suboptions of “-qfloat” on page 162.
-qhssngl -qnohssngl	Obsolete. Replaced by the hssngl and nohssngl suboptions of “-qfloat” on page 162.
-qipa=pdfname	Replaced by -qpdf1=pdfname , -qpdf2=pdfname .
-qposition=append	-qposition=appendunknown replaces the -qposition=append suboption.
-qrecur -qnorecur	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.
-qlm -qnolm	Obsolete. The license management control system (LM) is no longer supported in this product version.

Table 17. *Deprecated options (continued)*

Option name	Replacement option
-qrndsngl	Replaced by -qfloat=rndsngl .
-qxflag=alias	Obsolete. Replaced by -qalias=nostd .

Chapter 6. Detailed descriptions of the XL Fortran compiler options

This section contains descriptions of the individual options available in XL Fortran.

For each option, the following information is provided:

Category

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

@process directive

For many compiler options, you can use an equivalent @PROCESS directive to apply the option's functionality within the source code, limiting the scope of the option's application to a single source file or compilation unit, or even selected sections of code.

Purpose

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

Syntax

This section provides the syntax for the command-line option and for the equivalent @PROCESS directive, if applicable. Syntax is shown first in command-line form, and then in @PROCESS form. For an explanation of the notations used to represent command-line syntax, see "Conventions and terminology used in this document" on page viii.

For @PROCESS syntax, the following notations are used:

- 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 (...).

Defaults

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

Parameters

This section describes the suboptions that are available for the option.

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

Examples

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

-1

Category

Language element control

Purpose

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.

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

Syntax

Option:

►► — -1 ————— ◀◀

@PROCESS:
@PROCESS ONETRIP | NOONETRIP

Defaults

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.

-B

Category

Compiler customization

Purpose

Determines substitute path names for XL Fortran executables such as the compiler, assembler, linker, and preprocessor.

It can be used in combination with the **-t** option, which determines which of these components are affected by **-B**.

Syntax

►► -B prefix ◀◀

@PROCESS:

@PROCESS -Bprefix

Defaults

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

Parameters

prefix

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

Usage

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 **/usr/lpp/xlf/bin**. 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:

```
xlf95 -tchbI -B/home/jim/usr/lpp/xlf/bin/ test_suite.f
```

Once the upgrade meets the acceptance criteria, the system administrator installs it over the old level in `/usr/lpp/xlf/bin`.

Related information

- “-t” on page 303
- “-F” on page 92
- “Using custom compiler configuration files” on page 11
- “Running two levels of XL Fortran” on page 22

-b64

Category

Linking

@PROCESS directive

None.

Purpose

Instructs the linker to bind with 64-bit objects.

The AIX operating system provides 64-bit shared object files in both **libc.a** and **libm.a**. In 64-bit mode, you can use the **-b64** linker option to instruct **ld** to bind with 64-bit objects.

Syntax

▶▶ -b64 ◀◀

Defaults

Not applicable.

Related information

- Chapter 7, “Using XL Fortran in a 64-Bit Environment,” on page 313
- For more information on **-b64**, see *AIX General Programming Concepts: Writing and Debugging Programs*.

-bdynamic, -bshared, and -bstatic

Category

Linking

@PROCESS directive

None.

Purpose

These options are toggles that are used to control the processing of **-l** options and the way that shared objects are processed.

The options **-bdynamic** and **-bshared** are synonymous.

Syntax



Defaults

-bshared or **-bdynamic**

Usage

When **-bstatic** is in effect, shared objects are statically linked into the output file. When **-bdynamic** is in effect, shared objects are linked dynamically.

When **-brtl** is used in conjunction with either **-bdynamic** or **-bshared**, the search for libraries specified with the **-l** option is satisfied by the suffix *.so* or *.a*. For each directory searched, a file with the suffix *.so* is looked for. If it is not found, a file with the suffix *.a* is looked for. If neither file is found, the search continues with the next directory.

Rules

These options are passed directly to the **ld** command and are not processed by XL Fortran at all.

These options are position-significant and affect all files that are specified after the options on the command-line.

Table 18 on page 80 summarizes how these options interact with **-brtl** and **-bnortl** to affect the file suffix that is being searched.

Table 18. Interaction of linker options

		Position-significant	
		-bdynamic -bshared (default)	-bstatic
Global Influence	-brtl	.so .a	.a
	-bnortl (default)	.a	.a

Examples

```
xlf95 f.f -brtl -bshared -lmylib
```

In this case, the linker searches for the library **libmylib.so** first and then the library **libmylib.a** in each directory in the search path consecutively until either is encountered.

```
xlf95_r f.f -bdynamic -llib1 -bstatic -llib2 -brtl
```

In this case, to satisfy the first library specification, the linker searches for the library **liblib1.so** first and then the library **liblib1.a** in each directory (as described in the previous example). However, at the same time the linker only searches for **liblib2.a** in those same directories.

Related information

- “-brtl” on page 85
- “-l” on page 98
- For more information on these options, see *AIX General Programming Concepts: Writing and Debugging Programs*.

-bhalt

Category

Linking

@PROCESS directive

None.

Purpose

Specifies the maximum error level that is allowed before the linker (**ld**) command halts.

Syntax

►► — `-bhalt` —:— `error_level` —————►►

Defaults

The default value is 4, as specified in the configuration file. If any linker command has an error return value greater than the value that is specified by the `error_level` variable, linking stops.

Rules

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

Related information

- For more information on these options, see *AIX General Programming Concepts: Writing and Debugging Programs*.

-bloadmap

Category

Linking

@PROCESS directive

None.

Purpose

Saves a log of linker actions and messages in the specified file *name*.

Syntax

►► -bloadmap—:—*name*—————►►

Defaults

Not applicable.

Usage

You can use the log to help diagnose linking problems. For example, the log contains information about type mismatches that the **-qextchk** option detected.

Rules

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

Related information

- For more information on these options, see *AIX General Programming Concepts: Writing and Debugging Programs*.

-bmaxdata, -bmaxstack

Category

Linking

@PROCESS directive

None.

Purpose

Specifies the maximum amount of space to reserve for the program data segment and stack segment for programs where the size of these regions is a constraint.

Syntax

►► -bmaxdata—:—bytes—►►

►► -bmaxstack—:—bytes—►►

Defaults

Not applicable.

Parameters

Specify the size as a decimal, octal (which is prefixed by 0), or hexadecimal value (which is prefixed by 0x).

Usage

The data segment holds, among other things, heap storage that is used by the program.

If your program allocates large arrays, statically or dynamically, specify **-bmaxdata** when linking the program. The resulting executable program uses the large data model and can have a data region larger than a single segment, up to a maximum of 2 GB. Refer to the **ld** documentation in the *AIX Commands Reference, Volumes 1 - 6* for allowable values. Note that since the compiler might create temporary arrays during compilation, it may be useful to define a value for the **-bmaxdata** compiler option in anticipation of this.

If the program has large amounts of automatic data or otherwise exceeds the soft limit on stack size for a program, specify **-bmaxstack** when you link the program. Use this option to define the soft limit up to 256 MB for 32-bit mode or up to the limit imposed by system resources for 64-bit mode. However, each main program or subprogram is limited to 256 MB per instance.

Rules

These options are passed directly to the **ld** command and are not processed by XL Fortran at all.

Examples

```
xlf95 -O3 -qhot -bmaxdata:0x200000000 huge_data_model.f  
xlf95 -O3 -qhot -bmaxstack:2000000 lots_of_automatic_data.f
```

Related information

For a discussion of the issues involved in creating large AIX programs, see “Large Program Support Overview” in *AIX General Programming Concepts: Writing and Debugging Programs*.

-brtl

Category

Linking

@PROCESS directive

None.

Purpose

Controls runtime linking for the output file.

Syntax

►► [-bnortl]
[-brtl] ◄◄

Defaults

-bnortl

Usage

When used in conjunction with either **-bdynamic** or **-bshared**, the search for libraries that you specified with the **-l** option is satisfied by the suffix *.so* or *.a*.

For each directory searched, a file with the suffix *.so* is looked for. If it is not found, a file with the suffix *.a* is looked for. If neither file is found, the search continues with the next directory.

Table 18 on page 80 shows how these options combine to affect the file suffix being searched for.

Rules

This option is passed directly to the **ld** command and is not processed by XL Fortran at all. Only the last specified option will be used.

This option has a global effect; regardless of where it appears on the command line; it affects the entire command.

Examples

```
xlf95 -brtl f.f -lmylib  
xlf95_r -bnortl f.f -bdynamic -llib1 -bstatic -llib2
```

Note that if you add **-brtl** to the end of the last example, it will override the earlier occurrence of **-bnortl**.

Related information

- “-bdynamic, -bshared, and -bstatic” on page 79
- “-l” on page 98
- For more information on these options, see *AIX General Programming Concepts: Writing and Debugging Programs*.

-bshared

Category

Linking

Purpose

See “-bdynamic, -bshared, and -bstatic” on page 79.

-bstatic

Category

Linking

Purpose

See “-bdynamic, -bshared, and -bstatic” on page 79.

-C

Category

Error checking and debugging

Purpose

Checks each reference to an array element, array section, or character substring to ensure the reference stays within the defined bounds of the entity.

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

Syntax

Option:

►► `-C` ◄◄

@PROCESS:

@PROCESS CHECK | **NOCHECK**

Defaults

`-qnocheck`

Usage

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 runtime 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).

The `-C` option prevents some optimizations. You may want to remove the `-C` option after the debugging of your code is complete and then add any desired optimization options for better performance.

The valid bounds for character substring expressions differ depending on the setting of the `-qzerosize` option.

Related information

- “`-qhot`” on page 174
- “`-qzerosize`” on page 301
- “`-qsigtrap`” on page 248 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.

-C

Category

Object code control

@PROCESS directive

None.

Purpose

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

Syntax

►► -c ◀◀

Defaults

Not applicable.

Usage

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

- “-o” on page 103.

-D

Category

Language element control

Purpose

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

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

Syntax

►► — `-D` —————►►

@PROCESS:
`@PROCESS D LINES` | `NODLINES`

Usage

If you specify `-D`, 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, when compiling a file that ends with `.F`, use the `-W` option. For example:
`-WF, -DDEFINE_THIS`

-d

Category

Output control

@PROCESS directive

None.

Purpose

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

Syntax

▶▶ -d ◀◀

Defaults

Not applicable.

Results

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

Related information

- “Passing Fortran files through the C preprocessor” on page 33

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.

Alternatively, you can store customized settings in the user-defined configuration file specified by the `XL_FUSR_CONFIG` environment variable. This file will not be replaced during reinstallation.

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

- “Creating custom configuration files” on page 12 explains the contents of a custom, user-defined configuration file and shows how to select different stanzas in the file without using the `-F` option.
- “Editing the default configuration file” on page 14 explains how to edit the contents of a configuration file for use with the `-F` option.
- “-B” on page 76
- “-t” on page 303
- “-W” on page 309

-g

Category

Error checking and debugging

Purpose

Generates debug information for use by a symbolic debugger.

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

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

Syntax

Option:

►► `-g` ◄◄

@PROCESS:

@PROCESS `DBG` | `NODBG`

Related information

- “`-qlinedebug`” on page 202
- “Debugging a Fortran 90 or Fortran 95 program” on page 323
- “A Sample dbx session for an XL Fortran program” on page 324
- “Symbolic debugger support” on page 5

Category

Input control

@PROCESS directive

None.

Purpose

Adds a directory to the search path for include files and .mod files.

Syntax

►► -I—*path_name*◄◄

Defaults

Not applicable.

Parameters

path_name

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

Usage

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.

Rules

The compiler appends a */* to *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**.

Related information

- “-qmoddir” on page 212
- “-qfullpath” on page 171

-k

Category

Input control

Purpose

Indicates that the source code is in free source form.

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

Syntax

Option:

▶▶ -k ◀◀

@PROCESS:

@PROCESS FREE(F90)

Related information

- “-qfree” on page 169
- *Free Source Form* in the *XL Fortran Language Reference*.

-L

Category

Linking

@PROCESS directive

None.

Purpose

Searches the directory path for library files specified by the **-l** option.

Syntax

Option:

▶▶ `-L`*path_name*◀◀

Defaults

Not applicable.

Usage

If you use libraries other than the default ones in `/usr/lib`, you can specify one or more **-L** options that point to the locations of the other libraries. You can also set the `LIBPATH` environment variable, which lets you specify a search path for libraries at run time.

Rules

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

Related information

- “Linking” on page 68
- “Linking XL Fortran programs” on page 35

-l

Category

Linking

@PROCESS directive

None.

Purpose

Searches for the specified library file, *libkey.so*, and then *libkey.a* for dynamic linking, or just for *libkey.a* for static linking.

Syntax

►► -l—*key*◄◄

Defaults

The compiler default is to search only for some of the compiler runtime libraries. The default configuration file specifies the default library names to search for with the **-l** compiler option, and the default search path for libraries with the **-L** compiler option.

Parameters

key

The name of the library minus the `lib` characters.

Rules

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

Related information

- “-brtl” on page 85
- “Linking” on page 68
- “Linking XL Fortran programs” on page 35

-NS

Category

Compiler customization

Purpose

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

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

Syntax

Option:

►► `-NS` *bytes* ◀◀

@PROCESS:

`@PROCESS SPILLSIZE` (*bytes*)

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.

Parameters

bytes

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.

Related information

- “`-qspillsize`” on page 258

-O

Category

Optimization and tuning

Purpose

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

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

Syntax

Option:



@PROCESS:

@PROCESS OPTimize[(level)] | NOOPTimize

Defaults

`nooptimize` or `-O0` or `optimize=0`

Parameters

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 runtime 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 is ignored and has no effect on the outcome of the compilation. In past releases, it was interpreted as a combination of the `-O` and `-1` options, which may have had unintended results.
- 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 runtime 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=ppc** 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). These algorithms 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.

Usage

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 runtime 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 maintains the same program behavior as with **-O2**, at the cost of optimization opportunity. Refer to the **-qstrict** option for the list of optimizations it disables.

If the **-O** option is used in an **@PROCESS** statement, only an optimization level of 0, 2, or 3 is allowed. Note that unlike using **-O3** in command line invocation, specifying **@PROCESS OPT(3)** does not imply **-qhot=level=0**.

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

- “-qessl” on page 153 allows the use of ESSL routines.
- “-qstrict” on page 261 shows how to turn off the effects of **-O3** that might change the semantics of a program.
- “-qipa” on page 186, “-qhot” on page 174, and “-qpdf1, -qpdf2” on page 221 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.

-o

Category

Output control

@PROCESS directive

None.

Purpose

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

Syntax

►► — *-o—name—* ————— ◀◀

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.

Usage

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.

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

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Prepares the object files produced by the compiler for profiling.

The compiler produces monitoring code that counts the number of times each routine is called. The compiler inserts a call to the monitor subroutine at the start of each subprogram.

Syntax

Diagram illustrating the syntax for the `-p` flag. A horizontal line with arrowheads at both ends represents the command line. The flag `-p` is positioned at the start of the line. A bracket below the line indicates that the flag is optional, with a 'g' below the bracket.

Defaults

Not applicable.

Usage

When you run a program compiled with `-p` and it ends normally, it produces a **mon.out** file with the profiling information. You can then use the **prof** command to generate a runtime profile.

`-pg` is like `-p`, but it produces more extensive statistics. Running a program compiled with `-pg` produces a **gmon.out** file, which you use with the **gprof** command to generate a runtime profile.

Examples

```
$ xlf95 -p needs_tuning.f
$ a.out
$ prof
.
```

profiling data

```
.
```

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

```
.
```

detailed and verbose profiling data

```
.
```

Related information

- Refer to your operating system documentation for more information on profiling and the **prof** or **gprof** command.

-Q

Category

Optimization and tuning

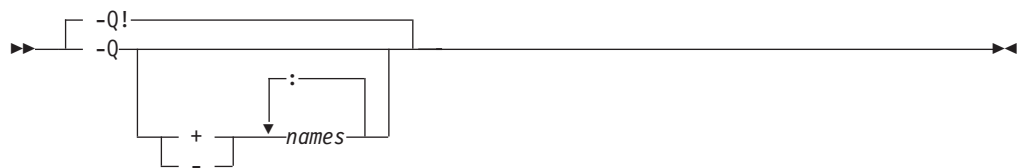
@PROCESS directive

None.

Purpose

Specifies whether procedures are considered for inlining and/or the names of particular procedures that should or should not be considered for inlining.

Syntax



Defaults

-Q!

Parameters

+names

Procedure names, separated by colons, to be inlined.

-names

Procedure names, separated by colons, not to be inlined.

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* raises these limits for the named procedures.

You can specify more than one of these options to precisely control which procedures are most likely to be inlined.

-Q! turns off inlining.

Usage

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

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.

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 define at the source level). A procedure named by `-Q+names` can be up to approximately 20 times larger and still be inlined.

Conflicting `@PROCESS` directives or compilation options applied to different compilation units can impact inlining effectiveness. For example, if you specify inlining for a procedure, some `@PROCESS` compiler directives can be rendered ineffective. See the *XL Fortran Optimization and Programming Guide* for more information on inlining and IPA.

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” on page 186
- *Benefits of Interprocedural Analysis* in the *XL Fortran Optimization and Programming Guide*

-q32

Category

Object code control

@PROCESS directive

None.

Purpose

Enables 32-bit compilation mode (or, more briefly, 32-bit mode) support in a 64-bit environment.

Syntax

►► -q32 ◀◀

Defaults

-q32 is the default, if you have not specified either **-q32** or **-q64** and if you have not set the **OBJECT_MODE** environment variable. For a description of the **OBJECT_MODE** environment variable, see “Default bit mode” on page 314.

Usage

- 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.
- **-q64** will override **-q32**.
- All settings for **-qarch** are compatible with **-q32**. If you specify **-q32**, the default **-qarch** suboption is **ppc**, and the default **-qtune** suboption for **-q32** is **balanced..**
- The **LOC** intrinsic returns an **INTEGER(4)** value.

Examples

- Using 32-bit compilation mode and targeting a generic PowerPC architecture:
-qarch=ppc -q32
- Now keep the same compilation mode, but change the target to POWER5:
-qarch=ppc -q32 -qarch=pwr5
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=pwr5 -q64

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

Related information

- “-q64” on page 109
- “-qarch” on page 119
- “-qtune” on page 273
- “-qwarn64” on page 284
- Chapter 7, “Using XL Fortran in a 64-Bit Environment,” on page 313

-q64

Category

Object code control

@PROCESS directive

None.

Purpose

Indicates 64-bit compilation bit mode and, together with the **-qarch** option, determines the target machines on which the 64-bit executable will run.

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.

Syntax

►► — -q—64— ◄◄

Purpose

Defaults

Not applicable.

Rules

- Settings for **-qarch** that are compatible with **-q64** are as follows:
 - **-qarch=auto** (if compiling on a 64-bit system)
 - **-qarch=ppc** (With **-q64** and **-qarch=ppc**, the compiler will silently upgrade the arch to **ppc64**.)
 - **-qarch=ppcgr** (With **-q64** and **-qarch=ppcgr**, the compiler will silently upgrade the arch to **ppc64gr**.)
 - **-qarch=ppc64**
 - **-qarch=ppc64v**
 - **-qarch=ppc64gr**
 - **-qarch=ppc64grsq**
 - **-qarch=rs64a**
 - **-qarch=rs64b**
 - **-qarch=rs64c**
 - **-qarch=pwr3**
 - **-qarch=pwr4**
 - **-qarch=pwr5**
 - **-qarch=pwr5x**
 - **-qarch=pwr6**
 - **-qarch=pwr6e**
 - **-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`. For example, `-q64 -qarch=604` will be changed to the setting `-qarch=ppc64`.
- The default tune setting for `-q64` is `-qtune=balanced`.
- 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 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.

Restrictions

- Objects that are generated with the 64-bit LDT ABI are not compatible with 64-bit non-LDT ABI objects. 64-bit LDT ABI objects cannot be linked with 64-bit non-LDT ABI objects on any level of AIX. XL Fortran no longer supports non-LDT ABI objects either for producing them or linking with them.
- 64-bit LDT ABI objects must be linked on AIX version 5 and above. Objects created with the old 64-bit non-LDT ABI must be linked on AIX 4.3.3. XL Fortran no longer supports emitting code that executes on AIX version 4.
- 64-bit LDT ABI applications cannot be loaded or executed on AIX 4.3.3. 64-bit non-LDT ABI applications cannot be loaded or executed on AIX Version 5 and above. **Existing 64-bit applications compiled on AIX 4.3.3 must be recompiled to run on AIX Version 5 and above!**
- 64-bit module (.mod) files created by previous versions of XL Fortran can only be used if they were compiled with `-q64=largetype`.
- The compiler no longer appends `ldt` to the specified directory name at compilation time with `-q64=largetype` if the `include_64` attribute is used in the `xlf.cfg` file to specify an alternate directory for 64-bit include and module files. As a result, you may need to change your existing build environment.
- Each of the following situations will produce an error message:
 1. Attempting to link, load, or execute conflicting 64-bit ABI objects on any level of AIX
 2. Attempting to link, load, or execute 64-bit LDT ABI objects on AIX 4.3.3
 3. Attempting to link, load, or execute 64-bit non-LDT ABI objects on AIX version 5 and above.

Examples

This example targets the POWER5 in 64-bit mode:

```
-q32 -qarch=pwr5 -q64
```

In this example 64-bit compilation that targets the common group of 64-bit architectures:

```
-q64 -qarch=ppc
```

The arch setting is silently upgraded to `ppc64`, the most "common" 64-bit mode compilation target.

In this example, the **-qarch** option conflicts with **-q64**:
`-qarch=604 -q64`

which results in a suboption setting of **-q64 -qarch=ppc64** and a warning message.

Related information

- “-qarch” on page 119
- “-qtune” on page 273
- Chapter 7, “Using XL Fortran in a 64-Bit Environment,” on page 313
- “-qwarn64” on page 284

-qalias

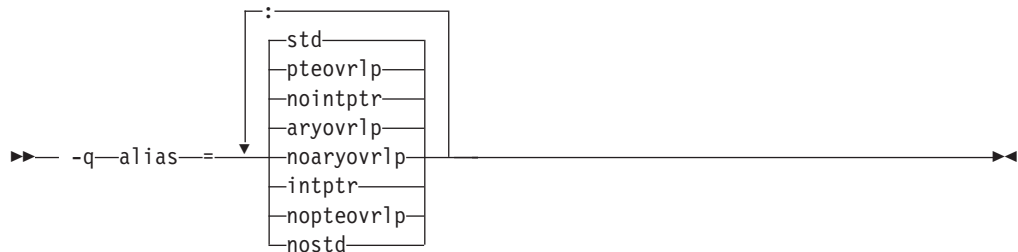
Category

Optimization and tuning

Purpose

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

Syntax



```
@PROCESS:  
@PROCESS ALIAS( {ARGUMENT_LIST} )
```

Defaults

-qalias=aryovrlp: nointptr: pteovrlp: std

Parameters

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**.

Usage

An alias exists when an item in storage can be referred to by more than one name. The Fortran 90, Fortran 95, and Fortran 2003 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.
- A subscript to an array within a common block exceeds that array's bounds.

The **-qipa** option does not remove the need for **-qalias**.

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 **xlfr_r**, **xlfr_r7**, **xlfr**, and **f77/fort77** commands, for compatibility with XL Fortran Version 2, assume that integer **POINTERS** may be present (**-qalias=aryovrlp:pteovrlp:std:intptr**), while all other invocation commands assume that a program contains only standard aliasing (**-qalias=aryovrlp:pteovrlp:std:nointptr**).

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

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

```

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)

```

Related information

- See *Optimizing XL compiler programs* in the *XL Fortran Optimization and Programming Guide* for information on aliasing strategies you should consider.

-qalias_size

Category

Compiler customization

Purpose

Specifies an appropriate initial size, in bytes, for the aliasing table. This option has effect only when optimization is enabled.

Syntax

```
►► — -q—alias_size—==—size— ◄◄
```

@PROCESS:

@PROCESS ALIAS_SIZE(*bytes*)

Defaults

None.

Parameters

size

The initial size of the alias table, in bytes.

Usage

Compiling very large programs with optimization can cause aliasing tables to get very large, which may result in memory fragmentation. Use this option only when the compiler issues an error message with a suggested value for *bytes*. Specifying this option in other situations, or with values not recommended by the compiler, may cause the compiler to run out of memory.

Related information

- “-qsaveopt” on page 244
- “-qxlf2003” on page 294

-qalign

Processing

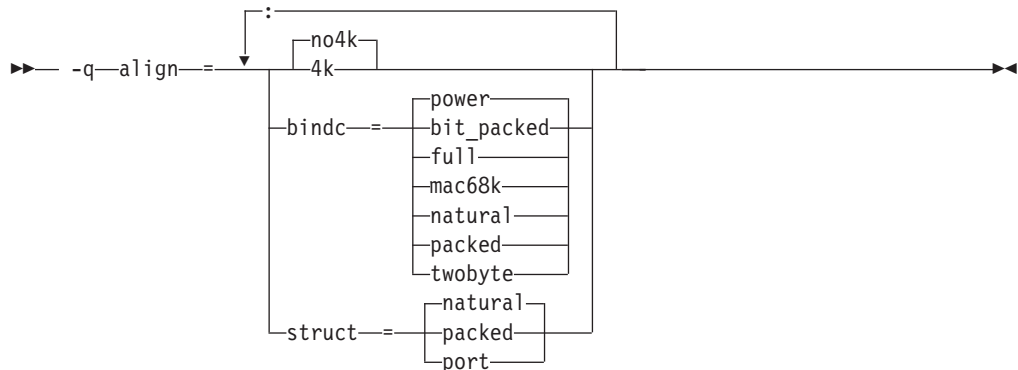
Portability and migration

Purpose

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.

Format



@PROCESS:

```
@PROCESS ALIGN({[NO]4K|STRUCT{(suboption)}|BINDC{(suboption)}})
```

Defaults

-qalign=no4k:struct=natural:bindc=power.

Parameters

[no]4k Specifies whether to align large data objects on page (4 KB) boundaries, for improved performance with data-stripped 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=full power	-qalign=full power
-qalign=bindc=mac68k twobyte	-qalign=mac68k twobyte
-qalign=bindc=natural	-qalign=natural
-qalign=bindc=packed	-qalign=packed

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.

You must use **-qalign=4k** if you are using the I/O techniques that are described in *Increasing throughput with logical volume I/O and data striping* of the *XL Fortran Optimization and Programming Guide*.

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” on page 124. This listing also shows the offsets of data objects.

-qarch

Category

Optimization and tuning

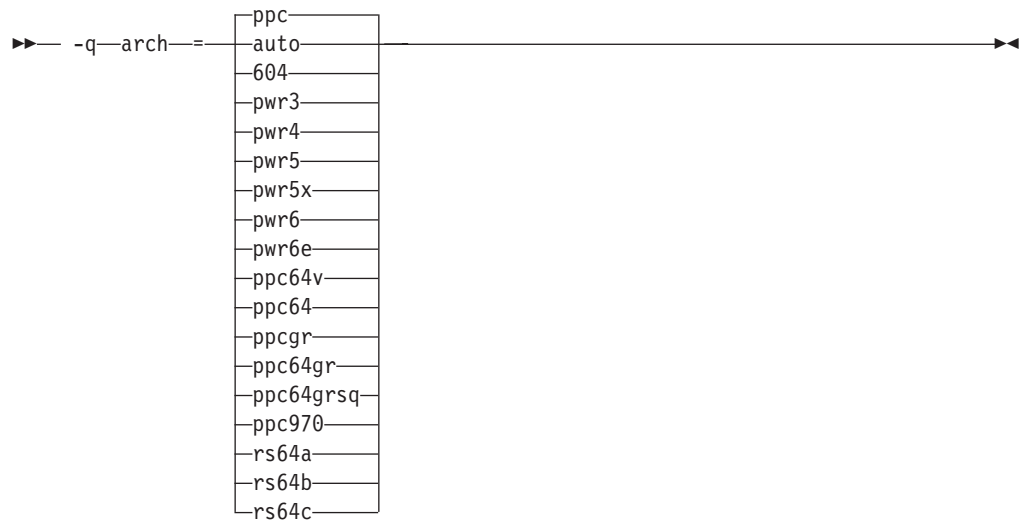
@PROCESS directive

None.

Purpose

Specifies the processor architecture, or family of architectures, where the code may run. This allows the compiler to take maximum advantage of the machine instructions specific to an architecture, or common to a family of architectures.

Syntax



Defaults

- `-qarch=ppc` when `-q32` is in effect.
- `-qarch=ppc64` when `-q64` is in effect.
- `-qarch=auto` when `-O4` or `-O5` is in effect.

Parameters

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.

604

Produces object code containing instructions that will run on the PowerPC 604™ hardware platform. This suboption is not valid if `-q64` is in effect.

pwr3

Produces object code containing instructions that will run on any POWER3, POWER4, POWER5, POWER5+, POWER6, or PowerPC 970 hardware platform.

pwr4

Produces object code containing instructions that will run on the POWER4, POWER5, POWER5+, POWER6, or PowerPC 970 hardware platform.

pwr5

Produces object code containing instructions that will run on the POWER5, POWER5+, or POWER6 hardware platforms.

pwr5x

Produces object code containing instructions that will run on the POWER5+ or POWER6 hardware platforms.

pwr6

Produces object code containing instructions that will run on the POWER6 hardware platforms running in POWER6 architected mode.

pwr6e

Produces object code containing instructions that will run on the POWER6 hardware platforms running in POWER6 raw mode.

ppc

In 32-bit mode, produces object code containing instructions that will run on any of the 32-bit PowerPC hardware platforms. This suboption causes the compiler to produce single-precision instructions to be used with single-precision data. Specifying **-qarch=ppc** together with **-q64** silently upgrades the architecture setting to **-qarch=ppc64**.

ppc64

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

ppcgr

In 32-bit mode, produces object code for PowerPC processors that support optional graphics instructions. Specifying **-qarch=ppcgr** together with **-q64** silently upgrades the architecture setting to **-qarch=ppc64gr**.

ppc64gr

Produces code for any 64-bit PowerPC hardware platform that supports optional graphics instructions.

ppc64grsq

Produces code for any 64-bit PowerPC hardware platform that supports optional graphics and square root instructions.

ppc64v

Generates instructions for generic PowerPC chips with vector processors, such as the PowerPC 970. Valid in 32-bit or 64-bit mode.

ppc970

Generates instructions specific to the PowerPC 970 architecture.

rs64a

Produces object code that will run on RS64I platforms.

rs64b

Produces object code that will run on RS64II platforms.

rs64c

Produces object code that will run on RS64III platforms.

Note: As of the V11.1 release of the compiler, the **com** suboption, and suboptions representing POWER™ and POWER2™ architectures, are no longer supported. If you would like similar floating-point behavior to that provided by this suboption, use the **-qfloat=nosingle:norndsngl** option. See “-qfloat” on page 162 for details.

Usage

All PowerPC machines share a common set of instructions, but may also include additional instructions unique to a given processor or processor family. Using the **-qarch** option to target a specific architecture for the compilation results in code that may not run on other architectures, but provides the best performance for the selected architecture. If you want maximum performance on a specific architecture and will not be using the program on other architectures, use the appropriate architecture option. If you want to generate code that can run on more than one architecture, specify a **-qarch** suboption that supports a group of architectures. Table 19 shows the features supported by the different processor architectures and their representative **-qarch** suboptions:

Table 19. Feature support in processor architectures

Architecture	Graphics support	Square root support	64-bit support	Vector processing support	Large page support
604	yes	no	no	no	no
rs64a	no	no	yes	no	no
rs64b	yes	yes	yes	no	no
rs64c	yes	yes	yes	no	no
pwr3	yes	yes	yes	no	no
pwr4	yes	yes	yes	no	yes
pwr5	yes	yes	yes	no	yes
pwr5x	yes	yes	yes	no	yes
ppc	no	no	no	no	yes
ppc64	no	no	yes	no	yes
ppc64gr	yes	no	yes	no	yes
ppc64grsq	yes	yes	yes	no	yes
ppc64v	yes	yes	yes	yes	yes
ppc970	yes	yes	yes	yes	yes
pwr6	yes	yes	yes	yes	yes
pwr6e	yes	yes	yes	yes	yes

For any given **-qarch** setting, the compiler defaults to a specific, matching **-qtune** setting, which can provide additional performance improvements. Alternatively, if you specify **-qarch** with a group argument, you can specify **-qtune** as either **auto** or provide a specific architecture in the group. For detailed information on using **-qarch** and **-qtune** together, see “-qtune” on page 273.

Specifying **-q64** changes the effective **-qarch** setting as follows:

Original -qarch setting	Effective setting when -q64 is specified
ppc	ppc64
ppcgr	ppc64gr

For a given application program, make sure that you specify the same **-qarch** setting when you compile each of its source files. Although the linker and loader may detect object files that are compiled with incompatible **-qarch** settings, you should not rely on it.

Examples

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

```
xlf -o testing myprogram.f -q32 -qarch=ppc
```

Related information

- “-qtune” on page 273
- "Choosing the best -qarch suboption" in the *XL Fortran Optimization and Programming Guide*

-qassert

Category

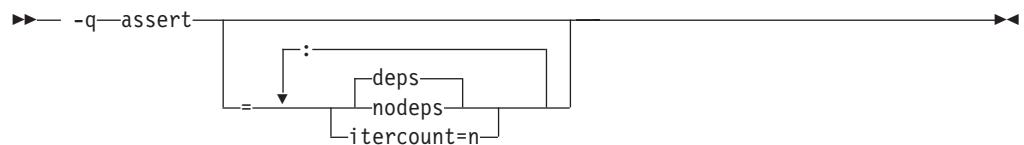
Optimization and tuning

Purpose

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

Syntax

Option:



@PROCESS:

@PROCESS ASSERT(suboptions)

Defaults

-qassert=deps

Parameters

deps | nodeps

Specifies whether or not any loop-carried dependencies exist.

itercnt=*n*

Specifies a value for unknown loop iteration counts for the optimizer to use when it cannot statically determine the loop iteration count.

Related information

- *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

Category

Listings, messages, and compiler information

Purpose

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

Syntax



```
@PROCESS:  
@PROCESS ATTR[(FULL)] | NOATTR
```

Defaults

`-qnoattr`

Parameters

full

Reports all identifiers in the program. If you specify `-qattr` without this suboption, only those identifiers that are used are reported.

If you specify `-qattr=full`, all identifiers, whether referenced or not, are reported.

Usage

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

- “Listings, messages, and compiler information” on page 63
- “Attribute and cross reference section” on page 338

-qautodbl

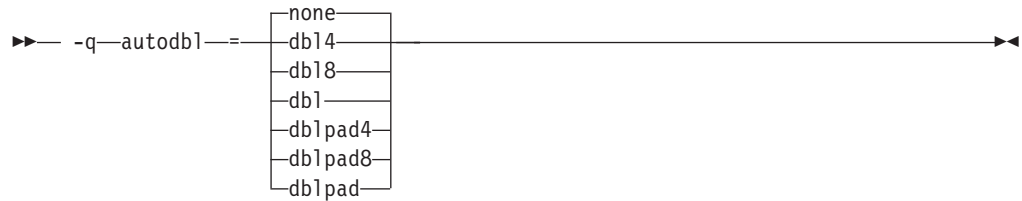
Category

Floating-point and integer control

Purpose

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

Syntax



@PROCESS:

@PROCESS AUTODBL(*setting*)

Defaults

-qautodbl=none

Parameters

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:

- | | |
|--------------------|---|
| <u>none</u> | Does not promote or pad any objects that share storage. This setting is the default. |
| db14 | 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): <ul style="list-style-type: none">• REAL(4) is promoted to REAL(8).• COMPLEX(4) is promoted to COMPLEX(8). This suboption requires the libxlfpm4.a library during linking. |
| db18 | Promotes floating-point objects that are double-precision (8 bytes in size) or that are composed of such objects: <ul style="list-style-type: none">• REAL(8) is promoted to REAL(16).• COMPLEX(8) is promoted to COMPLEX(16). This suboption requires the libxlfpm8.a library during linking. |
| dbl | Combines the promotions that db14 and db18 perform.

This suboption requires the libxlfpm4.a and libxlfpm8.a libraries during linking. |

dblpad4	<p>Performs the same promotions as dbl4 and pads objects of other types (except CHARACTER) if they could possibly share storage with promoted objects.</p> <p>This suboption requires the libxlfpm4.a and libxlfpad.a libraries during linking.</p>
dblpad8	<p>Performs the same promotions as dbl8 and pads objects of other types (except CHARACTER) if they could possibly share storage with promoted objects.</p> <p>This suboption requires the libxlfpm8.a and libxlfpad.a libraries during linking.</p>
dblpad	<p>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.</p> <p>This suboption requires the libxlfpm4.a, libxlfpm8.a, and libxlfpad.a libraries during linking.</p>

Usage

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.

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. To detect inconsistent **-qautodbl** settings, use the **-qextchk** option when compiling the source file.

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 345.

“**-qrealsize**” on page 235 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.

“Linking 32-bit non-SMP object files using the **ld** command” on page 37 explains how to manually link additional libraries with object files that you compiled with **-qautodbl**.

-qcache

Category

Optimization and tuning

@PROCESS directive

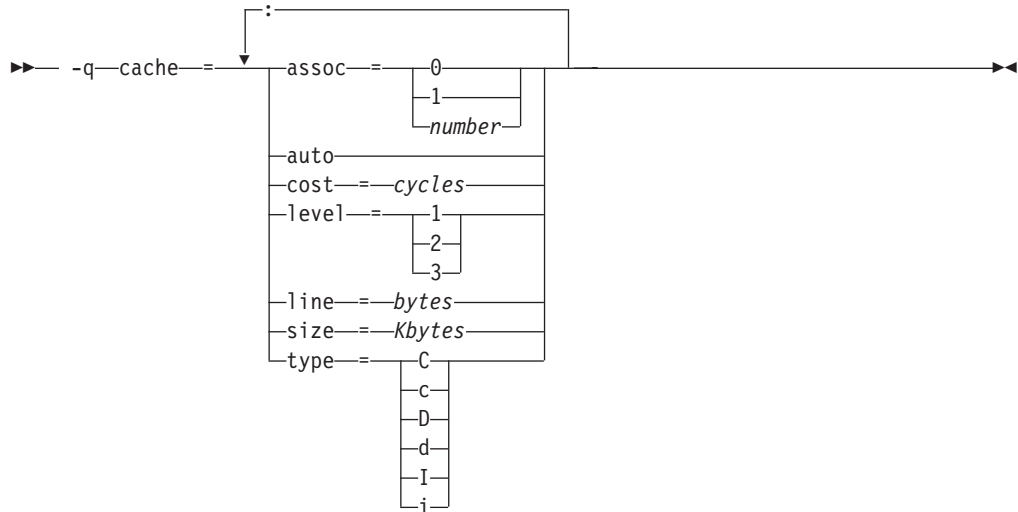
None.

Purpose

When specified with **-O4**, **-O5**, or **-qipa**, 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.

Syntax



Defaults

Not applicable.

Parameters

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

Usage

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.

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

- “-qarch” on page 119
- “-qhot” on page 174
- “-qtune” on page 273

-qcclines

Category

Input control

Purpose

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

Syntax

►► -q { cclines | nocclines } ◄◄

@PROCESS:

@PROCESS CCLINES | NOCCLINES

Defaults

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

Related information

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

-qcheck

Category

Error checking and debugging

Purpose

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

Syntax

►► -q nocheck
check _____►►

@PROCESS:

@PROCESS CHECK | NOCHECK

Defaults

-qnocheck

-qci

Category

Input control

Purpose

Specifies the identification numbers (from 1 to 255) of the **INCLUDE** lines to process.

Syntax

```
→ -qci= : number →
```

@PROCESS:

```
@PROCESS CI(number,...,number)
```

Defaults

Not applicable.

Usage

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.

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.

Notes:

1. Because the optional number in **INCLUDE** lines is not a widespread XL Fortran feature, using it may restrict the portability of a program.
2. This option works only with the XL Fortran **INCLUDE** directive and not with the **#include** C preprocessor directive.

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.

Related information

- The **INCLUDE** directive in the *XL Fortran Language Reference*

-qcompact

Category

Optimization and tuning

Purpose

Avoids optimizations that increase code size.

Syntax

►► -q nocompact
compact _____►►

@PROCESS:

@PROCESS COMPACT | NOCOMPACT

Defaults

-qnocompact

Usage

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, **-Q** and other optimization options still work; the reductions in code size come from limiting code replication that is done automatically during optimization.

-qcr

Category

Input control

@PROCESS directive

None.

Purpose

Controls how the compiler interprets the CR (carriage return) character.

This option allows you to compile code written using a Mac OS or DOS/Windows editor.

Syntax

►► -q  ◀◀

Defaults

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.

Usage

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.

-qctyp1ss

Category

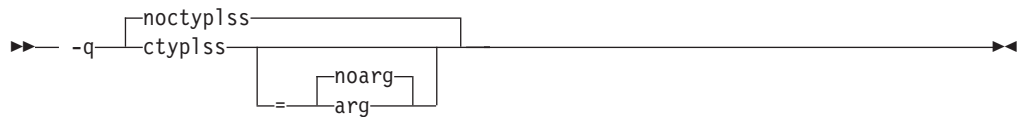
Portability and migration

Purpose

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.

Syntax



@PROCESS:

@PROCESS CTYPLSS[([NO]ARG)] | NOCTYPLSS

Defaults

-qnoctyp1ss

Parameters

arg | noarg Suboptions retain the behavior of **-qctyp1ss**. Additionally, **arg** specifies that Hollerith constants used as actual arguments will be treated as integer actual arguments.

Usage

With **-qctyp1ss**, character constant expressions are treated as if they were Hollerith constants and thus can be used in logical and arithmetic expressions.

- If you specify the **-qctyp1ss** 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 **-qctyp1ss** 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

- *Hollerith Constants* in the *XL Fortran Language Reference*
- *Passing arguments by reference or by value* in the *XL Fortran Optimization and Programming Guide*

-qdbg

Category

Error checking and debugging

Purpose

-qdbg is the long form of “-g” on page 94.

Syntax

►► -q nodbg
dbg ◀◀

@PROCESS:

@PROCESS DBG | NODBG

Defaults

-qnodbg

-qddim

Category

Portability and migration

Purpose

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.

Syntax

►► -q noddim
ddim ►►

@PROCESS:

@PROCESS DDIM | **NODDIM**

Defaults

-qnoddim

Usage

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
```

-qdescriptor

Category

Portability and migration

@PROCESS directive

None.

Purpose

Specifies the XL Fortran internal descriptor data structure format to use for non object-oriented entities in your compiled applications.

Syntax

►► -qdescriptor=[v1/v2] ►►

Defaults

- -qdescriptor=v1

Parameters

- v1 Use an internal descriptor data structure format that provides compatibility with objects compiled with XL Fortran V10.1 and earlier.
- v2 Use an internal descriptor data structure format that provides compatibility with new features available in XL Fortran V11.1 and above. This setting allows your programs to take advantage of new object-oriented features and constructs.

Usage

Regardless of what **-qdescriptor** setting is in effect, applications containing object-oriented constructs will use the **v2** data structure format for those constructs, and will not be compatible with objects compiled with XL Fortran V10.1 or earlier. You should consider explicitly using the **v2** setting if your applications do not need to interact with objects that were compiled with earlier versions of XL Fortran.

The choice of **-qdescriptor** setting is an important consideration when building libraries or modules for distribution. Users of these libraries and modules will need to be aware of the **-qdescriptor** setting and compile the code that uses them in a compatible way. It is suggested that such libraries and modules be built with the **-qsaveopt** option so that the objects themselves will encode the compilation options in a user-readable form.

If you are building modules with V11.1 or later that contain user-visible derived types, consider building them with the **-qxf2003=polymorphic** suboption. This allows users of the module to use or extend the derived types in a Fortran object-oriented context that uses polymorphism.

In the Fortran 2003 object-oriented programming model, the XL Fortran compiler supports using types and type extensions from types defined in modules not compiled with **-qxf2003=polymorphic**, as long as the types are not used in a

context that requires polymorphism. This support extends to modules built with older XL Fortran compilers, as well. However, if the compiler detects the attempted use of a type or a type extension from a module not compiled with **-qxf2003=polymorphic** in a context that requires polymorphism, an error message will be issued and compilation halted.

If a module built with the **-qdescriptor=v1** setting or a module built with XL Fortran v10.1 or earlier is used in a compilation where **-qdescriptor=v2** has been specified, the compiler will diagnose this mismatch and halt compilation after issuing an error message.

When using the **-qdescriptor=v2** option, the compiler is unable to diagnose unsafe usage where objects built with the **v2** setting are mixed with those built with the **v1** setting or with XL Fortran 10.1 or older compilers. Even if your program appears to function properly, this usage is unsupported. The descriptor formats are different sizes and, when used with certain constructs, data layouts will change resulting in undefined and unsupported behavior. For example, the sizes of allocatable and pointer entities within derived types will be different resulting a differing size for the derived type itself.

Related information

- “-qsaveopt” on page 244
- “-qxf2003” on page 294

-qdirective

Processing

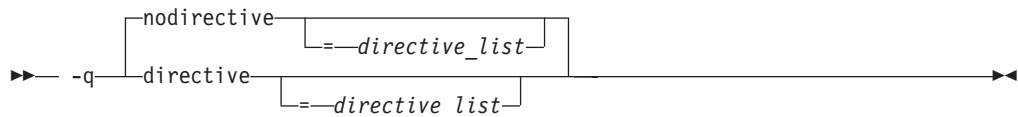
Input control

Purpose

Specifies sequences of characters, known as trigger constants, that identify comment lines as compiler comment directives.

A compiler comment directive is a line that is not a Fortran statement but is recognized and acted on by the compiler.

Format



@PROCESS:

@PROCESS DIRECTIVE[(*directive_list*)] | **NODIRECTIVE**[(*directive_list*)]

Defaults

The compiler recognizes the default trigger constant **IBM***.

Specifying **-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. Specifying **-qthreaded** implies **-qdirective=ibmt**, and, by default, the trigger constant **IBMT** is also turned on.

Parameters

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**.

Usage

Note the following:

- Multiple **-qdirective** and **-qnodirective** options are additive; that is, you can turn directive identifiers on and off again multiple times.
- One or more *directive_lists* 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.
- As the use of incorrect trigger constants can generate warning messages, error messages, or both, you should check the particular directive statement for the suitable associated trigger constant.

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.

- The **SOURCEFORM** directive in the *XL Fortran Language Reference*
- The *Directives* section in the *XL Fortran Language Reference*

-qdirectstorage

Processing

Optimization and tuning

Context

None.

Purpose

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

Format

►► -q nodirectstorage
directstorage ◀◀

Defaults

-qnodirectstorage

Usage

Use this option with discretion. It is intended for programmers who know how the memory and cache blocks work, and how to tune their applications for optimal performance. 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

Processing

Language element control

Purpose

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

Format

►► — `-q` —

<code>nodlines</code>
<code>dlines</code>

 —————►►

@PROCESS:

`@PROCESS` `DLINES` | **NODLINES**

Defaults

`-qnodlines`

-qdpc

Processing

Floating-point and integer control

Purpose

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.

Format



@PROCESS:

@PROCESS DPC[(E)] | NODPC

Defaults

-qnodpc

Usage

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.

-qautodbl and **-qrealize** are more general-purpose options that can also do what **-qdpc** does. **-qdpc** has no effect if you specify either of these options.

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
```

```
end

program testdpc
call nodpc
call dpc
end
```

When compiled, this program prints the following:

```
1.000000000      1.0000000000000000000      T
1.000000000      1.0000000000100009         F
```

showing that with **-qdpc** the extra precision is preserved.

- “-qautodbl” on page 125
- “-qrealsize” on page 235

-qdpcl

Processing

Error checking and debugging

Purpose

Generates symbols that tools based on the IBM Dynamic Probe Class Library (DPCL) can use to see the structure of an executable file.

Format

►► -q nodpcl
dpcl _____►►

@PROCESS:

@PROCESS DPCL | NODPCL

Defaults

-qnodpcl

Usage

When you specify the **-qdpcl** option, the compiler emits symbols to define blocks of code in a program. You can then use tools that use the DPCL interface to examine performance information, such as memory usage, for object files that you compiled with this option.

You must also specify the **-g** option when you specify **-qdpcl**.

-qdpcl is not supported at **-O2** or higher optimization levels. If **-O2** is specified or implied by other options, **-qdpcl** will be disabled.

- “-g” on page 94
- “-O” on page 100
- For more information on DPCL, visit the following Web page:
<http://dpcl.sourceforge.net>

-qenablevmx

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Enables generation of vector instructions for processors that support them.

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

Syntax

The diagram shows the syntax for the `-qenablevmx` option. It starts with a right-pointing arrow, followed by a hyphen and the letter 'q'. A bracket above the line indicates that the option can be either `-qenablevmx` or `-qnoenablevmx`. The line ends with a left-pointing arrow.

Defaults

`-qnoenablevmx`

Usage

Do not specify `-qenablevmx` unless your operating system version supports vector instructions.

If `-qnoenablevmx` is in effect, `-qvecnvml`, and `-qhot=simd` cannot be used.

Specify `-qenablevmx` to use the VMX hardware intrinsics and **vector** data type. If you do not, the compiler will flag usage of the type and these intrinsics as an error.

Related information

- “-qarch” on page 119
- “-qhot” on page 174
- “-qvecnvml” on page 280
- VMX intrinsic procedures in the *XL Fortran Language Reference*
- Vector data type in the *XL Fortran Language Reference*

-qenum

Category

Floating-point and integer control

@PROCESS directive

None.

Purpose

Specifies the range of the enumerator constant and enables storage size to be determined.

Syntax



Defaults

`-qenum=4`

Usage

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 20. 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

Category

Portability and migration

Purpose

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.

Syntax

```
→ -q ————— →  
    | escape  
    |_____  
    | noescape
```

@PROCESS:

@PROCESS ESCAPE | NOESCAPE

Defaults

-qescape

Usage

When **-qescape** is specified, 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\bcd\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\bcd\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 strings* in the *XL Fortran Optimization and Programming Guide*.

-qessl

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Allows the compiler to substitute 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.

Syntax

►► -q noessl
essl ◀◀

Defaults

-qnoessl

Usage

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.

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 Web page:

<http://publib.boulder.ibm.com/clresctr/windows/public/esslbooks.html>

-qextern

Category

Portability and migration

@PROCESS directive

None.

Purpose

Allows user-written procedures to be called instead of XL Fortran intrinsics.

Syntax

►► `-qextern=names` ◄◄

Defaults

Not applicable.

Parameters

names

A list of procedure names separated by colons.

Usage

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.

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 GETENV(VAR)
  CHARACTER(10) VAR
  PRINT *,VAR
END

CALL GETENV('USER')
END
```

Compiling this program with no options fails because the call to **GETENV** is actually calling the intrinsic subroutine, not the subroutine defined in the program. Compiling with **-qextern=getenv** allows the program to be compiled and run successfully.

-qextname

Category

Portability and migration

Purpose

Adds an underscore to the names of all global entities.

Syntax



@PROCESS:

@PROCESS EXTNAME[(*name1*, *name2*,...)] | NOEXTNAME

Defaults

-qnoextname

Parameters

name

Identifies a specific global entity (or entities). For a list of named entities, separate each name with a colon. For example: *name1: name2:...*

The name of a main program is not affected.

Usage

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

If your program has only a few instances of the naming problems that `-qextname` solves, you may prefer to select new names with the `-brename` option of the `ld` command.

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 **xlfortility** module to ensure that the Service and Utility subprograms are correctly declared, you must change the name to **xlfortility_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 **xlfortility_extname** module may cause the procedure declaration check not to work accurately.

This option also affects the names that are specified in the **-qextern**, **-Q**, and **-qsigtrap** options. You do not have to include underscores in their names on the command line.

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

- “-qextern” on page 155
- “-Q” on page 106
- “-qsigtrap” on page 248

-qfdpr

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

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

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

Syntax

►► -q nofdpr
fdpr ◀◀

Defaults

-qnofdpr

Usage

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

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

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

Examples

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

```
xlf myprogram.f -qfdpr
```

Related information

- “-qpdf1, -qpdf2” on page 221

-qfixed

Category

Input control

Purpose

Indicates that the input source program is in fixed source form and optionally specifies the maximum line length.

Syntax

►► -qfixed [==right_margin]

@PROCESS:

@PROCESS FIXED[(right_margin)]

Defaults

-qfixed=72 is the default for the `xl`, `xl_r`, `xl_r7`, `f77`, and `fort77` commands.

-qfree=f90 is the default for the `f90`, `f95`, `xl90`, `xl90_r`, `xl90_r7`, `xl95`, `xl95_r`, `xl95_r7`, `f2003`, `xl2003`, and `xl2003_r` commands.

Usage

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.

Related information

- “-qfree” on page 169
- See *Fixed source form* in the *XL Fortran Language Reference*.

-qflag

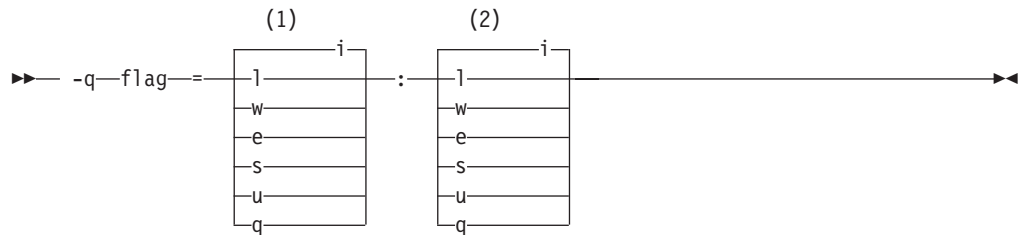
Category

Listings, messages, and compiler information

Purpose

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

Syntax



Notes:

- 1 Minimum severity level of messages reported in listing
- 2 Minimum severity level of messages reported on terminal

@PROCESS:

@PROCESS FLAG(*listing_severity*,*terminal_severity*)

Defaults

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

Parameters

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.

Usage

You must specify both *listing_severity* and *terminal_severity*.

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.

The **-qflag** option overrides any **-qlanglvl** or **-qsaa** options specified.

The **-w** option is a short form for **-qflag=e:e**.

Related information

- “-qhalt” on page 172
- “-qlanglvl” on page 196
- “-qsaa” on page 241
- “-w” on page 311
- “Understanding XL Fortran error messages” on page 317

-qfloat

Category

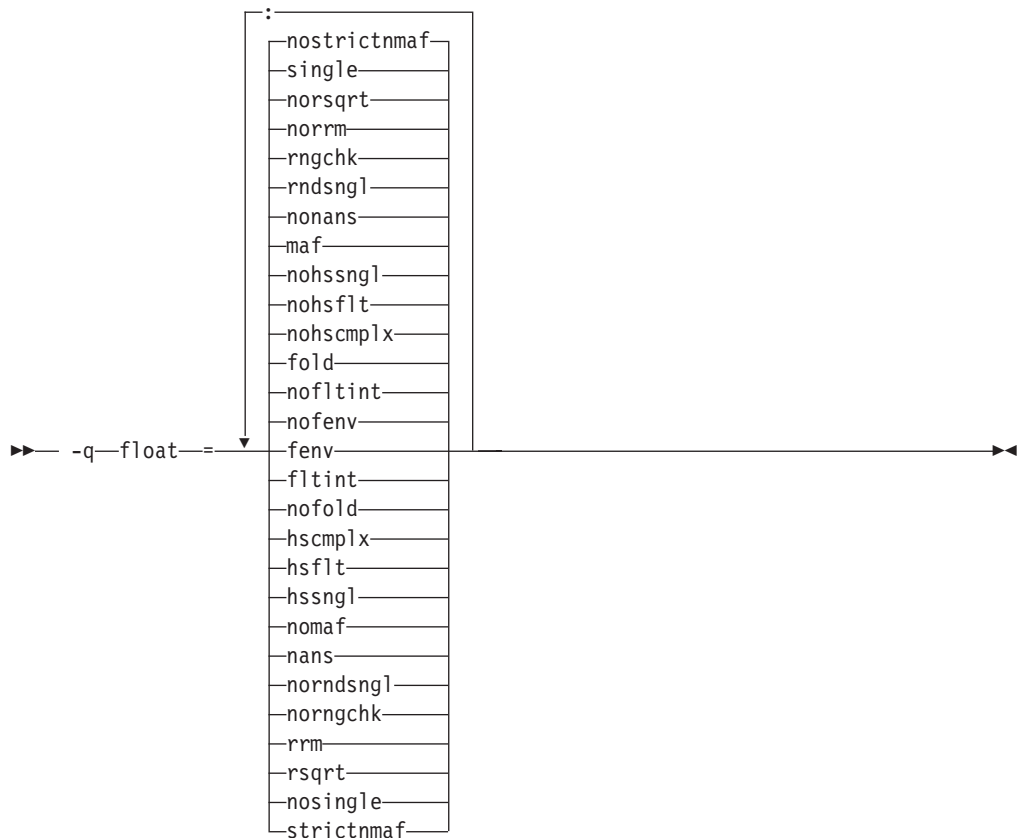
Floating-point and integer control

Purpose

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

Syntax

Option:



@PROCESS:

@PROCESS FLOAT(*suboptions*)

Defaults

- `-qfloat=nofenv:nofltint:fold: nohscmplx:nohsflt:nohssnglmaf:nonans:rndsngl:rngchk:norm:norsqrt:single:nostrictnmaf`
- `-qfloat=fltint:rsqrt:norngchk` when `-qnostrict` or `-O3` or higher optimization level is in effect.

Parameters

fenv | **nofenv**

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

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

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

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

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

fltint | **nofltint**

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

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.

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

fold | **nofold**

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

The **-qfloat=[no]fold** option replaces the deprecated **-q[no]fold** option. Use **-qfloat=[no]fold** in your new applications.

hscmplx | **nohscmplx**

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

hsflt | **nohsflt**

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

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

Note: Use **-qfloat=hsflt** on applications that perform complex division and floating-point conversions where floating-point calculations have known characteristics. In particular, all floating-point results must be within the defined range of representation of single precision. Use with discretion, as this option may produce unexpected results without warning. For complex computations, it is recommended that you use the **hscmplx** suboption (described above), which provides equivalent speed-up without the undesirable results of **hsflt**.

hssngl | **nohssngl**

Specifies that single-precision expressions are rounded only when the results are stored into memory locations, but not after expression evaluation. Using **hssngl** can improve runtime performance and is safer than using **hsflt**.

This option only affects double-precision (double) expressions cast to single-precision (float) and used in an assignment operator for which a store instruction is generated, when **-qfloat=nosingle** is in effect. Do not use this option if you are compiling with the default **-qfloat=single**.

maf | **nomaf**

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

The **-qfloat=[no]maf** option replaces the deprecated **-q[no]maf** option. Use **-qfloat=[no]maf** in your new applications.

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.

The **hsflt** option overrides the **nans** option.

The **-qfloat=[no]nans** option replaces the deprecated **-qfloat=[no]spnans** option and the **-q[no]spnans** option. Use **-qfloat=[no]nans** in your new applications.

norndsngl | **rndsngl**

Rounds the result of each single-precision operation to single-precision, rather than waiting until the full expression is evaluated. It sacrifices speed for consistency with results from similar calculations on other types of computers.

This option only affects double-precision expressions cast to single-precision. You can only specify **norndsngl** when **-qfloat=nosingle** is in effect.

The **hsflt** suboption overrides the **rndsngl** option.

rngchk | **norngchk**

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

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

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

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

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

rrm | norrm

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

The **-qfloat=[no]rrm** option replaces the deprecated **-q[no]rrm** option. Use **-qfloat=[no]rrm** in your new applications.

single | nosingle

Allows single-precision arithmetic instructions to be generated for single-precision floating-point values. All PowerPC processors support single-precision instructions; however, if you wish to preserve the behavior of applications compiled for earlier architectures, in which all floating-point arithmetic was performed in double-precision and then truncated to single-precision, you can use **-qfloat=nosingle:norndsngl**. This suboption provides computation precision results compatible with those provided by the deprecated options **-qarch=com | pwr | pwr2 | pwr2 | p2sc | 601 | 602 | 603**. **-qfloat=nosingle** can be specified in 32-bit mode only.

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.

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

Usage

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

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

Examples

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

```
xlf myprogram.f -qfloat=fold:nomaf
```

Related information

- “`-qarch`” on page 119
- “`-qflttrap`” on page 167
- “`-qstrict`” on page 261

-qflttrap

Category

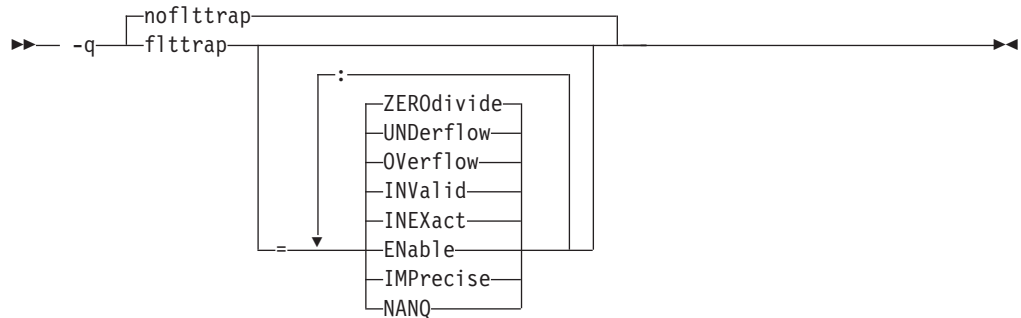
Error checking and debugging

Purpose

Determines what types of floating-point exception conditions to detect at run time.

The program receives a **SIGTRAP** signal when the corresponding exception occurs.

Syntax



@PROCESS:

FLTTRAP[(*suboptions*)] | NOFLTTRAP

Defaults

-qnoflttrap

Parameters

- | | |
|------------------|--|
| ENable | Turn on checking for the specified exceptions in the main program so that the exceptions generate SIGTRAP 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.

Usage

Specifying **-qfltrap** without suboptions is equivalent to **-qfltrap=inv:inex:ov:und:zero**. 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 **-qfltrap** more than once, both with and without suboptions, the **-qfltrap** without suboptions is ignored.

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

If you use **-qfltrap=inv:en** to compile a program containing an IEEE invalid **SQRT** operation without also specifying a **-qarch** target that implements the **sqrt** instruction set, the expected **SIGTRAP** signal will not occur when you run the program.

You can fix this problem for AIX Version 5.2 and higher by specifying the following command before running the program:

```
export SQRT_EXCEPTION=3.1
```

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 -qfltrap=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 **SIGTRAP** signal when the exception occurs. The **-qsigtrap** option produces informative output when the signal stops the program.

Related information

- “-qsigtrap” on page 248
- “-qarch” on page 119
- *Detecting and trapping floating-point exceptions* in the *XL Fortran Optimization and Programming Guide* has full instructions on how and when to use the **-qfltrap** option, especially if you are just starting to use it.

-qfree

Category

Input control

Purpose

Indicates that the source code is in free source form.

Syntax



@PROCESS:

```
@PROCESS FREE[({F90|IBM})]
```

Defaults

-qfree by itself specifies Fortran 90 free source form.

-qfixed=72 is the default for the **xl**, **xl_r**, **xl_r7**, **f77**, and **fort77** commands.

-qfree=f90 is the default for the **f90**, **f95**, **xl**, **xl_r**, **xl_r7**, **xl95**, **xl95_r**, **xl95_r7**, **f2003**, **xl2003**, and **xl2003_r** commands.

Parameters

ibm

Specifies compatibility with the free source form defined for VS FORTRAN.

f90

Specifies compatibility with the free source form defined for Fortran 90.

Note that the free source form defined for Fortran 90 also applies to Fortran 95, and Fortran 2003.

Usage

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).

Fortran 90 free source form 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.

-k is equivalent to **-qfree=f90**.

Related information

- “-qfixed” on page 159
- “-k” on page 96

- *Free Source Form in the XL Fortran Language Reference*

-qfullpath

Category

Error checking and debugging

@PROCESS directive

None.

Purpose

When used with the **-g** option, this option records the full, or absolute, path names of source and include files in object files compiled with debugging information, so that debugging tools can correctly locate the source files.

Syntax

```
→ -q ————|————→  
           |  
           |nofullpath  
           |  
           |  
           |fullpath
```

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.

Usage

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.

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  
$ dbx debug_version
```

Related information

- “-g” on page 94

-qhalt

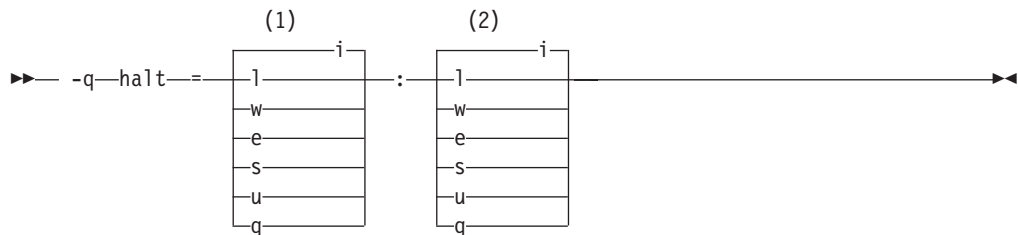
Category

Error checking and debugging

Purpose

Stops compilation before producing any object, executable, or assembler source files if the maximum severity of compile-time messages equals or exceeds the severity you specify.

Syntax



Notes:

- 1 Minimum severity level of messages reported in listing
- 2 Minimum severity level of messages reported on terminal

@PROCESS:

@PROCESS HALT(*severity*)

Defaults

-qhalt=s, which prevents the compiler from generating an object file when compilation fails.

Parameters

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.

Usage

The **-qhalt** option can override the **-qobject** option, and **-qnoobject** can override **-qhalt**.

Related information

- “-qflag” on page 160
- “-qobject” on page 217

-qhot

Category

Optimization and tuning

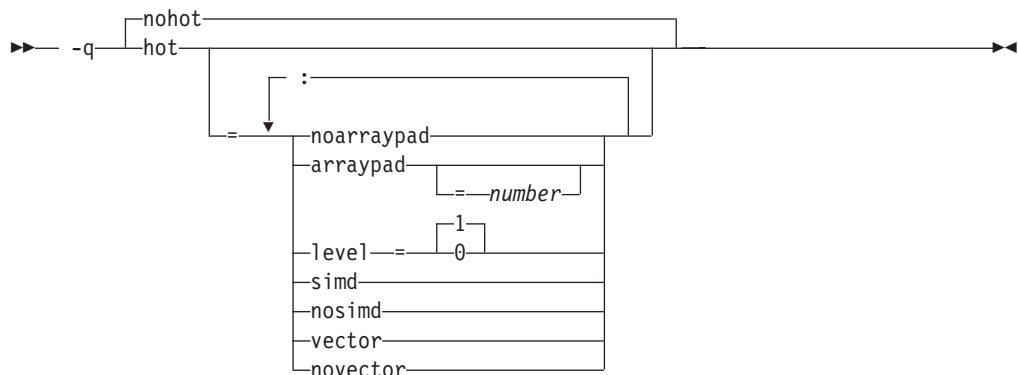
Purpose

Performs high-order loop analysis and transformations (HOT) during optimization.

The **-qhot** compiler option is a powerful alternative to hand tuning that provides opportunities to optimize loops and array language. This compiler option will always attempt to optimize loops, regardless of the suboptions you specify.

Syntax

Option :



@PROCESS:

@PROCESS HOT[=suboptions] | **NOHOT**

Defaults

- -qnohot
- **-qhot=noarraypad:level=0:nosimd:vector** when **-O3** is in effect.
- **-qhot=noarraypad:level=1:nosimd:vector** when **-qsmp**, **-O4** or **-O5** is in effect.
- Specifying **-qhot** without suboptions is equivalent to **-qhot=level=1:nosimd:noarraypad:vector**. If you specify **-qhot** without suboptions with **-qenablevmx** and a **-qarch** value that supports vector processing, **-qhot=simd** is enabled by default.

Parameters

arraypad | **noarraypad**

Permits the compiler to increase the dimensions of arrays where doing so might improve the efficiency of array-processing loops. (Because of the implementation of the cache architecture, array dimensions that are powers of two can lead to decreased cache utilization.) Specifying **-qhot=arraypad** when your source includes large arrays with dimensions that are powers of 2 can reduce cache misses and page faults that slow your array processing programs. This can be particularly effective when the first dimension is a power of 2. If you use this suboption with no *number*, the compiler will pad any arrays

where it infers there may be a benefit and will pad by whatever amount it chooses. Not all arrays will necessarily be padded, and different arrays may be padded by different amounts. If you specify a *number*, the compiler will pad every array in the code.

Note: Using **arraypad** can be unsafe, as it does not perform any checking for reshaping or equivalences that may cause the code to break if padding takes place.

number

A positive integer value representing the number of elements by which each array will be padded in the source. The pad amount must be a positive integer value. It is recommended that pad values be multiples of the largest array element size, typically 4, 8, or 16.

level=0

Performs a subset of the high-order transformations and sets the default to **novector:nosimd:noarraypad**.

level=1

Performs the default set of high-order transformations.

simd | nosimd

When **simd** is in effect, the compiler converts certain operations that are performed in a loop on successive elements of an array into a call to a vector instruction. This call calculates several results at one time, which is faster than calculating each result sequentially. Applying this suboption is useful for applications with significant image processing demands.

This suboption has effect only if you specify an architecture that supports vector processing, and **-qenablevmx** is enabled.

Note: This suboption is supported on AIX 5L™ Version 5.3 with the 5300-03 Recommended Maintenance package and higher.

nosimd disables the conversion of loop array operations into calls to vector instructions.

vector | novector

When specified with **-qnostrict**, or an optimization level of **-O3** or higher, **vector** causes the compiler to convert certain operations that are performed in a loop on successive elements of an array (for example, square root, reciprocal square root) into a call to a routine in the Mathematical Acceleration Subsystem (MASS) library in **libxlopt**. If the operations are in a loop, the vector version of the routine is called. If the operations are scalar, the scalar version of the routine is called. The **vector** suboption supports single and double-precision floating-point mathematics, and is useful for applications with significant mathematical processing demands.

novector disables the conversion of loop array operations into calls to MASS library routines.

Since vectorization can affect the precision of your program's results, if you are using **-O4** or higher, you should specify **-qhot=novector** if the change in precision is unacceptable to you.

Usage

If you do not also specify an optimization level when specifying **-qhot** on the command line, the compiler assumes **-O2**.

If you specify **-O3**, the compiler assumes **-qhot=level=0**; to prevent all HOT optimizations with **-O3**, you must specify **-qnohot**.

If you want to override the default **level** setting of 1 when using **-qsmp**, **-O4** or **-O5**, be sure to specify **-qhot=level=0** after the other options.

If **-O2**, **-qnohot**, or **-qnoopt** is used on the command line, specifying HOT options in an **@PROCESS** directive will have no effect on the compilation unit.

The **-C** option turns off some array optimizations.

You can also use the **-qreport** option in conjunction with **-qhot** to produce a pseudo-Fortran report showing how the loops were transformed; see “-qreport” on page 239 for details.

Related information

- “-qarch” on page 119
- “-C” on page 88
- “-qenablevmx” on page 149
- “-O” on page 100
- “-qstrict” on page 261
- “-qsmp” on page 251
- "Directives for loop optimization" in the *XL Fortran Language Reference*
- "Benefits of High Order Transformation" in the *XL Fortran Optimization and Programming Guide*

-qieee

Category

Floating-point and integer control

Purpose

Specifies the rounding mode that the compiler will use when it evaluates constant floating-point expressions at compile time.

Syntax



@PROCESS:

```
@PROCESS IEEE({Near | Minus | Plus | Zero})
```

Defaults

Near, which rounds to the nearest representable number.

Parameters

The choices are:

<u>Near</u>	Round to nearest representable number.
<u>Minus</u>	Round toward minus infinity.
<u>Plus</u>	Round toward plus infinity.
<u>Zero</u>	Round toward zero.

Usage

Use this option 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**).

Specifying the same rounding mode for compile-time and runtime operations avoids 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 from 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” on page 100
- “-qfloat” on page 162

-qinit

Category

Language element control

Purpose

Makes the initial association status of pointers disassociated.

Note that this option applies to Fortran 90 and above.

Syntax

►► `-qinit===f90ptr` ◄◄

@PROCESS:

@PROCESS INIT(F90PTR)

Defaults

Not applicable.

Usage

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

Category

Error checking and debugging

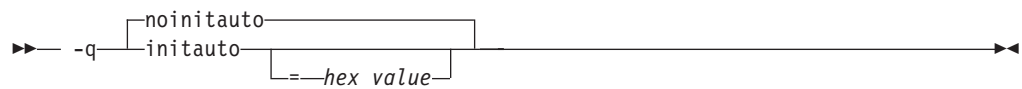
@PROCESS directive

None.

Purpose

Initializes uninitialized automatic variables to a specific value, for debugging purposes.

Syntax



Defaults

-qnoinitauto

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.

Parameters

hex_value

A 1 to 8 digit hexadecimal number.

- If you do not specify a *hex_value* number, the compiler initializes the value of each byte of automatic storage to zero.
- 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.

Usage

This option 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 NaNs value and the **-qflttrap** option, it is possible to identify references to uninitialized **REAL** variables at run time. Prior to XL Fortran Version 5.1.1, you could only use this option to initialize each byte of storage.

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 runtime 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 the *hex_value* to **FF** (255) gives **REAL** and **COMPLEX** variables an initial value of “negative not a number”, or NaNQ. Any operations on these variables will also result in NaNQ 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 NaNS value. You can initialize 8-byte **REAL** variables to double-precision NaNS values by specifying an 8-digit hexadecimal number, that, when repeated, has a double-precision NaNS value. For example, you could specify a number such as 7FBFFFFF, that, when stored in a **REAL(4)** variable, has a single-precision NaNS value. The value 7FF7FFFF, when stored in a **REAL(4)** variable, has a single-precision NaNQ value. If the same number is stored twice in a **REAL(8)** variable (7FF7FFFF7FF7FFFF), it has a double-precision NaNS value.

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

- “-qfltrap” on page 167
- The **AUTOMATIC** directive in the *XL Fortran Language Reference*

-qinlglue

Category

Object code control

Purpose

When used with **-O2** or higher optimization, inlines glue code that optimizes external function calls in your application.

Glue code, generated by the linker, is used for passing control between two external functions. When **-qinlglue** is in effect, the optimizer inlines glue code for better performance. When **-qnoinlglue** is in effect, inlining of glue code is prevented.

Syntax



@PROCESS:

@PROCESS INLGLUE | **NOINLGLUE**

Defaults

- **-qnoinlglue**
- **-qinlglue** when **-qtune=pwr4**, **-qtune=pwr5**, **-qtune=pwr6**, **-qtune=ppc970**, **-qtune=auto**, or **-qtune=balanced** is in effect.

Usage

If you use the **-qtune** option with any of the suboptions that imply **-qinlglue** and you want to disable inlining of glue code, make sure to specify **-qnoinlglue** as well.

Inlining glue code can cause the code size to grow. Specifying **-qcompact** overrides the **-qinlglue** setting to prevent code growth. If you want **-qinlglue** to be enabled, do not specify **-qcompact**.

Specifying **-qnoinlglue** or **-qcompact** can degrade performance; use these options with discretion.

Related information

- “-q64” on page 109
- “-qcompact” on page 134
- “-qtune” on page 273
- Inlining in the *XL Fortran Optimization and Programming Guide*
- Managing code size in the *XL Fortran Optimization and Programming Guide*

-qintlog

Category

Floating-point and integer control

Purpose

Specifies that you can mix integer and logical data entities in expressions and statements.

Syntax

►► -q nointlog
intlog ►►

@PROCESS:

@PROCESS INTLOG | NOINTLOG

Defaults

-qnointlog

Usage

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.

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

You can also use the intrinsic functions **IAND**, **IOR**, **IEOR**, and **NOT** to perform bitwise logical operations.

The **MOVE_ALLOC** intrinsic function cannot take one integer and one logical argument.

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) + 1
END
```

Related information

- -qport=clogicals option.

-qintsize

Category

Floating-point and integer control

Purpose

Sets the size of default **INTEGER** and **LOGICAL** data entities that have no length or kind specified.

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.

Syntax

►► -qintsize=

4
2
8

►►

@PROCESS:

@PROCESS INTSIZE(*bytes*)

Defaults

-qintsize=4

Parameters

bytes

Allowed sizes are 2, 4, or 8.

Usage

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**.

You might need to add **PARAMETER** statements to give explicit lengths to constants that you pass as arguments.

The specified size¹ 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.

1. In Fortran 90/95 terminology, these values are referred to as *kind type parameters*.

- 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.

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

- “-qrealsize” on page 235
- *Type Parameters and Specifiers in the XL Fortran Language Reference*

-qipa

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Enables or customizes a class of optimizations known as interprocedural analysis (IPA).

IPA is a two-step process: the first step, which takes place during compilation, consists of performing an initial analysis and storing interprocedural analysis information in the object file. The second step, which takes place during linking, and causes a complete recompilation of the entire application, applies the optimizations to the entire program.

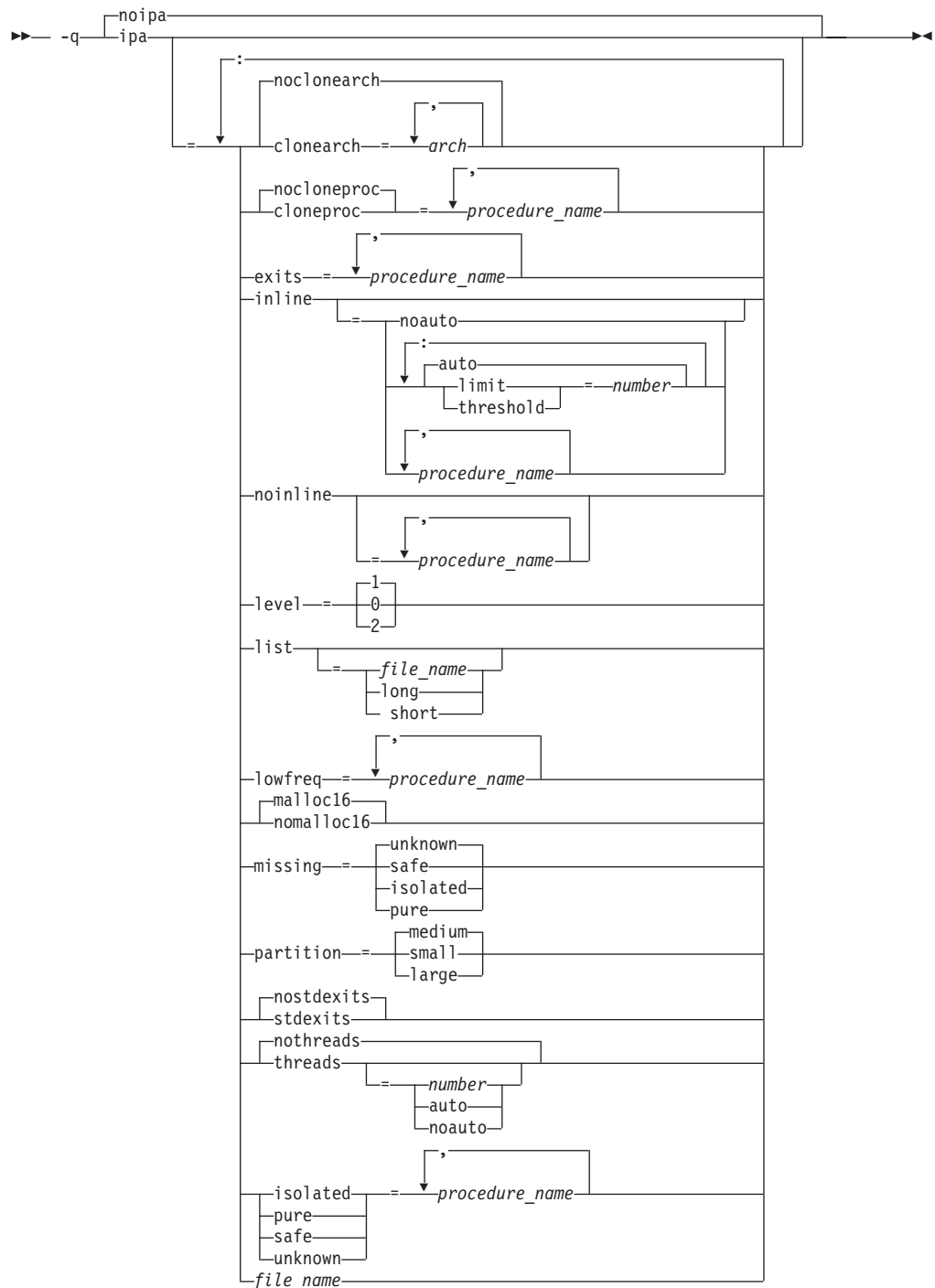
You can use **-qipa** during the compilation step, the link step, or both. If you compile and link in a single compiler invocation, only the link-time suboptions are relevant. If you compile and link in separate compiler invocations, only the compile-time suboptions are relevant during the compile step, and only the link-time suboptions are relevant during the link step.

Syntax

-qipa compile-time syntax



-qipa link-time syntax



Defaults

- **-qnoipa**
- **-qipa=inline=auto:level=1:missing=unknown:partition=medium:nothreads** when **-O4** is in effect
- **-qipa=inline=auto:level=2:missing=unknown:partition=medium:nothreads** when **-O5** is in effect
- **-qipa=inline=auto:level=0:missing=unknown:partition=medium:nothreads** when **-qpdf1** or **-qpdf2** is in effect

Parameters

Compile-time suboptions

The following parameters may be specified during a separate compile-time step only:

object | **noobject**

Specifies whether to include standard object code in the output object files.

Specifying **noobject** can substantially reduce overall compile time by not generating object code during the first IPA phase. Note that if you specify **-S** with **-qipa=noobject**, **-qipa=noobject** will be ignored.

If compiling and linking are performed in the same step and you do not specify the **-S** or any listing option, **-qipa=noobject** is implied.

Specifying **-qipa** with no suboptions on the compile step is equivalent to **-qipa=object**.

Link-time suboptions

The following parameters may be specified during a combined compile and link in the same compiler invocation, or during a separate link step only:

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.

If **clonearch** is in effect, during the IPA link phase, 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 runtime environment is selected.

This suboption is disabled if **-qcompact** is in effect.

arch

A comma-separated list of architectures. The supported values are:

- pwr4
- pwr5
- pwr6
- 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. The following table lists allowed **clonearch** values for different architectures.

Table 21. Compatible architecture and clonearch settings

-qarch setting	Allowed clonearch value
ppc, pwr3, ppc64, ppcgr, ppc64gr, ppc64grsq	pwr4, pwr5, pwr6, ppc970
pwr4	pwr5, pwr6, ppc970,
ppc64v	pwr6, ppc970
pwr5	pwr6

Table 21. Compatible architecture and clonearch settings (continued)

-qarch setting	Allowed clonearch value
ppc970	pwr6
pwr6	None

To ensure compatibility across multiple platforms, the **-qarch** option must be set to a value that is a subset of the architectures specified by **-qipa=clonearch**. If the case that suboptions are specified for **-qipa=clonearch** and **-qarch** that do not match the target architecture, the compiler will generate instructions based on the suboption that most closely matches the system on which the application is currently running.

You can also use the **-qreport** option in conjunction with **-qipa=clonearch** to produce a report showing how functions were cloned; see “-qreport” on page 239 for details.

cloneproc=*procedure_name*{,*procedure_name*} |

nocloneproc[=*procedure_name*{,*procedure_name*}]

When **-qipa=clonearch** is in effect, **cloneproc** specifies that only the named procedures are to be cloned; **nocloneproc** specifies procedures that should not be cloned. Note that by default the compiler avoids cloning procedures that are specified as low frequency procedures with the **lowfreq** suboption.

procedure_name

For all suboptions, the name of a procedure, or a comma-separated list of procedures.

Regular expression syntax can be used to specify names for all suboptions that take procedure names as suboptions. Syntax rules for specifying regular expressions are described below:

Expression	Description
<i>string</i>	Matches any of the characters specified in <i>string</i> . For example, <i>test</i> will match <i>testimony</i> , <i>latest</i> , and <i>intestine</i> .
^ <i>string</i>	Matches the pattern specified by <i>string</i> only if it occurs at the beginning of a line.
<i>string</i> \$	Matches the pattern specified by <i>string</i> only if it occurs at the end of a line.
<i>string</i>	The period (.) matches any single character. For example, <i>t.st</i> will match <i>test</i> , <i>tast</i> , <i>tZst</i> , and <i>t1st</i> .
<i>string</i> \ <i>special_char</i>	The backslash (\) can be used to escape special characters. For example, assume that you want to find lines ending with a period. Simply specifying the expression <i>.\$</i> would show all lines that had at least one character of any kind in it. Specifying <i>\.\$</i> escapes the period (.), and treats it as an ordinary character for matching purposes.
[<i>string</i>]	Matches any of the characters specified in <i>string</i> . For example, <i>t[a-g123]st</i> matches <i>tast</i> and <i>test</i> , but not <i>t-st</i> or <i>tAst</i> .
[^ <i>string</i>]	Does not match any of the characters specified in <i>string</i> . For example, <i>t[^a-zA-Z]st</i> matches <i>t1st</i> , <i>t-st</i> , and <i>t,st</i> but not <i>test</i> or <i>tYst</i> .
<i>string</i> *	Matches zero or more occurrences of the pattern specified by <i>string</i> . For example, <i>te*st</i> will match <i>tst</i> , <i>test</i> , and <i>teeeest</i> .

Expression	Description
<i>string+</i>	Matches one or more occurrences of the pattern specified by <i>string</i> . For example, <i>t(es)+t</i> matches <i>test</i> , <i>tesest</i> , but not <i>tt</i> .
<i>string?</i>	Matches zero or one occurrences of the pattern specified by <i>string</i> . For example, <i>te?st</i> matches either <i>tst</i> or <i>test</i> .
<i>string{m,n}</i>	Matches between <i>m</i> and <i>n</i> occurrence(s) of the pattern specified by <i>string</i> . For example, <i>a{2}</i> matches <i>aa</i> , and <i>b{1,4}</i> matches <i>b</i> , <i>bb</i> , <i>bbb</i> , and <i>bbbb</i> .
<i>string1 string2</i>	Matches the pattern specified by either <i>string1</i> or <i>string2</i> . For example, <i>s o</i> matches both characters <i>s</i> and <i>o</i> .

exits=procedure_names

Specifies names of procedures which represent program exits. Program exits are calls which can never return and can never call any procedure which has been compiled with IPA pass 1. 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]

Enables function inlining by the high-level optimizer. Valid suboptions are any of the following:

auto | noauto

Enables or disables automatic procedure inlining by the high-level optimizer. When **-qipa=inline=auto** is in effect, the compiler considers all procedure that are under the maximum size limit (see below) for inlining. When **-qipa=inline=noauto** is in effect, only procedures listed in the *function_name* suboption are considered for inlining.

limit=number

When **-qipa=inline=auto** is in effect, specifies a limit on the size of a calling procedure after inlining.

threshold=number

When **-qipa=inline=auto** is in effect, specifies a limit on the size of a called procedure for it to be considered for inlining.

number

A nonnegative integer representing the relative size of procedure before and after inlining. The *size* is an arbitrary value representing a combination of factors, including the estimated size of the called procedure, the number of calls to the procedure, and so on. If you do not specify a *size*, the default is 1024 for the **threshold** suboption and 8192 for the **limit** suboption. Larger values for this number allow the compiler to inline larger procedures, more function calls, or both.

Specifying **-qipa=inline** with no suboptions is equivalent to **-qipa=inline=auto**.

Note: By default, the compiler will try to inline all procedures, not just those that you specified with the *function_name* suboption. If you want to turn on inlining for only certain procedures, specify **inline=noauto** after you specify **inline=function_name**. (You must specify the suboptions in this order.) For example, to turn off inlining for all procedures other than for *sub1*, specify **-qipa=inline=sub1:inline=noauto**.

noinline[=*procedure_names*]

When specified with no suboption, disables automatic procedure inlining by the high-level optimizer (equivalent to **-qipa=inline=noauto**). (Inlining may still be performed by the compiler front end or by the low-level optimizer; see “-Q” on page 106 for details.) When used with the *function_name* suboption, specifies procedures that are not to be considered for automatic inlining by the high-level optimizer.

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[=*opt_level*]

Specifies the optimization level for interprocedural analysis. Valid suboptions are one of the following:

- **0** - Performs only minimal interprocedural analysis and optimization.
- **1** - Enables inlining, limited alias analysis, and limited call-site tailoring.
- **2** - Performs full interprocedural data flow and alias analysis.

If you do not specify a level, the default is 1.

list

Specifies that a listing file be generated during the link phase. The listing file contains information about transformations and analyses performed by IPA, as well as an optional object listing for each partition.

If you do not specify a *list_file_name*, the listing file name defaults to a.lst. If you specify **-qipa=list** together with any other option that generates a listing file, IPA generates an a.lst file that overwrites any existing a.lst file. If you have a source file named a.f, the IPA listing will overwrite the regular compiler listing a.lst. You can use the **-qipa=list=list_file_name** suboption to specify an alternative listing file name.

Additional suboptions are one of the following:

- short** Requests less information in the listing file. Generates the Object File Map, Source File Map and Global Symbols Map sections of the listing.
- long** Requests more information in the listing file. Generates all of the sections generated by the **short** suboption, plus the Object Resolution Warnings, Object Reference Map, Inliner Report and Partition Map sections.

lowfreq=*procedure_names*

Specifies functions that are likely to be called infrequently. These are typically error handling, trace, or initialization functions. The compiler may be able to make other parts of the program run faster by doing less optimization for calls to these procedures.

malloc16 | **nomalloc16**

Informs the compiler that the dynamic memory allocation routines will return 16-byte aligned memory addresses. The compiler can then optimize the code based on that assertion.

In 64-bit mode, AIX always returns 16-byte aligned addresses and therefore by default **-qipa=malloc16** is in effect. You can use **-qipa=nomalloc16** to override the default setting.

Note: You must make sure that the executables generated with **-qipa=malloc16** run in an environment in which dynamic memory allocations return

16-byte aligned addresses, otherwise, wrong results can be generated. For example, in 32-bit mode, addresses are not 16-byte aligned. In this case, you must set the `MALLOCALIGN=16` runtime environment variable.

missing[=*procedure_behavior*]

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.

Valid suboptions are one of the following:

safe Specifies that the missing procedures do not indirectly call a visible (not missing) procedure either through direct call or through a procedure pointer.

isolated

Specifies that the missing procedures do not directly reference global variables accessible to visible procedures. Those bound from shared libraries are assumed to be *isolated*.

pure Specifies that the missing procedures are *safe* and *isolated* and do not indirectly alter storage accessible to visible procedures. *pure* procedures also have no observable internal state.

unknown

Specifies that the missing procedures are not known to be *safe*, *isolated*, or *pure*. This option greatly restricts the amount of interprocedural optimization for calls to missing procedures.

The default is to assume **unknown**.

partition

Specifies the size of each program partition created by IPA during pass 2. Valid suboptions are one of the following:

- **small**
- **medium**
- **large**

Larger partitions contain more 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 = *pdf_file_path*

As of the V11.1 release of the compiler, the **pdfname** suboption is deprecated; you should use **-qpdf1=pdfname** or **-qpdf2=pdfname** in your new applications. See “-qpdf1, -qpdf2” on page 221 for more information.

pure=procedure_names

Specifies *pure* procedures that are not compiled with **-qipa**. Any procedure specified as *pure* must be *isolated* and *safe*, and must not alter the internal state nor have side-effects, defined as potentially altering any data visible to the caller.

safe=procedure_names

Specifies *safe* procedures that are not compiled with **-qipa** and do not call any other part of the program. Safe procedures can modify global variables and dummy arguments, but may not call procedures compiled with **-qipa**.

stdexits | nostdexits

Specifies that certain predefined routines can be optimized as with the **exits** suboption. The procedures are: `abort`, `exit`, `_exit`, and `_assert`.

threads | nothreads

Runs portions of the IPA optimization process during pass 2 in parallel threads, which can speed up the compilation process on multiprocessor systems. Valid **threads** suboptions are as follows:

auto

The compiler selects a number of threads heuristically based on machine load.

noauto

The compiler spawns one thread per machine processor.

number

Instructs the compiler to use a specific number of threads. *number* can be any integer value in the range of 1 to 32 767. However, *number* is effectively limited to the number of processors available on your system.

Specifying **threads** with no suboptions implies **-qipa=threads=auto**.

unknown

Specifies *unknown* procedures that are not compiled with **-qipa**. Any procedure specified as *unknown* can make calls to other parts of the program compiled with **-qipa**, and modify global variables and dummy arguments.

file_name

Gives the name of a file which contains suboption information in a special format.

The file format is the following:

```
# ... comment
attribute{, attribute} = name{, name}
clonearch=arch,{arch}
cloneproc=name,{name}

nocloneproc=name,{name}
missing = attribute{, attribute}
exits = name{, name}
lowfreq = name{, name}
inline
inline [ = auto | = noauto ]
inline = name{, name} [ from name{, name}]
inline-threshold = unsigned_int
inline-limit = unsigned_int
list [ = file-name | short | long ]
noinline
noinline = name{, name} [ from name{, name}]
level = 0 | 1 | 2
partition = small | medium | large
```

where *attribute* is one of:

- clonearch
- cloneproc
- nocloneproc
- exits
- lowfreq
- unknown
- safe
- isolated

- pure

Specifying **-qipa** with no suboptions on the link step is equivalent to **-qipa=inline=auto:level=1:missing=unknown:partition=medium:nothreads**.

Note: As of the V11.1 release of the compiler, the *pdfname* suboption is deprecated. Instead, use **-qpdf1=pdfname** or **-qpdf2=pdfname** in your new applications. See “-qpdf1, -qpdf2” on page 221 for details.

Usage

Specifying **-qipa** automatically sets the optimization level to **-O2**. For additional performance benefits, you can also specify the **-Q** option. The **-qipa** option extends the area that is examined during optimization and inlining from a single procedure to multiple procedures (possibly in different source files) and the linkage between them.

If any object file used in linking with **-qipa** was created with the **-qipa=noobject** option, any file containing an entry point (the main program for an executable program, or an exported procedure for a library) must be compiled with **-qipa**.

You can link objects created with different releases of the compiler, but you must ensure that you use a linker that is at least at the same release level as the newer of the compilers used to create the objects being linked.

Some symbols which are clearly referenced or set in the source code may be optimized away by IPA, and may be lost to **debug**, **dump**, or **nmoutputs**. Using IPA together with the **-g** compiler will usually result in non-steppable output.

Note that if you specify **-qipa** with **#**, the compiler does not display linker information subsequent to the IPA link step.

For recommended procedures for using **-qipa**, see "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*.

Examples

The following example shows how you might compile a set of files with interprocedural analysis:

```
xlf -c *.f -qipa
xlf -o product *.o -qipa
```

Here is how you might compile the same set of files, improving the optimization of the second compilation, and the speed of the first compile step. Assume that there exist a set of routines, *user_trace1*, *user_trace2*, and *user_trace3*, which are rarely executed, and the routine *user_abort* that exits the program:

```
xlc -c *.f -qipa=noobject
xlc -c *.o -qipa=lowfreq=user_trace[123]:exit=user_abort
```

Related information

- “-O” on page 100
- “-qarch” on page 119
- “-Q” on page 106
- “-S” on page 302
- "Optimizing your applications" in the *XL Fortran Optimization and Programming Guide*

-qkeepparm

Category

Error checking and debugging

@PROCESS directive

None.

Purpose

When used with **-O2** or higher optimization, specifies whether function parameters are stored on the stack.

A procedure usually stores its incoming parameters on the stack at the entry point. However, when you compile code with optimization options enabled, the optimizer may remove these parameters from the stack if it sees an optimizing advantage in doing so.

Syntax

►► -q nokeepparm
keepparm ◀◀

Defaults

-qnokeepparm

Usage

When **-qkeepparm** is in effect, parameters are stored on the stack even when optimization is enabled. This option then provides access to the values of incoming parameters to tools, such as debuggers, simply by preserving those values on the stack. However, this may negatively impact execution performance.

When **-qnokeepparm** is in effect, parameters are removed from the stack if this provides an optimization advantage.

-qlanglvl

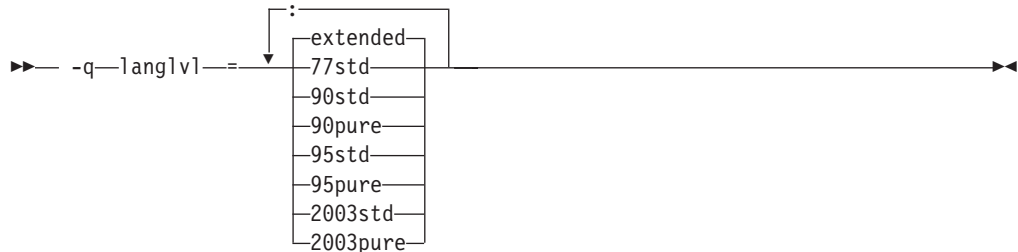
Category

Language element control

Purpose

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.

Syntax



@PROCESS:

@PROCESS LANGLVL({*suboption*})

Defaults

-qlanglvl=extended

Parameters

77std	Accepts the language that the ANSI FORTRAN 77 standard specifies and reports anything else using language-level messages.
90std	Accepts the language that the ISO Fortran 90 standard specifies and reports anything else using language-level messages.
90pure	The same as 90std except that it also issues language-level messages for any obsolescent Fortran 90 features used.
90ext	Obsolete suboption that is equivalent to extended .
95std	Accepts the language that the ISO Fortran 95 standard specifies and reports anything else using language-level messages.
95pure	The same as 95std except that it also issues language-level messages 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 using language-level messages.
2003pure	The same as 2003std except that it also issues language-level messages for any obsolescent Fortran 2003 features used.
<u>extended</u>	Accepts the full Fortran 95 language standard, all Fortran 2003 features supported by XL Fortran, and all extensions, effectively turning off language-level checking.

Usage

The `langlvl` runtime option, which is described in “Setting runtime options” on page 44, helps to locate runtime extensions that cannot be checked for at compile time.

The `-qflag` option can override the `-qlanglvl` option.

Results

The compiler issues a message with severity code **L** if it detects syntax that is not allowed by the language level that you specified.

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

- “-qflag” on page 160
- “-qhalt” on page 172
- “-qsaa” on page 241
- `langlvl` runtime option in “Setting runtime options” on page 44

-qlargepage

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Takes advantage of large pages provided on POWER4 and higher systems, for applications designed to execute in a large page memory environment.

Syntax

►► -q no|largepage | largepage ◀◀

Defaults

-qno|largepage

Usage

When using **-qlargepage** with a program designed for a large page environment, an increase in performance can occur. See *AIX Performance Management* for more information on using large page support.

Note: Performance degradation can occur if there are too many programs attempting to access large pages at the same time. Performance degradation can also occur if you attempt to use **-qlargepage** without meeting the hardware requirements. Use this option with discretion.

The **-qlargepage** compiler option only takes effect with an optimization level that turns on the optimizer; a higher optimization level may do more.

To have the linker exploit large pages as well, specify the **-blpdt** flag or use **ledit**. See the AIX information center at URL <http://publib.boulder.ibm.com/infocenter/pseries/v5r3/index.jsp> for more information.

-qlibansi

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Assumes that all functions with the name of an ANSI C library function are, in fact, the library functions and not a user function with different semantics.

Syntax

►► -q no libansi
libansi ◀◀

Defaults

-qno libansi

Usage

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 library function that is incompatible with the standard one.

Related information

See “-qipa” on page 186.

-qlibessl

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Assumes that all functions with the name of an ESSL library function are, in fact, the library functions and not a user function with different semantics.

Syntax

►► -q no libessl
libessl ◀◀

Defaults

-qnolibessl

Usage

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 library function that is incompatible with the standard one.

Related information

See “-qipa” on page 186.

-qlibposix

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Assumes that all functions with the name of a POSIX 1003.1 library function are, in fact, the system functions and not a user function with different semantics.

Syntax

►► -q no libposix libposix ►►

Defaults

-qno libposix

Usage

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 library function that is incompatible with the standard one.

Related information

See “-qipa” on page 186.

-qlinedebug

Category

Error checking and debugging

Purpose

Generates only line number and source file name information for a debugger.

When **-qlinedebug** is in effect, the compiler produces minimal debugging information, so the resulting object size is smaller than that produced by the **-g** debugging option. You can use the debugger to step through the source code, but you will not be able to see or query variable information. The traceback table, if generated, will include line numbers.

Syntax

```
►► -q [nolinedebug | linedebug] ◄◄
```

@PROCESS:

@PROCESS LINEDEBUG | NOLINEDEBUG

Defaults

-qnolinedebug

Usage

When **-qlinedebug** is in effect, function inlining is disabled.

As with all debug information, the output of **-qlinedebug** may be incomplete or misleading if the code is optimized.

The **-g** option overrides the **-qlinedebug** option. If you specify **-g** with **-qnolinedebug** on the command line, **-qnolinedebug** is ignored and a warning is issued.

Related information

- “-g” on page 94
- “-O” on page 100

-qlist

Category

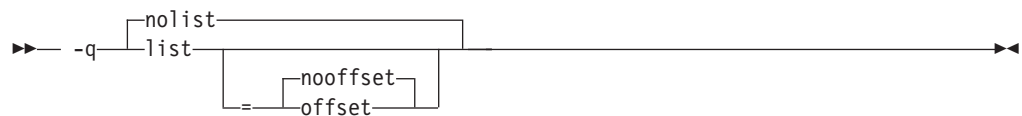
Listings, messages, and compiler information

Purpose

Produces a compiler listing file that includes an object listing.

When **-qlist** is in effect, a listing file is generated with a `.lst` suffix for each source file named on the command line.

Syntax



@PROCESS:

@PROCESS LIST[[([NO]OFFSET)] | NOLIST

Defaults

-qnolist

Parameters

offset | **nooffset**

When **-qlist=offset** is in effect, the listing will show the offset from the start of the procedure rather than the offset from the start of code generation. This suboption allows any program reading the `.lst` file to add the value of the PDEF and the line in question, and come up with the same value whether **offset** or **nooffset** is specified.

The **offset** suboption is relevant only if there are multiple procedures in a compilation unit. For example, this may occur if nested procedures are used in a program.

Specifying **-qlist** with no suboption is equivalent to **-qlist=nooffset**.

Usage

You can use the object listing to help understand the performance characteristics of the generated code and to diagnose execution problems.

If you specify **-qipa** and want to generate the IPA listing file, use the **-qipa=list=filename** suboption to get an alternative listing.

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

Related information

- “Listings, messages, and compiler information” on page 63
- “Object section” on page 339
- “-qnoprint” on page 214
- “-S” on page 302

- Program units and procedures in the *XL Fortran Language Reference*

-qlistopt

Category

Listings, messages, and compiler information

Purpose

Produces a compiler listing file that includes all options in effect at the time of compiler invocation.

When **listopt** is in effect, a listing file is generated with a `.lst` suffix for each source file named on the command line. The listing shows options in effect as set by the compiler defaults, the configuration file, and command line settings.

Syntax

```
►► -q ┌───no listopt───┐
      │──listopt───┘───►►
```

@PROCESS:

@PROCESS LISTOPT | NOLISTOPT

Defaults

-qnolistopt

Usage

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.

Options that are always displayed in the listing include:

- 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

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

Related information

- “Listings, messages, and compiler information” on page 63
- “Options section” on page 335

-qlog4

Category

Portability and migration

Purpose

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.

Syntax

►► -q no1og4 1og4 ◄◄

@PROCESS:

@PROCESS LOG4 | **NOLOG4**

Defaults

-qnolog4, which makes the result depend on the lengths of the operands.

Usage

Specifying **-qlog4** makes the result a **LOGICAL(4)**.

If you use **-qintsize** to change the default size of logicals, **-qlog4** is ignored.

-qmaxmem

Category

Optimization and tuning

Purpose

Limits the amount of memory that the compiler allocates while performing specific, memory-intensive optimizations to the specified number of kilobytes.

Syntax

►► — -q—maxmem—=—*Kbytes*—————►►

@PROCESS:

@PROCESS MAXMEM(*Kbytes*)

Defaults

- **maxmem=8192** when **-O2** is in effect.
- **maxmem=-1** when **-O3** or higher optimization is in effect.

Parameters

Kbytes

The number of kilobytes worth of memory to be used by optimizations. The limit is the amount of memory for specific optimizations, and not for the compiler as a whole. Tables required during the entire compilation process are not affected by or included in this limit.

A value of **-1** permits each optimization to take as much memory as it needs without checking for limits.

Usage

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” on page 100
- *Optimizing XL compiler programs* in the *XL Fortran Optimization and Programming Guide*

-qmbcs

Category

Language element control

Purpose

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.

Syntax

►► -q nombcs
mbsc ◄◄

@PROCESS:

@PROCESS MBCS | NOMBCS

Defaults

-qnombcs

Usage

Each byte of a multibyte character is counted as a column.

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.

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

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Minimizes the number of entries in the global entity table of contents (TOC).

Syntax

►► -q nominaltoc
minimaltoc ◀◀

Defaults

-qnominaltoc

Usage

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

Category

Input control

Purpose

This is the long form of the “-U” on page 305.

Syntax

►► -q nomixed
mixed ◀◀

@PROCESS:

@PROCESS MIXED | NOMIXED

Defaults

-qnomixed

-qmoddir

Category

Output control

@PROCESS directive

None.

Purpose

Specifies the location for any module (**.mod**) files that the compiler writes.

Syntax

►► — `-q—moddir—=—directory` —————►►

Defaults

Not applicable.

Usage

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.

Related information

- “XL Fortran Output files” on page 29
- “-I” on page 95
- Modules section of the *XL Fortran Language Reference*.

-qmodule

Category

Portability and migration

@PROCESS directive

None.

Purpose

Specifies that the compiler should use the XL Fortran Version 8.1 naming convention for non-intrinsic module files.

Syntax

►► — -q—module=mangle81 ————— ◀◀

Defaults

Not applicable.

Usage

This option allows you to produce modules and their associated object files with the V11.1 compiler and link these object files with others compiled with the Version 8.1 compiler, or earlier.

Use this option only if you need to link applications that were compiled with the Version 8.1 compiler, or earlier.

It is recommended that you avoid using this compiler option and recompile 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 modules.

Related information

- Modules section in the *XL Fortran Language Reference*.
- *Conventions for XL Fortran external names* in the *XL Fortran Optimization and Programming Guide*
- “Avoiding naming conflicts during linking” on page 41

-qnoprint

Category

Listings, messages, and compiler information

@PROCESS directive

None.

Purpose

Prevents the compiler from creating the listing file, regardless of the settings of other listing options.

Syntax

►► — -q—noprint ————— ◀◀

Defaults

Not applicable.

Usage

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.

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

- “Listings, messages, and compiler information” on page 63

-qnullterm

Category

Language element control

Purpose

Appends a null character to each character constant expression that is passed as a dummy argument, making 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.

Syntax



@PROCESS:

@PROCESS NULLTERM | NONULLTERM

Defaults

-qnonnullterm

Usage

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
- 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

Category

Error checking and debugging

Purpose

Specifies whether to produce an object file or to stop immediately after checking the syntax of the source files.

Syntax



```
►► -q ———— Object ———— NOObject ———— ◀◀
```

@PROCESS:

@PROCESS Object | NOObject

Defaults

-qnoobject

Usage

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.

The **-qhalt** option can override the **-qobject** option, and **-qnoobject** can override **-qhalt**.

Related information

- “Listings, messages, and compiler information” on page 63
- “Object section” on page 339
- “The compiler phases” on page 343
- “-qhalt” on page 172

-qonetrip

Category

Language element control

Purpose

This is the long form of the “-1” on page 75.

Syntax

▶▶ -q noonetrip
onetrip ▶▶

@PROCESS:

@PROCESS ONETRIP | NOONETRIP

Defaults

-qnoonetrip

-qoptdebug

Category

Error checking and debugging

@PROCESS directive

None.

Purpose

When used with high levels of optimization, produces files containing optimized pseudocode that can be read by a debugger.

An output file with a .optdbg extension is created for each source file compiled with **-qoptdebug**. You can use the information contained in this file to help you understand how your code actually behaves under optimization.

Syntax

►► -q nooptdebug optdebug ◄◄

Defaults

-qnooptdebug

Usage

-qoptdebug only has an effect when used with an option that enables the high-level optimizer, namely **-O3** or higher optimization level, or **-qhot**, **-qsmp**, **-qipa**, or **-qpdf**. You can use the option on both compilation and link steps. If you specify it on the compile step, one output file is generated for each source file. If you specify it on the **-qipa** link step, a single output file is generated.

You must still use the **-g** or **-qlinedebug** option to include debugging information that can be used by a debugger.

For more information and examples of using this option, see "Using -qoptdebug to help debug optimized programs" in the *XL Fortran Optimization and Programming Guide*.

Related information

- “-qhot” on page 174
- “-qipa” on page 186
- “-qpdf1, -qpdf2” on page 221
- “-qsmp” on page 251

-qoptimize

Purpose

This is the long form of the “-O” on page 100.

Syntax

►► -q NOOPTimize
OPTimize==*level* ◄◄

@PROCESS:

@PROCESS OPTimize[(*level*)] | NOOPTimize

Defaults

-qnooptimize

-qpdf1, -qpdf2

Category

Optimization and tuning

@PROCESS directive

None.

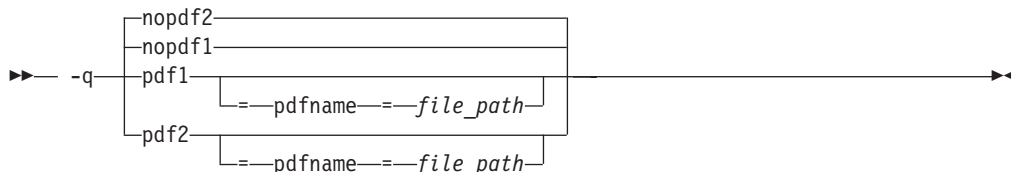
Purpose

Tunes optimizations through **profile-directed feedback** (PDF), where results from sample program execution are used to improve optimization near conditional branches and in frequently executed code sections.

PDF is a two-step process. You first compile the application with **-qpdf1** and a minimum optimization level of **-O2**, with linking. You then run the resulting application with a typical data set. During the test run, profile data is written to a profile file (by default, this file is named `._pdf` and is saved in the current working directory, or in the directory named by the `PDFDIR` environment variable, if it is set). You then recompile, and/or link or relink the application with **-qpdf2** and a minimum optimization level of **-O2**, which fine-tunes the optimizations applied according to the profile data collected during the program execution.

PDF is intended to be used after other debugging and tuning is finished, as one of the last steps before putting the application into production.

Syntax



Defaults

`-qnopdf1, -qnopdf2`

Parameters

pdfname= *file_path*

Specifies the path to the file that will hold the profile data. By default, the file name is `._pdf`, and it is placed in the current working directory or in the directory named by the `PDFDIR` environment variable. You can use the **pdfname** suboption to allow you to do simultaneous runs of multiple executables using the same PDF directory. This is especially useful when tuning with PDF on dynamic libraries.

Usage

You must compile the main program with PDF for profiling information to be collected at run time.

You must use the same compilation options for the PDF2 compilation as for the PDF1 compilation.

If you do not want the optimized object files to be relinked during the second step, specify **-qpdf2 -qnoipa**. Note, however, that if you change a source file that was compiled previously with **-qpdf1**, you will need to go through the entire first pass process again.

If you want to specify an alternate path and file name for the profile file, use the **pdfname** suboption. Alternatively, you can use the PDFDIR environment variable to specify the absolute path name for the directory. Do not compile or run two different applications that use the same profiling directory at the same time, unless you have used the **pdfname** suboption to distinguish the sets of profiling information.

You can also use the following option with **-qpdf1**:

-qshowpdf

Provides additional information, such as block and function call counts, to the profile file. See “-qshowpdf” on page 247 for more information.

For recommended procedures for using PDF, see "Benefits of Profile-Directed Feedback" in the *XL Fortran Optimization and Programming Guide*.

The following utility programs, found in `/usr/lpp/xf/bin/`, are available for managing the directory to which profile data is written:

cleanpdf

►► cleanpdf directory_path ►►

Removes all profiling information from the directory specified by *directory_path*; or if *pathname* is not specified, from the directory set by the PDFDIR environment variable; or if PDFDIR is not set, from the current directory. Removing profiling information reduces runtime overhead if you change the program and then go through the PDF process again.

Run **cleanpdf** only when you are finished with the PDF process for a particular application. Otherwise, if you want to resume using PDF with that application, you will need to recompile all of the files again with **-qpdf1**.

mergepdf

►► mergepdf -r-scaling input -o output -n -v ►►

Merges two or more PDF records into a single PDF output record.

-r scaling Specifies the scaling ratio for the PDF record file. This value must be greater than zero and can be either an integer or floating point value. If not specified, a ratio of 1.0 is assumed.

input Specifies the name of a PDF input record file, or a directory that contains PDF record files.

- o** *output* Specifies the name of the PDF output record file, or a directory to which the merged output will be written.
- n** If specified, PDF record files are not normalized. If not specified, **mergepdf** normalizes records based on an internally-calculated ratio before applying any user-defined scaling factor.
- v** Specifies verbose mode, and causes internal and user-specified scaling ratios to be displayed to standard output.

resetpdf

►► resetpdf directory_path ◀◀

Same as **cleanpdf**, described above.

showpdf

►► showpdf directory_path -f file_path ◀◀

Displays the function call and block counts written to the profile file, specified by the **-f** option, during a program run. To use this command, you must first compile your application specifying both **-qpdf1** and **-qshowpdf** compiler options on the command line.

Results

None.

Examples

Here is a simple example:

```
# Compile all files with -qpdf1.
xlf -qpdf1 -O3 file1.f file2.f file3.f

# Run with one set of input data.
./a.out < sample.data

# Recompile all files with -qpdf2.
xlf -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.
xlf -qpdf1 -O3 -c file1.f file2.f file3.f

# This file is not so important to optimize.
xlf -c file4.f

# Non-PDF object files such as file4.o can be linked in.
xlf -qpdf1 -O3 file1.o file2.o file3.o file4.o
```

```

# Run several times with different input data.
./a.out < polar_orbit.data
./a.out < elliptical_orbit.data
./a.out < geosynchronous_orbit.data

# No need to recompile the source of non-PDF object files (file4.f).
xlf -qpdf2 -O3 file1.f file2.f file3.f

# Link all the object files into the final application.  */
xlf -qpdf2 -O3 file1.o file2.o file3.o file4.o

```

Here is an example that bypasses recompiling the source with **-qpdf2**:

```

# 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:

```

# 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

```

Here is an example that creates PDF-optimized object files without relinking into an executable:

```

# Compile source with -qpdf1.
xlf -c -O3 -qpdf1 file1.f file2.f file3.f

# Link in object files.
xlf -O3 -qpdf1 file1.o file2.o file3.o

# Run with one set of input data.
./a.out < sample data

# Recompile the instrumented source files
xlf -c -O3 -qpdf2 -qnoipa file1.f file2.f file3.f

```

Related information

- “-qshowpdf” on page 247
- “-qipa” on page 186
- “XL Fortran input files” on page 27
- “XL Fortran Output files” on page 29
- "Benefits of Profile-Directed Feedback" in the *XL Fortran Optimization and Programming Guide*

-qphsinfo


Category

Listings, messages, and compiler information

Purpose

Reports the time taken in each compilation phase to standard output.

Syntax



```
►─ -q ─┬─ nophsinfo ─┬─►
        │ phsinfo   │
        └───────────┘
```

@PROCESS:

@PROCESS PHSINFO | NOPHSINFO

Defaults

-qnophsinfo

Usage

The output takes the form *number1/number2* for each phase where *number1* represents the CPU time used by the compiler and *number2* represents the total of the compiler time and the time that the CPU spends handling system calls.

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 343.

-qpic

Category

Object code control

@PROCESS directive

None.

Purpose

Generates Position-Independent Code suitable for use in shared libraries.

Syntax

►► -qpic small
large ►►

Defaults

- -qpic=small

Parameters

small

Instructs the compiler to assume that the size of the Table Of Contents is no larger than 64 Kb.

large

Allows the Table Of Contents to be larger than 64 Kb in size, allowing more addresses to be stored in the table. Code generated with this option is usually larger than that generated with **-qpic=small**.

Specifying **-qpic** without any suboptions is equivalent to **-qpic=small**.

Usage

Specifying **-qpic=large** has the same effect as passing **-bbigtoc** to **ld**.

Related information

- “-q32” on page 108
- “-q64” on page 109

-qport

Category

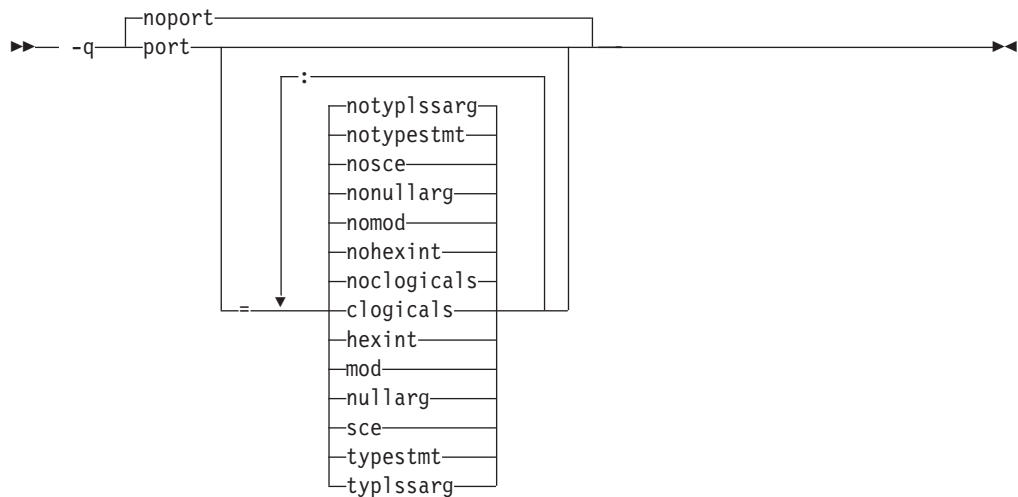
Portability and migration

Purpose

Provides options to accommodate other Fortran language extensions when porting programs to XL Fortran.

A particular **-qport** suboption will always function independently of other **-qport** and compiler options.

Syntax



@PROCESS:

@PROCESS PORT[(*suboptions*)] | **NOPORT**

Defaults

-qnoport

Parameters

logicals | **noclogicals**

When **logicals** is in effect, the compiler treats all non-zero integers that are used in logical expressions as TRUE. You must specify **-qintlog** for **-qport=logicals** to take effect.

The **-qport=logicals** 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=logicals** option active.

hexint | **nohexint**

When **hexint** is in effect, 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 **mod** 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 | **nonnullarg** For an external or internal procedure reference, specifying **nullarg** 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 **typestmt** is specified.

typlessarg | **notyplessarg**

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

- “-qintlog” on page 183
- “-qxlf77” on page 289
- See the section on the **INT** and **MOD** intrinsic functions in the *XL Fortran Language Reference* for further information.

-qposition

Category

Language element control

Purpose

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 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**.

Syntax

►► -qposition=appendold
 └─appendunknown┘

@PROCESS:

@PROCESS POSITION({APPENDOLD | APPENDUNKNOWN} ...)

Defaults

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**, **xlf_r7**, and **f77/fort77** commands
- The defined Fortran 90 and Fortran 95 behaviors for the **xlf2003**, **xlf2003_r**, **xlf90**, **xlf90_r**, **xlf90_r7**, **xlf95**, **xlf95_r**, **xlf95_r7**, **f2003**, **f90** and **f95** commands.

Usage

The **appendunknown** suboption is the same as the XL Fortran Version 2 **append** suboption, but we recommend using **appendunknown** to avoid ambiguity.

-qposition=appendold:appendunknown provides compatibility with XL Fortran Version 1 and early Version 2 behavior. **-qposition=appendold** provides compatibility with XL Fortran Version 2.3 behavior.

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

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Inserts prefetch instructions automatically where there are opportunities to improve code performance.

Syntax



The diagram shows the syntax for the `-q` option. It starts with a right-pointing arrow followed by `-q`. A bracket above `-q` is labeled `prefetch`, and a bracket below `-q` is labeled `noprefetch`. A long horizontal line with arrowheads at both ends extends to the right from the end of `-q`.

Defaults

`-qprefetch`

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`” on page 142.

-qqcount

Category

Language element control

Purpose

Accepts the **Q** character-count edit descriptor (**Q**) as well as the extended-precision **Q** edit descriptor (**Qw.d**).

Syntax

►► -q noqcount
qcount _____►►

@PROCESS:

@PROCESS QCOUNT | NOQCOUNT

Defaults

With **-qnoqcount**, all **Q** edit descriptors are interpreted as the extended-precision **Q** edit descriptor.

Usage

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

- *Q (Character Count) Editing* in the *XL Fortran Language Reference*

-qrealsize

Category

Floating-point and integer control

Purpose

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 a useful alternative to the **-qautodbl** option in some situations.

Syntax

►► -qrealsize=4
8►►

@PROCESS:

@PROCESS REALSIZE(*bytes*)

Defaults

The default, **-qrealsize=4**, is suitable for programs that are written specifically for 32-bit computers.

Parameters

The allowed values for *bytes* are:

- 4
- 8

Usage

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.

-qautodbl is related to **-qrealsize**, although you cannot combine these options. When the **-qautodbl** option turns on automatic doubling, padding, or both, the **-qrealsize** option has no effect.

Setting **-qrealsize** to 8 overrides the setting of the **-qdpic** option.

Results

The option affects the sizes² 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.

This option determines the sizes of affected objects as follows:

2. In Fortran 90/95 terminology, these values are referred to as *kind type parameters*.

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.

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” on page 184 is a similar option that affects integer and logical objects.
- “-qautodbl” on page 125
- *Type Parameters and Specifiers* in the *XL Fortran Language Reference*

-qrecur

Category

Deprecated options

Purpose

Specifies whether external subprograms may be called recursively.

Not recommended.

Syntax



@PROCESS:

@PROCESS RECUR | **NORECUR**

Defaults

-qnorecur

Usage

For new programs, use the **RECURSIVE** keyword, which provides a standards-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. With the **RECURSIVE** keyword, you can specify exactly which procedures are recursive.

If you use the **xl**, **xl_r**, **xl_r7**, **f77**, or **fort77** command to compile programs that contain recursive calls, specify **-qnosave** to make the default storage class automatic.

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
```

-qreport

Category

Listings, messages, and compiler information

Purpose

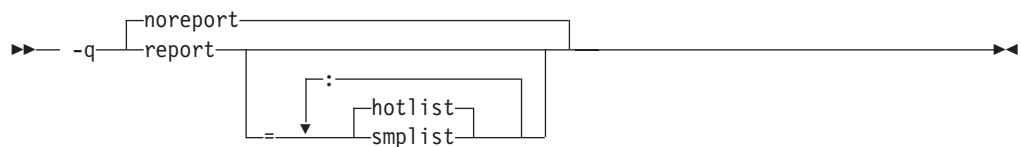
Produces listing files that show how sections of code have been optimized.

A listing file is generated with a .lst suffix for each source file named on the command line. When used with an option that enables automatic parallelization or vectorization, the listing file shows a pseudo-Fortran code listing and a summary of how program loops are parallelized and/or optimized. The report also includes diagnostic information to show why specific loops could not be parallelized and/or vectorized.

When used with **-qipa=clonearch**, produces transformation reports on the procedures that are cloned for the architectures specified by the option.

Syntax

Option:



@PROCESS:

@PROCESS REPORT[({SMPLIST | HOTLIST}...)] | **NOREPORT**

Defaults

-qnoreport

Parameters

smplist | **hotlist**

When **-qreport=smplist** is in effect, 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 is only produced if **-qsmp** is in effect.

When **-qreport=hotlist** is in effect, produces a pseudo-Fortran listing that shows how loops are transformed, to assist you in tuning the performance of all loops. This report is only produced if **-qhot** is in effect.

In addition, if you specify the **-qreport=hotlist** option when **-qsmp** is in effect, a pseudo-Fortran listing will be produced that shows the calls to the SMP runtime library and the procedures created for parallel constructs.

Specifying **-qreport** with no suboptions is equivalent to **-qreport=hotlist**.

Usage

For **-qreport** to generate a loop transformation listing, you must also specify one of the following options on the command line:

- **-qhot[=simd]**
- **-qsmp**
- **-O5**
- **-qipa=level=2**

For **-qreport** to generate a parallel transformation listing or parallel performance messages, you must also specify one of the following options on the command line:

- **-qsmp**
- **-O5**
- **-qipa=level=2**

For **-qreport** to generate a function cloning listing, you must also specify **-qipa=clonearch**.

If you use **-qreport** with **-O5** or **-qipa=level=2**, the report will be generated after the link step.

The pseudo-Fortran code listing is not intended to be compilable. Do not include any of the pseudo-Fortran code in your program, and do not explicitly call any of the internal routines whose names may appear in the pseudo-Fortran code listing.

Examples

To compile `myprogram.f` so the compiler listing includes a report showing how loops are optimized, enter:

```
xlf -qhot -O3 -qreport myprogram.f
```

To compile `myprogram.c` so the compiler listing also includes a report showing how parallelized loops are transformed, enter:

```
xlf_r -qhot -qsmp -qreport=smlist myprogram.c
```

Related information

- “-qhot” on page 174
- “-qipa” on page 186
- “-qsmp” on page 251
- “-qoptdebug” on page 219
- *Using -qoptdebug to help debug optimized programs* in the *XL Fortran Optimization and Programming Guide*

-qsaa

Category

Language element control

Purpose

Checks for conformance to the SAA FORTRAN language definition. It identifies nonconforming source code and also options that allow such nonconformances.

Syntax

► — -q — nosaa — saa — ►

@PROCESS:

@PROCESS SAA | NOSAA

Defaults

-qnosaa

Usage

The **-qflag** option can override this option.

Use the **-qlanglvl** option to check your code for conformance to international standards.

Results

Warnings have a prefix of **(L)**, indicating a problem with the language level.

Related information

- “-qflag” on page 160
- “-qlanglvl” on page 196

-qsave

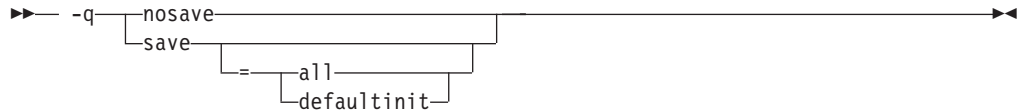
Category

Language element control

Purpose

Specifies the default storage class for local variables.

Syntax



@PROCESS:

@PROCESS SAVE[({ALL | DEFAULTINIT})] | NOSAVE

Defaults

When **-qnosave** is in effect, the default storage class is **AUTOMATIC**.

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 **xl**, **xl_r**, **xl_r7**, **f77**, and **fort77** commands have **-qsave** listed as a default option in `/etc/xlf.cfg` to preserve the previous behavior.

Parameters

The **-qsave** suboptions include:

all The default storage class is **STATIC**.

defaultinit

The default storage class is **STATIC** for variables of derived type that have default initialization specified, and **AUTOMATIC** otherwise.

The **all** and **defaultinit** suboptions are mutually exclusive.

Usage

The **-qnosave** option is usually necessary for multithreaded applications and subprograms that are compiled with the **-qrecur** option.

Examples

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_V̄AR
    END IF
END SUBROUTINE SUB

```

Related information

- “-qrecur” on page 237
- See *Storage Classes for Variables* in the *XL Fortran Language Reference* for information on how this option affects the storage class of variables.

-qsaveopt

Category

Object code control

@PROCESS directive

None.

Purpose

Saves the command-line options used for compiling a source file, the version and level of each compiler component invoked during compilation, and other information to the corresponding object file.

Syntax

►► -q nosaveopt
saveopt ◀◀

Defaults

-qnosaveopt

Usage

This option has effect only when compiling to an object (.o) file (that is, using the `-c` option). Though each object may contain multiple compilation units, only one copy of the command-line options is saved. Compiler options specified with @PROCESS directives are ignored.

Command-line compiler options information is copied as a string into the object file, using the following format:

►► @(#)—opt— f
c
C —invocation—options— ◀◀

where:

f Signifies a Fortran language compilation.

c Signifies a C language compilation.

C Signifies a C++ language compilation.

invocation

Shows the command used for the compilation, for example, `xlf`.

options The list of command line options specified on the command line, with individual options separated by spaces.

Compiler version and release information, as well as the version and level of each component invoked during compilation, are also saved to the object file in the format:

►► @(#)—version— Version— :—VV.RR.MMMM.LLLL—
component_name—Version—:—VV.RR—(—product_name—)—Level—:—YYMMDD— ◀◀

where:

V Represents the version.
R Represents the release.
M Represents the modification.
L Represents the level.
component_name
 Specifies the components that were invoked for this compilation, such as the low-level optimizer.
product_name
 Indicates the product to which the component belongs (for example, C/C++ or Fortran).
YYMMDD
 Represents the year, month, and date of the installed update (PTF). If the update installed is at the base level, the level is displayed as BASE.

If you want to simply output this information to standard output without writing it to the object file, use the **-qversion** option.

Examples

Compile `t.f` with the following command:

```
xlf t.f -c -qsaveopt -qhot
```

Issuing the **what** command on the resulting `t.o` object file produces information similar to the following:

```
opt f /usr/lpp/xlf/bin/xlf -c -qsaveopt -qhot t.f
version IBM XL Fortran Enterprise Edition for AIX, V11.1
version Driver Version: 11.01(Fortran) Level: YYMMDD
version Fortran Transformer Version: 11.01(Fortran) Level: YYMMDD
version Fortran Front End Version : 11.01(Fortran) Level: YYMMDD
version High Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran) Level: YYMMDD
version Low Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran) Level: YYMMDD
```

In the first line, `f` identifies the source used as Fortran, `/usr/lpp/xlf/bin/xlf` shows the invocation command used, and `-qhot -qsaveopt` shows the compilation options.

The remaining lines list each compiler component invoked during compilation, and its version and level. Components that are shared by multiple products may show more than one version number. Level numbers shown may change depending on the updates (PTFs) you have installed on your system.

Related information

- “-qversion” on page 282

-qclk

Category

Language element control

@PROCESS directive

None.

Purpose

Specifies the resolution that the **SYSTEM_CLOCK** intrinsic procedure uses in a program.

Syntax

►► -qclk=centi
micro►►

Defaults

The default is centisecond resolution (**-qclk=centi**). To use microsecond resolution, specify **-qclk=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

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

When used with **-qpdf1** and a minimum optimization level of **-O2** at compile and link steps, inserts additional profiling information into the compiled application to collect call and block counts for all procedures in the application.

Syntax

```
►► -q ———— showpdf ————— ►►  
      |-----|  
      |noshowpdf|
```

Defaults

-qnoshowpdf

Usage

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 “**-qpdf1, -qpdf2**” on page 221.

-qsigtrap

Category

Error checking and debugging

@PROCESS directive

None.

Purpose

Sets up the specified trap handler to catch **SIGTRAP** exceptions when compiling a file that contains a main program.

This option enables you to install a handler for **SIGTRAP** signals without calling the **SIGNAL** subprogram in the program.

Syntax

```
▶▶ -q-sigtrap [=-trap_handler-] ▶▶
```

Defaults

Not applicable.

Usage

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 runtime exceptions” on page 55 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

Category

Optimization and tuning

@PROCESS directive

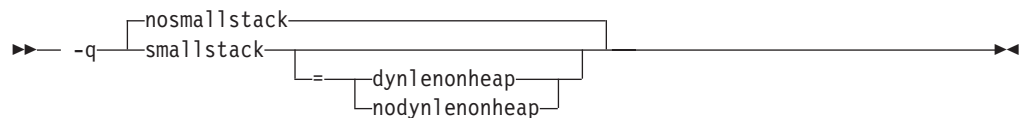
None.

Purpose

Minimizes 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.

Syntax



Defaults

-qnosmallstack

Parameters

dynlenonheap | nodynlenonheap

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.

Defaults

The default, **-qnosmallstack**, implies that all suboptions are off.

Usage

Using this option may adversely affect program performance; it should be used only for programs that allocate large amounts of data on the stack.

-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 it is set to a non-zero value, even if this setting conflicts with that of **-qsmallstack**. The **-qsmallstack** setting will continue to apply transformations not affected by **-qstacktemp**.

Related information

- “-qstacktemp” on page 259

-qsmp

Category

Optimization and tuning

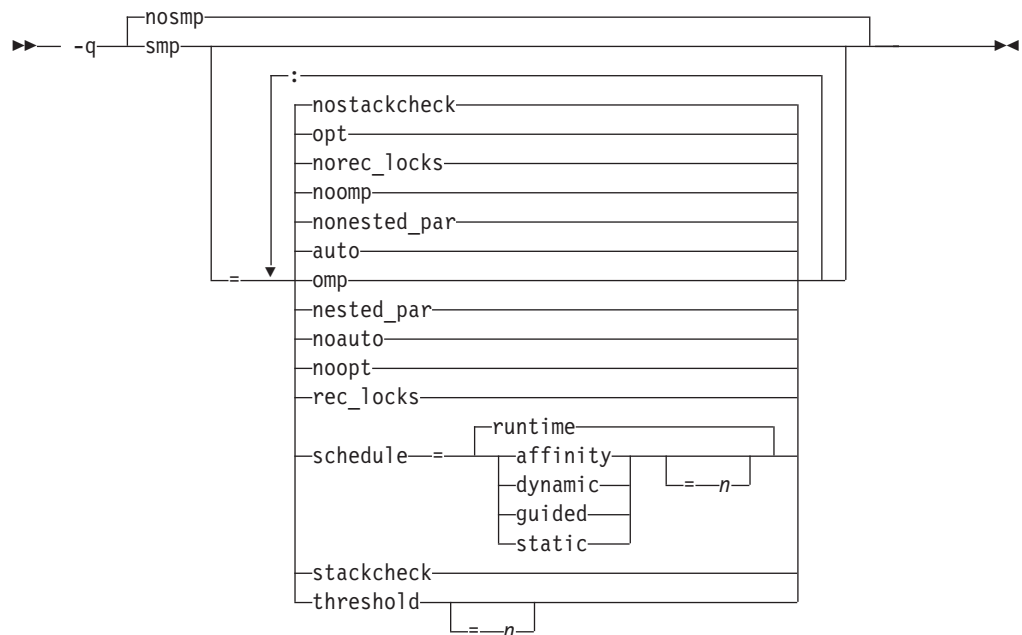
@PROCESS directive

None.

Purpose

Enables parallelization of program code.

Syntax



Defaults

`-qnosmp`. Code is produced for a uniprocessor machine.

Parameters

auto | noauto

Enables or disables automatic parallelization and optimization of program code. 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. When **noauto** is in effect, only program code explicitly parallelized with SMP or OpenMP directives is optimized. **noauto** is implied if you specify `-qsmp=omp` or `-qsmp=noopt`.

nested_par | nonested_par

By default, the compiler serializes a nested parallel construct. When **nested_par** is in effect, 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. Note that this suboption 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. **nested_par** does not provide true nested parallelism because it does not cause new team of threads to be created for nested parallel regions. Instead, threads that are currently available are reused.

This suboption should be used with caution. Depending on the number of threads available and the amount of work in an outer loop, inner loops could be executed sequentially even if this option is in effect. Parallelization overhead may not necessarily be offset by program performance gains.

Note that the implementation of the **nested_par** suboption does not comply with the OpenMP API. There is no support for OpenMP nested parallelism. As such, the **omp_get_nested** routine always returns false according to the OpenMP API. If you specify this suboption, the runtime library uses the same threads for the nested PARALLEL DO and PARALLEL SECTIONS constructs that it used for the enclosing PARALLEL constructs.

omp | noomp

Enforces or relaxes strict compliance to the OpenMP standard. When **noomp** is in effect, **auto** is implied. When **omp** is in effect, **noauto** is implied and only OpenMP parallelization directives are recognized. The compiler issues warning messages if your code contains any language constructs that do not conform to the OpenMP API.

Specifying **omp** also has the following effects:

- Automatic parallelization is disabled.
- All previously recognized directive triggers are ignored. The only recognized directive trigger is \$OMP. However, you can specify additional triggers on subsequent **-qdirective** options.
- The **-qcclines** compiler option is enabled.
- When the C preprocessor is invoked, the `_OPENMP` C preprocessor macro is defined automatically, with the value 200505, which is useful in supporting conditional compilation. See "Conditional Compilation" in the *XL Fortran Language Reference* for more information.

opt | **noopt**

Enables or disables optimization of parallelized program code. When **noopt** is in effect, 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

Determines whether recursive locks are used to avoid problems associated with CRITICAL constructs. When **rec_locks** is in effect, nested critical sections will not cause a deadlock; a thread can enter a CRITICAL construct from within the dynamic extent of another CRITICAL construct that has the same name. Note that the **rec_locks** suboption specifies behavior for critical constructs that is inconsistent with the OpenMP API.

schedule

Specifies the type of scheduling algorithms and chunk size (*n*) that are used for loops to which no other scheduling algorithm has been explicitly assigned in the source code. Suboptions of the **schedule** suboption are as follows:

affinity[=*n*]

The iterations of a loop are initially divided into *n* 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* is not 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.

The **affinity** scheduling type does not appear in the OpenMP API standard.

dynamic[=*n*]

The iterations of a loop are divided into chunks containing *n* iterations each. If *n* is not 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* is not specified, the default value for *n* is 1 iteration.

Active threads are assigned chunks on a "first-come, first-do" basis. 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.

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 *n* is not specified, 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.

n Must be an integral assignment expression of value 1 or greater.

Specifying **schedule** with no suboption is equivalent to **schedule=runtime**.

For more information on chunking algorithms and SCHEDULE, refer to "Directives" in the *XL Fortran Language Reference*.

stackcheck | **nostackcheck**

Causes the compiler to check for stack overflow by slave threads at run time, and issue a warning if the remaining stack size is less than the number of bytes specified by the **stackcheck** option of the XLSMPOPTS environment variable. This suboption is intended for debugging purposes, and only takes effect when **XLSMPOPTS=stackcheck** is also set; see "XLSMPOPTS" in the *XL Fortran Optimization and Programming Guide* for more information.

threshold[=*n*]

When **-qsmp=auto** is in effect, controls the amount of automatic loop parallelization that occurs. The value of *n* represents the minimum amount of work required in a loop in order for it to be parallelized. 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. Specifying a value of 0 instructs the compiler to parallelize all auto-parallelizable loops, whether or not it is profitable to do so. Specifying a value of 100 instructs the compiler to parallelize only those auto-parallelizable loops that it deems profitable. Specifying a value of greater than 100 will result in more loops being serialized.

n Must be a positive integer of 0 or greater.

If you specify **threshold** with no suboption, the program uses a default value of 100.

Specifying **-qsmp** without suboptions is equivalent to

-qsmp=auto:nomp:norec_locks:nonested_par:schedule=runtime:nostackcheck:threshold=100
or

-qsmp=opt:nomp:norec_locks:nonested_par:schedule=runtime:nostackcheck:threshold=100.

Usage

- Specifying the **omp** suboption always implies **noauto**. Specify **-qsmp=omp:auto** to apply automatic parallelization on OpenMP-compliant applications, as well.
- When **-qsmp** is in effect, the compiler recognizes all directives with the trigger constants **SMP\$**, **\$OMP**, and **IBMP**, unless you specify the **omp** suboption. If you specify **omp** and want the compiler to recognize directives specified with the other triggers, you can use the **-qdirective** option to do so.
- You should only use **-qsmp** with the **_r**-suffixed invocation commands, to automatically link in all of the threadsafe components. You can use the **-qsmp** option with the non-**_r**-suffixed invocation commands, but you are responsible for linking in the appropriate components. For a description of this, refer to "Linking 32-bit SMP object files using the **ld** command" on page 36. 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.
- If you use the **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 threadsafe code.
- 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.
- Specifying **-qsmp** implicitly sets **-O2**. The **-qsmp** option overrides **-qnooptimize**, but does not override **-O3**, **-O4**, or **-O5**. When debugging parallelized program code, you can disable optimization in parallelized program code by specifying **qsmp=noopt**.

- The `-qsmp=noopt` suboption overrides performance optimization options anywhere on the command line unless `-qsmp` appears after `-qsmp=noopt`. For example, `-qsmp=noopt -O3` is equivalent to `-qsmp=noopt`, while `-qsmp=noopt -O3 -qsmp` is equivalent to `-qsmp -O3`.

Examples

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
```

-qsource

Category

Listings, messages, and compiler information

Purpose

Produces a compiler listing file that includes the source section of the listing and provides additional source information when printing error messages.

Syntax



@PROCESS:

@PROCESS SOURCE | NOSOURCE

Defaults

-qnosource

Usage

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 “Listings, messages, and compiler information” on page 63 and “Source section” on page 336.

-qspillsize

Category

Compiler customization

Purpose

`-qspillsize` is the long form of `-NS`. See “`-NS`” on page 99.

Syntax

▶▶ `-qspillsize=bytes` ▶▶

@PROCESS:

@PROCESS SPILLSIZE(*bytes*)

Defaults

Not applicable.

-qstacktemp

Category

Optimization and tuning

Purpose

Determines where to allocate certain 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.

Syntax

►► -q-stacktemp=0
-1
value►►

@PROCESS:

@PROCESS STACKTEMP={0 | -1 | *positive signed integer value*}

Defaults

-qstacktemp=0

Parameters

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.
- value** Allocates applicable temporaries less than *value* on the stack and those greater than or equal to *value* on the heap. *value* is a positive signed integer. 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.

Usage

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.

The `-qstacktemp` option can take precedence over the `-qsmallstack` option for certain compiler-generated temporaries.

Related information

- “`-qsmallstack`” on page 249

-qstrict

Category

Optimization and tuning

Purpose

Ensures that optimizations done by default at optimization levels **-O3** and higher, and, optionally at **-O2**, do not alter certain program semantics mostly related to strict IEEE floating-point conformance.

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.

Syntax

►► -q

strict
nostrict

 ►►

@PROCESS:

@PROCESS STRICT | NOSTRICT

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.

Usage

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

- “-O” on page 100
- “-qhot” on page 174
- “-qfloat” on page 162

-qstrict_induction

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Prevents the compiler from performing induction (loop counter) variable optimizations. These optimizations may be unsafe (may alter the semantics of your program) when there are integer overflow operations involving the induction variables.

Syntax

```
►► -q nostrict_induction strict_induction ►►
```

Defaults

-qnostrict_induction

Usage

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                   ! Variable i can hold a maximum
i = 1_1                           ! 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.

Related information

- “-O” on page 100

-qsuffix

Category

Input control

@PROCESS directive

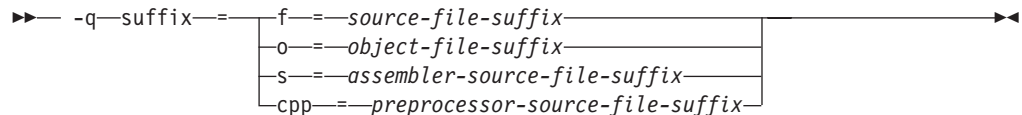
None.

Purpose

Specifies the source-file suffix on the command line.

This option saves time for the user by permitting files to be used as named with minimal makefile modifications. Only one setting is supported at any one time for any particular file type.

Syntax



Defaults

Not applicable.

Parameters

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.

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.

- 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 with **-qsuppress**.
- To suppress IPA messages, enter **-qsuppress** before **-qipa** on the command line.

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” on page 160.

-qswapomp

Category

Portability and migration

Purpose

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.

Syntax



@PROCESS:

@PROCESS SWAPOMP | NOSWAPOMP

Defaults

-qswapomp

Usage

The compiler does not perform substitution of OpenMP routines when you specify the **-qnoswapomp** option.

The **-qswapomp** and **-qnoswapomp** options only affect Fortran subprograms 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

Category

Object code control

@PROCESS directive

None.

Purpose

Controls the amount of debugging traceback information that is included in the object files.

Syntax



Defaults

Not applicable.

Parameters

- full** The object code contains full traceback information. The program is debuggable, and if it stops because of a runtime exception, it produces a traceback listing that includes the names of all procedures in the call chain.
- 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 runtime 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 runtime exception, it explains where the exception occurred but reports machine addresses rather than procedure names.

Defaults

- Code compiled with **-g** or without **-O** has full traceback information (**-qtbtable=full**).
- Code compiled with **-O** or higher optimization contains less traceback information (**-qtbtable=small**).

Usage

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.

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 **-qhtable=none**. Otherwise, the usual defaults apply:

Restrictions

To use the performance tools, such as **tprof**, in the AIX Performance Toolbox, you must compile the Fortran programs with **-qhtable=full**.

Related information

- “-g” on page 94
- “-qcompact” on page 134
- “-O” on page 100
- *Debugging optimized code* in the *XL Fortran Optimization and Programming Guide*

-qthreaded

Category

Object code control

@PROCESS directive

None.

Purpose

Indicates to the compiler whether it must generate thread-safe code.

Syntax

►► — -q—threaded ————— ◄◄

Defaults

-qthreaded is the default for the **xlf_r**, **xlf_r7**, **xlf90_r**, **xlf90_r7**, **xlf95_r**, **xlf95_r7** and **xlf2003_r** commands.

Usage

Specifying the **-qthreaded** option implies **-qdirective=ibmt**, and by default, the *trigger_constant* **IBMT** is recognized.

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 thread-safe; 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.

-qtune

Category

Optimization and tuning

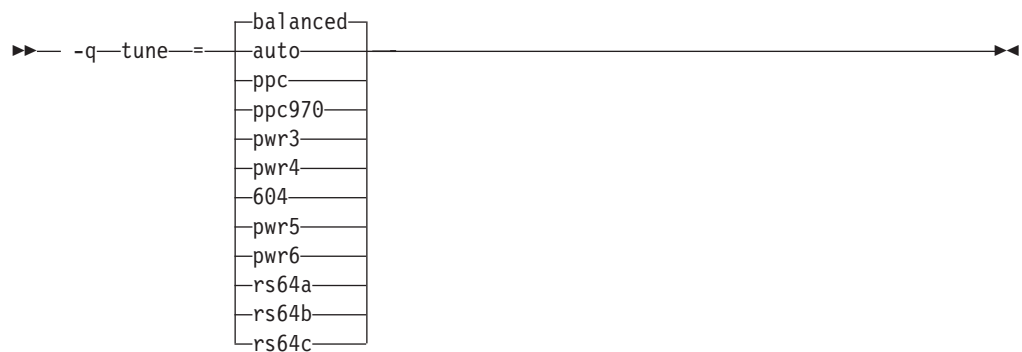
@PROCESS directive

None.

Purpose

Tunes instruction selection, scheduling, and other architecture-dependent performance enhancements to run best on a specific hardware architecture.

Syntax



Defaults

`-qtune=balanced` when the default `-qarch` setting is in effect. Otherwise, the default depends on the effective `-qarch` setting. See Table 22 on page 274 for details.

Parameters

604

Optimizations are tuned for the PowerPC 604 processor.

auto

Optimizations are tuned for the platform on which the application is compiled.

balanced

Optimizations are tuned across a selected range of recent hardware.

ppc970

Optimizations are tuned for the PowerPC 970 processor.

pwr3

Optimizations are tuned for the POWER3 hardware platforms.

pwr4

Optimizations are tuned for the POWER4 hardware platforms.

pwr5

Optimizations are tuned for the POWER5 hardware platforms.

pwr6

Optimizations are tuned for the POWER6 hardware platforms.

rs64a

Optimizations are tuned for the RS64I processor.

rs64b

Optimizations are tuned for the RS64II processor.

rs64c

Optimizations are tuned for the RS64III processor.

Note: As of the V11.1 release of the compiler, suboptions representing 601, 602, 603, POWER and POWER2 architectures are deprecated.

Usage

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.

Acceptable combinations of **-qarch**, and **-qtune** are shown in the following table.

Table 22. Acceptable **-qarch/-qtune** combinations

-qarch option	Default -qtune setting	Available -qtune settings
604	604	auto 604
ppc	balanced	auto 604 rs64a rs64b rs64c pwr3 pwr4 pwr5 pwr6 ppc970 balanced
ppcgr	balanced	auto 604 rs64b rs64c pwr3 pwr4 pwr5 pwr6 ppc970 balanced
ppc64	balanced	autors64a rs64b rs64c pwr3 pwr4 pwr5 pwr6 ppc970 balanced
ppc64gr	balanced	auto rs64b rs64c pwr3 pwr4 pwr5 pwr6 ppc970 balanced
ppc64grsq	balanced	auto rs64b rs64c pwr3 pwr4 pwr5 pwr6 ppc970 balanced
ppc64v	ppc970	auto ppc970 pwr6 balanced
ppc970	ppc970	auto ppc970 balanced
pwr3	pwr3	auto pwr3 pwr4 pwr5 ppc970 balanced
pwr4	pwr4	auto pwr4 pwr5 ppc970 balanced
pwr5	pwr5	auto pwr5 balanced
pwr5x	pwr5	auto pwr5 balanced
pwr6	pwr6	auto pwr6 balanced
pwr6e	pwr6	auto pwr6 balanced
rs64a	rs64a	auto rs64a

Table 22. Acceptable **-qarch/-qtune** combinations (continued)

-qarch option	Default -qtune setting	Available -qtune settings
rs64b	rs64b	auto rs64b
rs64c	rs64c	auto rs64c

Results

None.

Examples

To specify that the executable program `testing` compiled from `myprogram.f` is to be optimized for a POWER3 hardware platform, enter:

```
xlf -o testing myprogram.f -qtune=pwr3
```

Related information

- “-qarch” on page 119

-qundef

Category

Language element control

Purpose

-qundef is the long form of the “-u” on page 306.

Syntax

►► -q nundef
undef ◄◄

@PROCESS:

@PROCESS UNDEF | NOUNDEF

Defaults

-qnundef

-qunroll

Category

Optimization and tuning

@PROCESS directive

None.

Purpose

Specifies whether unrolling **DO** loops is allowed in a program. Unrolling is allowed on outer and inner **DO** loops.

Syntax



Defaults

-qunroll=auto if **-qunroll** is not specified on the command line.

Parameters

- auto** The compiler performs basic loop unrolling.
- yes** The compiler looks for more opportunities to perform loop unrolling than that performed with **-qunroll=auto**. 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.

Usage

Specifying **-qunroll** with no suboptions is equivalent to **-qunroll=yes**.

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

Category

Optimization and tuning

Purpose

Specifies that the compiler will preserve the default behavior for saves and restores to volatile registers during a procedure call.

Syntax



```
►► -q ┌── unwind ──┐
      │             │
      └── nounwind ─┘
```

@PROCESS:

@PROCESS UNWIND | NOUNWIND

Defaults

-qunwind

Usage

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.

-qvecnvolf

Category

Portability and migration

@PROCESS directive

None.

Purpose

Specifies whether to use volatile or non-volatile vector registers.

Volatile vector registers are those registers whose value is not preserved across function calls or across save context, jump or switch context system library functions.

Syntax

►► -q novectnvolf
 vecnvolf

Defaults

-qnovectnvolf

Usage

-qvecnvolf instructs the compiler to use both volatile and non-volatile vector registers. **-qnovectnvolf** instructs the compiler to use only volatile vector registers.

This option is required for programs where there is risk of interaction between modules built with AIX libraries prior to AIX 5.3 with 5300-03 and vector register use. Restricting the compiler to use only volatile registers will make your vector programs safe, but it potentially forces the compiler to store vector data to memory more often and thus may reduce your application's performance.

Notes

- This option is supported on AIX 5.3 with 5300-03, or higher.
- To use **-qvecnvolf**, you need `bos.adt.include` version 5.3.0.30 or greater installed on your system.
- If **-qnoenablevmx** is in effect, **-qnovectnvolf** is ignored.
- The **-qnovectnvolf** option performs independently of the **-qhot=[no]simd** option and **NOSIMD VMX** directive.
- On AIX 5.3 with 5300-03, only 20 volatile registers (vr0-vr19) are used by default; the 12 non-volatile vector registers (vr20 - vr31) are not used. You can use these registers only if **-qvecnvolf** is in effect.
- Only enable **-qvecnvolf** for older programs that do not perform saves and restores to non-volatile registers. Using **-qvecnvolf** and linking to such code may result in a runtime failure.

Related information

- “-qenablevmx” on page 149
- “-qhot” on page 174

-qversion

Category

Listings, messages, and compiler information

@PROCESS directive

None.

Purpose

Displays the version and release of the compiler being invoked.

Syntax



Defaults

-qnoverison

Parameters

verbose

Additionally displays information about the version, release, and level of each compiler component installed.

Usage

When you specify **-qversion**, the compiler displays the version information and exits; compilation is stopped

-qversion specified without the **verbose** suboption shows compiler information in the format:

```
product_name  
Version: VV.RR.MMMM.LLLL
```

where:

V Represents the version.
R Represents the release.
M Represents the modification.
L Represents the level.

Example:

```
IBM XL Fortran Enterprise Edition for AIX, V11.1  
Version: 11.01.0000.0001
```

-qversion=verbose shows component information in the following format:

```
component_name Version: VV.RR(product_name) Level: component_level
```

where:

component_name
Specifies an installed component, such as the low-level optimizer.

component_level

Represents the level of the installed component.

Example:

```
IBM XL Fortran Enterprise Edition for AIX, V11.1
Version: 11.01.0000.0001
Driver Version: 11.01(Fortran) Level: YYMMDD
Fortran Transformer Version: 11.01(Fortran) Level: YYMMDD
Fortran Front End Version: 11.01(Fortran) Level: YYMMDD
High Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran) Level: YYMMDD
Low Level Optimizer Version: 09.00(C/C++) and 11.01(Fortran) Level: YYMMDD
```

If you want to save this information to the output object file, you can do so with the `-qsaveopt -c` options.

Related information

- “-qsaveopt” on page 244

-qwarn64

Category

Error checking and debugging

@PROCESS directive

None.

Purpose

Displays informational messages identifying statements that may cause problems with 32-bit to 64-bit migration.

This option aids in porting code from a 32-bit to a 64-bit environment by detecting the truncation of an 8-byte integer pointer to 4 bytes.

Syntax

```
►► -q nowarn64 warn64 ◄◄
```

Defaults

-qnowarn64

Usage

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. We recommend the **-qextchk** option for common block length changes.
- The specification of an integer pointer within an equivalence statement.

You can use the **-qextchk** option and interface blocks for argument checking.

Related information

- “-q32” on page 108
- “-q64” on page 109
- Chapter 7, “Using XL Fortran in a 64-Bit Environment,” on page 313

-qxflag=dvz

Category

Error checking and debugging

@PROCESS directive

None.

Purpose

Causes the compiler to generate code to detect floating-point divide-by-zero operations.

Syntax

►► -q—xflag— = —dvz— ◀◀

Defaults

Not applicable.

Usage

This option takes effect at optimization levels 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*

- “-qfltrap” on page 167
- “Understanding XL Fortran error messages” on page 317

-qxflag=oldtab

Category

Portability and migration

Purpose

Interprets a tab in columns 1 to 5 as a single character (for fixed source form programs), for compatibility with XL Fortran Version 1.

Syntax

►► — -q—xflag— = —oldtab— ◀◀

@PROCESS:

@PROCESS XFLAG(OLDTAB)

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.

Usage

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.

-qxflag=xalias

Category

Deprecated options

Purpose

Replaced by **-qalias=nostd**. See “-qalias” on page 112 instead.

Syntax

▶▶ `-qxflag=xalias` ▶▶

@PROCESS:

`@PROCESS XFLAG(XALIAS)`

Defaults

Not applicable.

-qxlf77

Category

Language element control

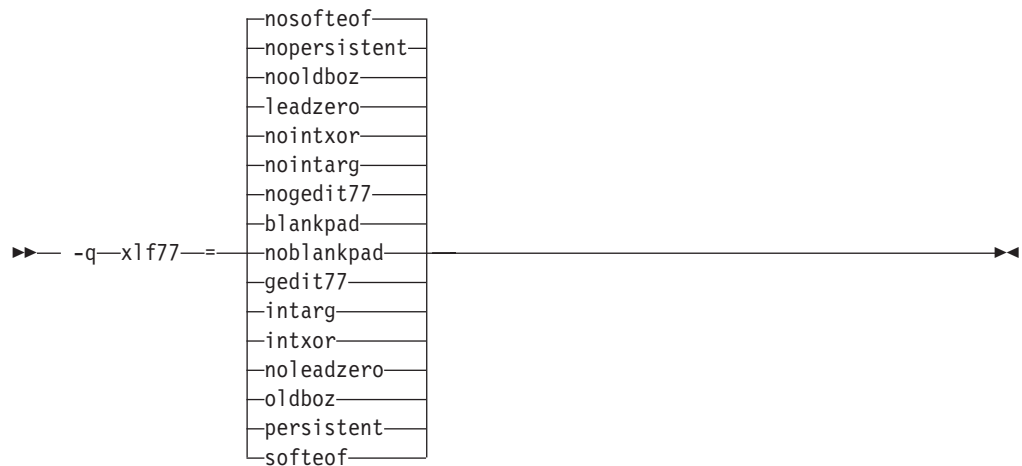
Purpose

Provides backward compatibility with XL Fortran Versions 1 and 2 aspects of language semantics and I/O data format that have changed.

Most of these changes are required by the Fortran 90 standard.

Syntax

Option:



@PROCESS:

@PROCESS XLF77(*settings*)

Defaults

By default, the compiler uses settings that apply to Fortran 95, Fortran 90, Fortran 2003, and the most recent compiler version in all cases.

The default suboptions are: **blankpad**, **nogedit77**, **nointarg**, **nointxor**, **leadzero**, **nooldboz**, **nopersistent**, and **nosofteof**.

These defaults are only used by the `xlf2003`, `xlf2003_r`, `xlf95`, `xlf95_r`, `xlf95_r7`, `xlf90`, `xlf90_r`, `xlf90_r7`, `f90`, `f95` and `f2003` commands, which you should use to compile new programs.

For maximum compatibility for programs and data created for XL Fortran Versions 1 and 2, the `xlf`, `xlf_r`, `xlf_r7`, `f77`, and `fort77` commands use the opposite settings for this option.

Parameters

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, thus duplicating the XL Fortran Version 2 behavior. 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, for compatibility with XL Fortran Version 2. 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.

Usage

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, Fortran 95 and Fortran 2003 and the `xlf90`, `xlf90_r`, `xlf90_r7`, `xlf95`, `xlf95_r`, `xlf95_r7`, `xlf2003`, `xlf2003_r`, `f90`, `f95` or `f2003` command and find some incompatibility because of behavior or data format that has changed since XL Fortran Version 2.

Eventually, you should be able to recreate the data files or modify the source files to remove the dependency on the old behavior.

Related information

See “Avoiding or fixing upgrade problems” on page 19.

-qxlf90

Category

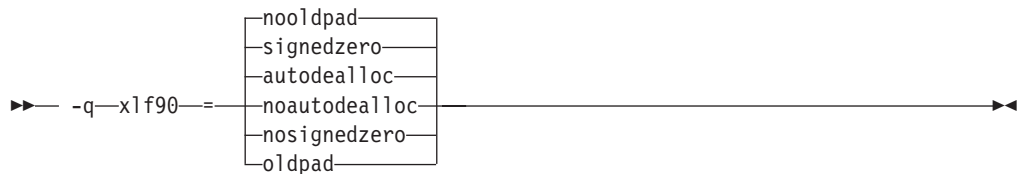
Language element control

Purpose

Provides backward compatibility with XL Fortran for AIX Version 5 and the Fortran 90 standard for certain aspects of the Fortran language.

Syntax

Option:



@PROCESS:

@PROCESS XLF90(*settings*)

Defaults

The default suboptions for **-qxlf90** depend on the invocation command that you specify.

For the **xlF2003**, **f2003**, **xlF2003_r**, **xlF95**, **f95**, **xlF95_r**, or **xlF95_r7** command, the default suboptions are **signedzero**, **autodealloc**, and **nooldpad**.

For all other invocation commands, the defaults are **nosignedzero**, **noautodealloc** and **oldpad**.

Parameters

signedzero | nosignedzero

Determines how the **SIGN(A,B)** function handles signed real 0.0. Prior to XL Fortran Version 6.1, **SIGN(A,B)** returned $|A|$ when $B=-0.0$. This behavior conformed with the Fortran 90 standard. Now, 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 and did not exist in XL Fortran prior to Version 6.1. 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.

oldpad | nooldpad

When the **PAD=specifier** is present in the **INQUIRE** statement, specifying **-qxf90=nooldpad** returns UNDEFINED when there is no connection, or when the connection is for unformatted I/O. This behavior conforms with the Fortran 95 standard and above. Specifying **-qxf90=oldpad** preserves the Fortran 90 behavior.

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 **-qxf90** suboption that you specify. For example:

Invocation Command/xlf90 Suboption	Output
xlf2003	-1.0
xlf2003 -qxf90=signedzero	-1.0
xlf2003 -qxf90=nosignedzero	1.0
xlf95	-1.0
xlf95 -qxf90=signedzero	-1.0
xlf95 -qxf90=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*.

-qxlf2003

Category

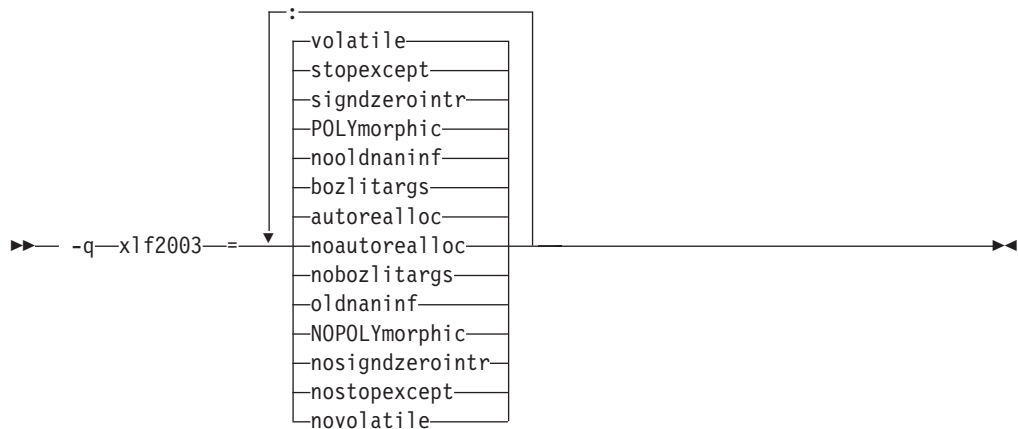
Language element control

Purpose

Provides the ability to use language features specific to the Fortran 2003 standard when compiling with compiler invocations that follow earlier Fortran standards, as well as the ability to disable these features when compiling with compiler invocations that follow the Fortran 2003 standard.

Syntax

Option:



@PROCESS:

@PROCESS XLF2003(*suboption,suboption,...*)

Defaults

The default suboption depends on the invocation command that you specify.

For the **f2003**, **xlf2003**, or **xlf2003_r** command, the defaults are:

autorealloc:bozlitargs:nooldnaninf:polymorphic:signdzerointr:stopexcept:volatile

For all other invocation commands, the defaults are:

noautorealloc:nobozlitargs:oldnaninf:nopolymorphic:nosigndzerointr:nostopexcept:novolatile

Parameters

autorealloc | **noautorealloc**

Controls whether the compiler automatically reallocates the left-hand-side (LHS) with the shape of the right-hand-side (RHS) when assigning into an allocatable variable. If the LHS variable was not allocated before the assignment, it is allocated automatically. The default is **autorealloc** for the **f2003**, **xlf2003** and **xlf2003_r** commands, and **noautorealloc** for all other

commands. This suboption has no effect on reallocation when the values of length type parameters in the LHS and RHS differ.

bozlitargs | nobozlitargs

The **bozlitargs** suboption ensures that the passing of boz-literal constants as arguments to the **INT**, **REAL**, **CMPLX**, or **DBLE** intrinsic function conforms to the Fortran 2003 standard. The default is **bozlitargs** for the **f2003**, **xlF2003**, or **xlF2003_r** command. The **-qlanglvl=2003pure** or **-qlanglvl=2003std** option must be specified, as well. If **-qport=typlessarg** and **-qxlF2003=bozlitargs** are specified, passing boz-literal constants to the **CMPLX** intrinsic will yield non-standard results.

oldnaninf | nooldnaninf

The **oldnaninf** suboption controls the formatting of the output of IEEE NaN and infinity exceptional values. This suboption has no effect on input. When **oldnaninf** is in effect, the compiler uses the XL Fortran V10.1 (and earlier) behavior for output. That is, INF for infinity, NaNQ for a quiet NaN, and NANS for a signaling NaN.

When **nooldnaninf** is in effect, the compiler output for IEEE exceptional values is compliant with the Fortran 2003 standard. That is, Inf for infinity, NaN(Q) for a quiet NaN, and NaN(S) for a signaling NaN.

polymorphic | nopolymorphic

When **polymorphic** is in effect, the compiler allows polymorphic items in Fortran source files. You can specify the **CLASS** type specifier, the **SELECT TYPE** construct, and use polymorphic items in other Fortran statements. The use of the polymorphic argument also causes the compiler to produce runtime type information for each derived type definition.

When **nopolymorphic** is in effect, polymorphic items cannot be specified in Fortran source files and no runtime type information is generated.

signdzerointr | nosigndzerointr

When **signdzerointr** is in effect, the passing of signed zeros to the **SQRT**, **LOG**, and **ATAN2** intrinsic functions returns results consistent with the Fortran 2003 standard. The **-qxlF90=signedzero** option must be in effect, as well. For the **xlF90**, **xlF77** and **xlF** invocations, specify both options to have the Fortran 2003 behavior.

The following example shows the use of this suboption:

```
!If the Test program is compiled with -qxlF2003=signdzerointr and
-qxlF90=signedzero
!then Fortran 2003 behavior is seen.
!Otherwise, this program will demonstrate Fortran 95 behavior.
```

```
Program Test
real a, b
complex j, l
a = -0.0
j = sqrt(cmplx(-1.0,a))
b = atan2(a,-1.0)
l = log(cmplx(-1.0,a))
print *, 'j=', j
print *, 'b=', b
print *, 'l=', l
end
```

! Fortran 95 output:

```
j= (-0.000000000000E+00,1.0000000000)
b= 3.141592741
l= (0.000000000000E+00,3.141592741)
```

```
! Fortran 2003 output:

j= (0.0000000000E+00,-1.000000000)
b= -3.141592741
l= (0.0000000000E+00,-3.141592741)
```

stopexcept | nostopexcept

When **stopexcept** is in effect, informational messages are displayed when IEEE floating-point exceptions are signaled by a **STOP** statement. Messages have the format:

```
STOP [stop-code]
(OVERFLOW, DIV-BY-ZERO, INVALID, UNDERFLOW, INEXACT)
```

where *stop-code* corresponds to the optional digit string or character constant specified in the **STOP** statement. OVERFLOW, DIV-BY-ZERO, INVALID, UNDERFLOW and INEXACT appear only if the corresponding flag is set.

The following example shows corresponding messages generated:

```
real :: r11, r12, r13, r14
logical :: l

r11 = 1.3
r12 = 0.0

r13 = r11 / r12 ! divide by zero

r14 = r13 ! to make sure r13 is actually used

r14 = log(-r11) ! invalid input for log

stop "The End"

end
```

Output:

```
STOP The End
(DIV-BY-ZERO, INVALID)
```

When **nostopexcept** is in effect, informational messages are suppressed.

volatile | novolatile

When **volatile** is in effect, a non-VOLATILE entity that is use- or host-associated can be specified as VOLATILE in inner or local scope.

Usage

If the application uses F2003 polymorphism, you must compile every unit with **polymorphic** specified. If the application does not use polymorphism, specify the **nopolymorphic** suboption; doing so may save compilation time and potentially improve runtime performance.

Related information

- See the **CLASS** type specifier and the **SELECT TYPE** construct in the *XL Fortran Language Reference*.

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

- “-D” on page 90
- *Conditional Compilation* in the *Language Elements* section of the *XL Fortran Language Reference*

-qxref

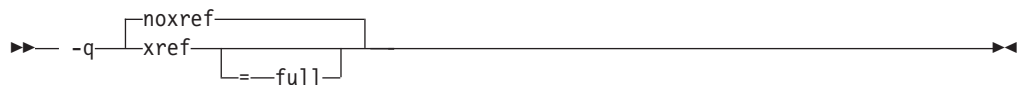
Category

Listings, messages, and compiler information

Purpose

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

Syntax



@PROCESS:

@PROCESS XREF[(FULL)] | NOXREF

Defaults

-qnoxref

Usage

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 “Listings, messages, and compiler information” on page 63 and “Attribute and cross reference section” on page 338.

-S

Category

Output control

@PROCESS directive

None.

Purpose

Generates an assembler language file for each source file.

Syntax

►► -S ◀◀

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”** on page 103 can be used to specify a name for the resulting assembler source file.

For information about the assembler-language format, see the *AIX Assembler Language Reference*.

-t

Category

Compiler customization

@PROCESS directive

None.

Purpose

Applies the prefix specified by the **-B** option to the designated components.

Syntax



Defaults

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

Parameters

The following table shows the correspondence between **-t** parameters and the component executable names:

Parameter	Description	Executable name
a	Assembler	as
b	Low-level optimizer	xlrcode
c	Compiler front end	xlrfentry
d	Disassembler	dis
F	C preprocessor	cpp
h	Array language optimizer	xlrfhot
I	High-level optimizer, compile step	ipa
l	Linker	ld
p	VAST-2 or KAP preprocessor	fpp, fppk
z	Binder	bolt

Usage

This option is intended to be used together with the **-B***prefix* option.

Note that using the **p** suboption causes the source code to be preprocessed separately before compilation, which can change the way a program is compiled.

Examples

To compile `myprogram.f` so that the name `/u/newones/compilers/` is prefixed to the compiler and assembler program names, enter:

```
xlf myprogram.f -B/u/newones/compilers/ -tca
```

Related information

- “-B” on page 76

-U

Category

Input control

Purpose

Makes the compiler sensitive to the case of letters in names.

Syntax

▶▶ -U ◀◀

@PROCESS:

@PROCESS MIXED | NOMIXED

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.

Usage

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.

If `-U` is specified, case is significant in names. For example, the names `Abc` and `ABC` refer to different objects.

This 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.

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.

The XL Fortran Version 2 requirement that keywords be all lowercase no longer applies.

Related information

This is the short form of `-qmixed`. See “`-qmixed`” on page 211.

-u

Category

Language element control

Purpose

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.

Syntax

▶▶ — -u ————— ▶▶

@PROCESS:

@PROCESS UNDEF | **NOUNDEF**

Defaults

-**qnoundef**, which allows implicit typing.

Related information

See **IMPLICIT** in the *XL Fortran Language Reference*.

This is the short form of **-qundef**. See “-qundef” on page 276.

-v

@PROCESS directive

None.

Purpose

Reports the progress of compilation, by naming the programs being invoked and the options being specified to each program.

Syntax

▶▶ -v ◀◀

Defaults

Not applicable.

Usage

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

- “-#” on page 74 is similar to -v, but it does not actually execute any of the compilation steps.
- “-V” on page 308

-V

Category

Listings, messages, and compiler information

Purpose

The same as `-v` except that you can cut and paste directly from the display to create a command.

Defaults

Not applicable.

Syntax

▶▶ -V ◀◀

Related information

- “-v” on page 307
- “-#” on page 74

-W

Category

Compiler customization

@PROCESS directive

None.

Purpose

Passes the listed options to a component that is executed during compilation.

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.

Syntax



Parameters

option

Any option that is valid for the component to which it is being passed. Spaces must not appear before the *option*.

The following table shows the correspondence between **-W** parameters and the component executable names:

Parameter	Description	Executable name
a	Assembler	as
b	Low-level optimizer	xlfcodes
c	Compiler front end	xlfcntry
d	Disassembler	dis
F	C preprocessor	cpp
h	Array language optimizer	xlfcot
I	High-level optimizer, compile step	ipa
l	Linker	ld
p	VAST-2 or KAP preprocessor	fpp, fppk

Parameter	Description	Executable name
z	Binder	bolt

Usage

In the string following the **-W** option, use a comma as the separator for each option, and do not include any spaces. If you need to include a character that is special to the shell in the option string, precede the character with a backslash. For example, if you use the **-W** option in the configuration file, you can use the escape sequence backslash comma (\,) to represent a comma in the parameter string.

You do not need the **-W** option to pass most options to the linker **ld**: unrecognized command-line options, except **-q** options, are passed to it automatically. Only linker options with the same letters as compiler options, such as **-v** or **-S**, strictly require **-W**.

Examples

To compile the file `file.f` and pass the linker option **-berok** to the linker, enter the following command:

```
xlf -Wl,-berok file.f
```

To compile the file `uses_many_symbols.f` and the assembly file `produces_warnings.s` so that `produces_warnings.s` is assembled with the assembler option **-x** (issue warnings and produce cross-reference), and the object files are linked with the option **-s** (write list of object files and strip final executable file), issue the following command:

```
xlf -Wa,-x -Wl,-s produces_warnings.s uses_many_symbols.f
```

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
```

Related information

- “Passing command-line options to the `ld` or `as` commands” on page 32

-W

Category

Listings, messages, and compiler information

@PROCESS directive

None.

Purpose

Suppresses informational, language-level and warning messages (equivalent to `-qflag=e:e`).

Syntax

▶▶ -W ◀◀

Defaults

Not applicable.

Related information

- “-qflag” on page 160

-y

Category

Floating-point and integer control

Purpose

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.

Syntax



@PROCESS:

@PROCESS IEEE(Near | Minus | Plus | Zero)

Defaults

-yn

Parameters

- | | |
|----------|------------------------------|
| <u>n</u> | Round to nearest. |
| <u>m</u> | Round toward minus infinity. |
| <u>p</u> | Round toward plus infinity. |
| <u>z</u> | Round toward zero. |

Usage

If your program contains operations involving real(16) values, the rounding mode must be set to **-yn**, round-to-nearest.

Related information

- “-O” on page 100
- “-qfloat” on page 162
- “-qieee” on page 177

Chapter 7. 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 AIX 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. XL Fortran only supports applications that target the 64-bit Large Data Type (LDT) Application Binary Interface (ABI). Non-LDT environments, such as AIX version 4, are no longer supported.

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 binder 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=ppc** 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 **thepwr5**, **pwr6**, **ppc970**, or **auto** settings will be more system-dependent.

64-Bit Large Data Type support

The 64-bit Large Data Type (LDT) Application Binary Interface (ABI), or 64-bit LDT ABI, increases scalability for 64-bit applications, while maintaining binary compatibility for existing 32-bit applications. To accomplish this, some system-derived types are increased from 32-bits to 64-bits. In addition, a new 64-bit magic number is being introduced in the XCOFF definition to identify object code files using the new 64-bit ABI.

The AIX 4.3 64-bit, non-LDT, ABI is no longer supported on AIX 5.2. Object code files with the old 64-bit magic number will not link, load, or execute. Pre-AIX 5.2

64-bit applications must be recompiled in order to execute them on AIX 5.2. Binary compatibility will be preserved for 32-bit objects generated on all earlier levels of AIX, regardless of LDT support.

64-Bit thread support

On AIX Version 5.2 with the POSIX 1003.1-1996 standard pthreads API, XL Fortran supports 64-bit thread programming. You can specify the **-q64** compiler option with the `xlfr_r`, `xlfr_r7`, `xlfr90_r`, `xlfr90_r7`, `xlfr95_r`, `xlfr95_r7`, and `xlfr2003_r` commands. For example, you can specify the following command to compile and then link a program in 64-bit object mode:

```
xlfr90_r -q64 -qsmp test.f
```

AIX Version 5.2 supports the POSIX 1003.1-1996 standard interface in both 32-bit and 64-bit object mode, but supports the Draft 7 interface in 32-bit object mode only. That is, the `libpthreads.a` library has a 32-bit and a 64-bit part, while the `libpthreads_compat.a` and `libxlfrthrds_compat.a` libraries have 32-bit parts only.

Compiler options for the 64-Bit environment

The **-q32**, **-q64**, and **-qwarn64** compiler options are primarily for developers who are targeting 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

Default bit mode

The AIX operating system provides support for the `OBJECT_MODE` environment variable to enable the user to obtain a 64-bit development environment. AIX tools use the setting of `OBJECT_MODE` to determine the type of object to be used or created. The `OBJECT_MODE` environment variable has three recognized settings:

OBJECT_MODE=32

Works with 32-bit objects

OBJECT_MODE=64

Works with 64-bit objects

OBJECT_MODE=32_64

Works with either 32-bit or 64-bit objects

The XL Fortran compiler determines the default bit mode through the setting of the `OBJECT_MODE` environment variable at the time of invocation. The following table shows the default bit mode and options that are set for each setting of the `OBJECT_MODE` environment variable:

Table 23. Default bit mode determined by the setting of OBJECT_MODE

OBJECT_MODE Setting	Default Bit Mode	Default Option Set
unset	32-bit	-q32
32	32-bit	-q32
64	64-bit	-q64
32_64	Not permitted	n/a

Specification of the following options on the command line or in the configuration file overrides the default option set:

- -q64
- -q32

Important note

Using **OBJECT_MODE** to determine the default bit mode can have serious implications if you are not aware of the setting of **OBJECT_MODE** at the time of invocation. For example, you may not be aware that **OBJECT_MODE** has been set to **64**, and you may unexpectedly obtain 64-bit object files.

We strongly urge you to be aware of the setting of **OBJECT_MODE** at all times and to set it yourself to ensure that the compiler is invoked for the correct bit mode. Alternatively, you can always use the **-q32** or **-q64** option to specify the bit mode.

Module support

64-bit support is provided in the Fortran module files that are shipped with XL Fortran.

Chapter 8. Problem determination and debugging

This section describes some methods you can use for locating and fixing problems in compiling or executing your programs.

Related information: You might encounter a number of potential problems when moving from previous versions of XL Fortran to XL Fortran V11.1. "Avoiding or fixing upgrade problems" on page 19 summarizes these potential problems.

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 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=e** 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” on page 266.

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.

Runtime 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 $\text{MOD}(\text{digit_string}, 256)$ 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:

►►—15—cc—--nnn— —┌(—severity_letter—)┐—message_text—►►

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

24	Indicates a VAST preprocessor message
25	Indicates a runtime message from an XL Fortran application program
26	Indicates a KAP preprocessor message
85	Indicates a loop-transformation message
86	Indicates an interprocedural analysis (IPA) message
<i>nnn</i>	Is the message number
<i>severity_letter</i>	Indicates how serious the problem is, as described in the preceding section
<i>'message text'</i>	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

XL Fortran comes with compiler and runtime messages in U.S. English and 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 runtime message appears in the wrong language, ensure that your program calls the **setlocale** routine to set the program's locale at run time.

To determine which XL Fortran message catalogs are installed, use the following commands to list them:

```
lsipp -f 'xlfcmp.msg.*' # compile-time messages
lsipp -f 'xlfrte.msg.*' # runtime 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, runtime 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 **/usr/lpp/xlf/bin/default_msg** to a directory that is part of the **NLSPATH** environment-variable setting on the execution system.

Related information: See “Environment variables for national language support” on page 8 and “Selecting the language for runtime messages” on page 44.

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

xlF90_r7: not found
xlF95: not found
xlF95_r: not found

xlF95_r7: not found
xlF: not found
xlF_r: not found

xlF_r7: not found
xlF2003: not found
xlF2003_r: not found
f77: not found
fort77: not found
f90: not found
f95: not found
f2003: not found

Symptom: The shell cannot locate the command to execute the compiler.

Solution: Make sure that your **PATH** environment variable includes the directory **/usr/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

Killed

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, as superuser you can set both your hard and soft limits with these **ksh** commands:

```
ulimit -s unlimited
ulimit -d unlimited
```

Non-superusers are not completely free to give themselves unlimited limits. If you are a superuser, you may find it more convenient to edit the file **/etc/security/limits** 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.a*

[object_name]

Error was: no such file or directory

Solution: Make sure the XL Fortran libraries are installed in **/usr/lib**, or set the **LIBPATH** environment variable to include the directory where **libxlF90.a** is installed if it is in a different directory. See “**LIBPATH: Setting library search paths**” on page 10 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 **smit chlang**.

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 “Portability and migration” on page 69 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 “Editing the default configuration file” on page 14 for 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.  
1501-224 fatal error in /usr/lpp/xlf/bin/xlfentry: signal 9 received.  
1517-011 Compilation ended. No more system resources available.  
Killed.  
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 *AIX General Programming Concepts: Writing and Debugging Programs* 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** or **bind** commands. A frequently encountered error and its solution are listed here for your convenience:

0706-317 ERROR: Undefined or unresolved symbols detected:

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 **-bloodmap** 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.
- Use the linker **-brename** option on the compiler command line to change the names of some symbols at link time.

Fixing runtime 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 runtime options” on page 44 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 **dbx**.

The causes for runtime exceptions are listed in “XL Fortran runtime exceptions” on page 55.

You can investigate errors that occur during the execution of a program by using a symbolic debugger, such as **dbx**.

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 “Portability and migration” on page 69 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

To detect arguments of different sizes or types, which might produce incorrect execution and results, you can compile with the **-qextchk** option. This option warns you of any problems at link time.

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 runtime 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 runtime options” on page 44 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 **ksh**, or through the **smit** command.

Tracebacks and core dumps

If a runtime 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 runtime exceptions” on page 55 for information about the causes of runtime 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:

- “Error checking and debugging” on page 62
- “A Sample dbx session for an XL Fortran program” on page 324

A Sample dbx session for an XL Fortran program

You can debug XL Fortran programs with any **dbx**-compatible symbolic debugger. For background information on **dbx**, see the *AIX General Programming Concepts: Writing and Debugging Programs* document. For information on **dbx** subcommands, see the *AIX Commands Reference, Volumes 1 - 6*.

The following example represents a typical XL Fortran problem that you may be able to resolve through **dbx**. Although it demonstrates only a small subset of **dbx** features and uses memory-allocation techniques made obsolete by Fortran 90/Fortran 95 allocatable arrays, it can serve as an introduction if you have not used this debugger before.

Problem with dynamic memory allocation

The following program tries to allocate an array at run time by using the AIX system subroutine **malloc**. When you use the following command to compile the program and then run the program, the program produces a core dump:

```
xlf95 -qddim testprog.f -o testprog
```

At this point, you may be wondering whether the C **malloc** routine is working correctly or whether this is the right way to allocate an array in a main program when the dimensions are not known until run time.

```
      program main

      pointer(p, array(nvar,nrec))
      real*8 array

      nvar = 2
      nrec = 3
      p = malloc(nvar*nrec*8)

      call test_sub(array, nvar, nrec)

      end

      subroutine test_sub(array, nvar, nrec)

      dimension array(nvar, nrec)

      array(1,1) = 1.
      array(2,1) = 2.
      array(1,2) = 3.
      array(2,2) = 4.
      array(1,3) = 5.
      array(2,3) = 6.

      write(*, 100) array(1,1), array(2,1), array(1,2),
         1          array(2,2), array(1,3), array(2,3)
100    format(//t2,f4.1/t2,f4.1/t2,f4.1/t2,f4.1/t2,f4.1/
         1          t2,f4.1/t2,f4.1)

      return
      end
```

You might go through the debugging process as follows:

1. Compile the program with the **-g** option, to allow debugging under **dbx**:

```
-> xlf95 -qddim -g testprog.f -o testprog
** main    === End of Compilation 1 ===
** test_sub === End of Compilation 2 ===
1501-510  Compilation successful for file testprog.f.
```

2. Run the program to verify the problem and create a core dump:

```
-> testprog
Segmentation fault(coredump)
->
```

3. Find out where in the program the core dump occurs:

```
-> dbx testprog core
Type 'help' for help.
reading symbolic information ...
[using memory image in core]

segmentation violation in test_sub at line 21 in file "testprog.f"
    21          array(1,1) = 1.
(dbx)
```

4. Use the **where** command to get a traceback of the calls that led to that point in the program:

```
(dbx) where
test_sub(array = (...), nvar = warning: Unable to access address 0x200aee94
from core
-1, nrec = warning: Unable to access address 0x200aee98 from core
-1), line 21 in "testprog.f"
main(), line 12 in "testprog.f"
(dbx)
```

main calls **test_sub** at line 12. The warning indicates that a problem occurs while evaluating the arguments for this call.

5. Look at the value of the first argument of the array:

```
(dbx) print array(1,1)
reference through nil pointer
(dbx)
```

This suggests that **array** does not have a value assigned. To verify that possibility, try to look at the address of an element in the array:

```
(dbx) p &array(1,1)
(nil)
(dbx)
```

It seems that XL Fortran has not allocated the space for the array. To verify that it has not, print the value of the pointer that points to the array:

```
(dbx) print p
warning: Unable to access address 0x200aee90 from core
0xffffffff
```

6. To find out what happens to **p** during execution, restart the program and trace the use of **p**:

```
(dbx) stop in main
[1] stop in main
(dbx) run
[1] stopped in main at line 7 in file "testprog.f"
    7          nvar = 2
(dbx) trace p
[3] trace p
(dbx) cont
initially (at line 8 in "testprog.f"): p = nil

segmentation violation in test_sub at line 21 in file "testprog.f"
    21          array(1,1) = 1.
(dbx) p p
nil
(dbx)
```

Because **p** is never set to a valid value, something must be wrong with the line that allocates space for the array:

```
9          p = malloc(nvar*nrec*8)
```

7. The next step is to research why the call to **malloc** does not work. Because **malloc** is a C function, you should read *Interlanguage calls* in the *XL Fortran Optimization and Programming Guide* for background knowledge and specific guidelines.

When you read that section, you find that calls to C functions require arguments to be passed by value, rather than by reference. To fix the problem in this sample program, replace the line:

```
p = malloc(nvar*nrec*8)
```

with the line:

```
p = malloc(%val(nvar*nrec*8))
```

8. Compiling and running the fixed program (**solution.f**) again produces the correct result:

```
-> xlf95 -qddim -g solution.f -o solution
** main   === End of Compilation 1 ===
** test_sub === End of Compilation 2 ===
1501-510  Compilation successful for file solution.f.
-> solution
```

```
1.0
2.0
3.0
4.0
5.0
6.0
```

9. It might be informative to trace the execution of the corrected program:

```
-> dbx solution
Type 'help' for help.
Core file program (testprog) does not match current program (core ignored)
reading symbolic information ...
(dbx) trace p
[1] trace p
(dbx) run
initially (at line 7 in "solution.f"): p = nil
after line 9 in "solution.f": p = 0x200af100
```

```
1.0
2.0
3.0
4.0
5.0
6.0
```

```
execution completed
(dbx)
```

To check whether the values of **p** and **array** are appropriate, turn off the trace:

```
(dbx) status
[1] trace p
(dbx) delete all
(dbx) status
(dbx)
```

Then set new break points and run through the program again. Notice that the address of **array(1,1)** is the same as the contents of **p(0x200af100)**, as expected:

```

(dbx) stop at 9
[11] stop at "solution.f":9
(dbx) run
[11] stopped in main at line 9 in file "solution.f"
     9          p = malloc(%val(nvar*nrec*8))
(dbx) p p
nil
(dbx) next
stopped in main at line 12 in file "solution.f"
     12          call test_sub(array, nvar, nrec)
(dbx) p p
0x200af100 <-----
(dbx)
(dbx) step      /* Notice we use step to step into subroutine test_sub. */
stopped in test_sub at line 21 in file "solution.f"
     21          array(1,1) = 1.
(dbx) p &array(1,1)
0x200af100 <-----
(dbx) next
stopped in test_sub at line 22 in file "solution.f"
     22          array(2,1) = 2.
(dbx) p array(1,1)
1.0
(dbx)

```

Using debug memory routines for XL Fortran

The XL Fortran compiler contains two libraries that are geared to various memory-allocation facilities. These libraries include:

- libhmd.a** A library that provides debug versions of memory-management routines.
- libhm.a** A non-debug library that provides replacement routines for **malloc**, **free**, and so on. These routines are faster than the usual AIX versions. In addition, this library contains a few new library routines to provide additional facilities for memory management and production-level heap error checking.

The library of most interest to Fortran users is **libhmd.a**. See “The libhmd.a library” on page 330 for additional details. If you are installing an application built with these libraries in an environment that does not have XL Fortran installed, you may need to include the library **libhu.a** as well. This is because some routines in **libhmd.a** and **libhm.a** are dependent on routines in **libhu.a**.

The libhm.a library

libhm.a provides fast replacement routines for the following **libc.a** procedures: **malloc**, **calloc**, **realloc**, **free**, **strdup**, **mallopt**, and **mallinfo**. The interfaces to these routines are exactly the same as the interfaces to the standard system routines, so a user need only link in **libhm.a** before the system libraries to make use of them.

In addition, the following library routines that are provided in **libhm.a** are available to Fortran users: **_heapchk** and **_heapset**. These routines provide production-level services that assist in maintaining consistent and correct heap storage.

Note that you cannot use the **-qextname** compiler option with programs that use these facilities. In other words, since these library routines are "system-like" routines that are not Fortran-specific, we do not provide "_" versions of the routines in our library.

The following table describes the additional routines that you can use from **libhm.a**:

C Function prototype	Fortran usage example	Description
int _heapchk(void);	integer(4) _heapchk, retc retc = _heapchk()	Does consistency checking for all allocated and freed objects on the heap. Return values: 0 The heap is consistent. 1 Reserved. 2 Heap errors have occurred.
int _heapset (unsigned int fill);	integer(4) _heapset, retc integer(4) fill /1/ retc = _heapset(%val(fill))	_heapset checks the heap for consistency (similar to _heapchk). It then sets each <i>byte</i> of any non-reserved freed storage to the value of <i>fill</i> . The value of <i>fill</i> must be an integer in the range of 0-255. Using _heapset can help a user locate problems where a program continues to use a freed pointer to an object. Return values: 0 The heap is consistent. 1 Reserved. 2 Heap errors have occurred.

Examples:

Example 1: Using **_heapchk** to test for heap errors

```

program tstheapchk
pointer (p,pbased),(q,qbased)
integer pbased,qbased

integer(4) _heapchk,retcode

p = malloc(%val(4))
pbased = 10

! Decrement the pointer and store into
! memory we do not own.
q = p-4;
qbased = 10

retcode = _heapchk()
if (retcode .ne. 0) call abort()

```


- Memory leak reporting that indicates where the allocation of non-freed storage occurred and that displays partial contents of the area that is not freed.
- Memory error detection that includes:
 - Freeing the same location multiple times
 - Overwriting the end of an allocated object (note that the **-qcheck** compiler option available with XL Fortran already provides much of this functionality)
 - Reading data from or writing data to a freed object
 - Freeing an invalid pointer

You obtain access to this functionality when you link in the **libhmd.a** library prior to the system libraries. References to **malloc**, **realloc**, and **free** can be explicit, or you can obtain heap debugging for memory allocated and deallocated via the **ALLOCATE** and **DEALLOCATE** statements. To obtain source line number information in the output that the debug library produces, you should compile with the **-g** compiler option.

Note that you cannot specify the **-qextname** compiler option with programs that use these facilities.

The following shows the external interface and description of the procedures that are provided. Note that the external interfaces and functionality of **malloc**, **free**, **calloc**, **realloc**, and **strdup** are not shown in this table, since they have not changed.

C Function prototype	Fortran usage example	Description
<pre>void _dump_allocated (int size);</pre>	<pre>integer(4) :: size=4 call _dump_allocated & (%val(size))</pre>	<p>This routine prints information to stderr about each memory block that is currently allocated or was allocated using the debug memory management routines. <i>size</i> indicates how many bytes of each memory block are to be printed, as follows:</p> <p>Negative size All bytes are displayed.</p> <p>0 size No bytes are displayed.</p> <p>Positive size Specified number of bytes are displayed.</p>

C Function prototype	Fortran usage example	Description
<pre>void _dump_allocated_delta (int size);</pre>	<pre>integer(4) :: size=4 call _dump_allocated_delta & (%val(size))</pre>	<p>This routine prints information to stderr about each memory block that is currently allocated or was allocated using the debug memory management routines since the last call to <code>_dump_allocated</code> or <code>_dump_allocated_delta</code>. <i>size</i> indicates how many bytes of each memory block are to be printed, as follows:</p> <p>Negative size All bytes are displayed.</p> <p>0 size No bytes are displayed.</p> <p>Positive size Specified number of bytes are displayed.</p>
<pre>void _heap_check(void);</pre>	<pre>call _heap_check()</pre>	<p>This routine does consistency checking for memory blocks that have been allocated using the debug memory-management routines. It checks that your program has not overwritten freed storage or memory outside the bounds of allocated blocks.</p> <p>All of the debug memory-allocation routines (debug version of malloc, and so on) invoke <code>_heap_check</code> automatically. It may also be invoked explicitly in areas of code where a user believes there may be memory problems.</p> <p>Calling <code>_heap_check</code> frequently can increase the memory requirements and affect the performance of a program. The HD_SKIP environment variable may be used to control how often the debug memory procedures check the heap.</p> <p>Note that the errors are detected when the <code>_heap_check</code> routine is invoked, not at the point of error in the program.</p>

Environment variables

The debug libraries support the following environment variables:

HD_SKIP=increment [,start] Control how often `_heap_check` is invoked from the debug versions of the memory-management routines. *increment* indicates how often you want the debug functions to check the heap. *start* specifies that the skipping of heap checks should begin after the debug memory routines have been

called a certain number of times. The default values for *increment* and *start* are 1 and 0, respectively.

HD_FILL

When this environment variable is exported, the debug versions of *malloc* and *realloc* set the memory allocated to a byte pattern of 0xAA.

HD_STACK=*n*

n specifies how many procedures should appear in the call chain that the debug memory routines produce. The default is 10, or it is the number of routines in the call chain, if fewer than 10.

For example:

```
export HD_SKIP=10
! Every 10th debug memory function calls _heap_check.

export HD_SKIP=100,10
! After 100 calls to debug memory functions, every 10th call
! will result in a call to _heap_check.
```

Examples:

Example 1: Memory leak detection

```
pointer (p,a),(p2,b),(p3,c)           ! 1
character a(4)                        ! 2
integer b,c                            ! 3
! 4
p = malloc(%val(4))                   ! 5
a(1) = 'a'                             ! 6
a(2) = 'b'                             ! 7
a(3) = 'c'                             ! 8
a(4) = 'd'                             ! 9
! 10
p2 = malloc(%val(4))                  ! 11
b = 1                                  ! 12
! 13
call _dump_allocated(%val(4))         ! 14
! 15
p3 = malloc(%val(4))                  ! 16
c = 2                                  ! 17
! 18
call _dump_allocated_delta(%val(4))   ! 19
end                                     ! 20
```

Compile with **-g -lhmd**. The output of the program will be similar to:

Output:

```
1546-515 -----
1546-516                               START OF DUMP OF ALLOCATED MEMORY BLOCKS
1546-515 -----
1546-518 Address: 0x20010C10           Size: 0x00000004 (4)
1546-527 This memory block was (re)allocated at
        _debug_umalloc + 74
        _dbg_umalloc + 18
        _umalloc_init + 4C
        malloc + 38
        main + 18
        [x.f:5]1546-520 Memory contents: 61626364
                               [abcd ]
1546-515 -----
1546-518 Address: 0x2001DC40           Size: 0x00000004 (4)
1546-527 This memory block was (re)allocated at
        _debug_umalloc + 74
```

```

        _dbg_umalloc + 18
        malloc + 38
        _main + 5C          [x.f:11]
1546-520 Memory contents: 00000001          [...]
1546-515 -----
1546-517                      END OF DUMP OF ALLOCATED MEMORY BLOCKS
1546-515 -----
1546-515 -----
1546-526                      START OF DELTA DUMP OF ALLOCATED MEMORY BLOCKS
1546-515 -----
1546-518 Address: 0x2001DC60      Size: 0x00000004 (4)
1546-527 This memory block was (re)allocated at
        _debug_umalloc + 74
        _dbg_umalloc + 18
        malloc + 38
        _main + 84          [x.f:16]
1546-520 Memory contents: 00000002          [...]
1546-515 -----
1546-517                      END OF DUMP OF ALLOCATED MEMORY BLOCKS
1546-515 -----

```

Example 2: Invalid write

```

pointer (p,a)          ! 1
integer a              ! 2
! 3
p = malloc(%val(4))   ! 4
a = 1                  ! 5
p = p + 4              ! 6
a = 2                  ! 7
! 8
call _heap_check()    ! 9
! 10
end                    ! 11

```

Compile with **-g -lhmd**. The output of the program will be similar to:

```

1546-503 End of allocated object 0x20010B80 was overwritten at 0x20010B84.
1546-514 The first eight bytes of the object (in hex) are: 0000000100000002.
1546-527 This memory block was (re)allocated at
        _debug_umalloc + 74
        _dbg_umalloc + 18
        _umalloc_init + 4C
        malloc + 38
        _main + 14          [x.f:4]
1546-522 Traceback:
d60f26c4 = _uheap_check_init + 0x34
d60f2260 = _heap_check + 0x38
100003c8 = _main + 0x54IOT/Abort trap(coredump)

```

Chapter 9. Understanding XL Fortran compiler listings

Diagnostic information is placed in the output listing produced by the **-qlist**, **-qsources**, **-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 “Listings, messages, and compiler information” on page 63.

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,j)
            |          .....a.b.
a - "t.f", line 2.24: 1514-117 (E) Same name appears more than once in an equivalence group.
b - "t.f", line 2.26: 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 File	Source Line	Loop Id	Action / Information
-----	-----	-----	-----
0	4	1	Loop interchanging applied to loop nest.

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 class of the name
 - The type
 - 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 argument
- 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 number of machine instructions that are produced and the total cycle time (straight-line execution time) 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. The table also includes the file creation date and time.

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, virtual CPU time, and a summary of diagnosed conditions. This section is always present in a listing.

Chapter 10. Fortran-Related AIX commands

You can use some AIX commands with XL Fortran files to perform several tasks, as outlined in this section.

Related information: See the *AIX Commands Reference, Volumes 1 - 6* for full details on these commands.

Working with object-code archives (ar)

The **ar** command performs operations on libraries of object files that are used during linking. You might use this command to create a library of support routines that can be linked into many different programs, as follows:

```
ar -q ~/mylibs/libgraphics.a raytrace.o shade.o illuminate.o
xlf95 spheres.f -L~/mylibs/ -lgraphics
```

Printing output files with Fortran ASA carriage controls (asa)

The **asa** command translates the output of Fortran programs that use the historical Fortran convention for ASA carriage-control characters.

The translated output is suitable for the **qprt** command:

```
generate_output | asa | qprt
```

The **fpr** command is the same as the **asa** command.

For a list of supported carriage-control characters, see *Formatted Records* in the *XL Fortran Language Reference*.

Splitting subprograms into individual files (fsplit)

The **fsplit** command splits the specified Fortran source program files into several files. You should only use **fsplit** with FORTRAN 77 programs.

```
$ cat fsplit.f
  subroutine sub1
    print *, 'Hello world'
  end

  subroutine sub2
    print *, 'Goodbye'
  end

  program main
    call sub1
    call sub2
  end
$ fsplit fsplit.f
sub1.f
sub2.f
main.f
```

Automating large, complex compilations (make)

The **make** command allows you to specify rules (sets of commands and options) to use for processing different types of files. By keeping track of which files are out-of-date and need to be recompiled, it can automate some or all aspects of the compilation process.

If you use **make** with XL Fortran, you may not want an object or an executable file created when the compiler encounters errors. The default setting of **-qhalt=s** prevents the compiler from generating the object file if it finds problems that it cannot correct.

Important: If you make any changes to the default configuration file and then move or copy your makefiles to another system, you also need to copy the changed configuration file.

Runtime profiling (prof, gprof)

The **prof** and **gprof** commands provide different levels of runtime profile reports, which you can examine to find performance bottlenecks and identify the subprograms that are called most or least often. This information can help you decide where to concentrate performance-tuning efforts.

See “-p” on page 104 for information on compiling for profiling and an example of the sequence of commands.

The **-qipa** option allows you to feed profiling information back into subsequent compilations to enhance optimization.

Translating programs into RATFOR (struct)

The **struct** command translates a FORTRAN 77 source program into a RATFOR program:

```
struct fortran.f >ratfor.f
```

Displaying information inside binary files (what)

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

- Information about the compiler version is encoded in `/usr/lpp/xlf/bin/xlfentry`.
- Information about the 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.

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 the XL Fortran shared libraries

The runtime libraries included in the XL Fortran Runtime Environment are AIX shared libraries, which are processed by the linker to resolve all references to external names. To minimize naming conflicts between user-defined names and the names that are defined in the runtime libraries, the names of routines in the runtime libraries are prefixed with an underscore (`_`), or `_xl`.

The XL Fortran runtime 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 Runtime 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 Runtime Environment also produces runtime 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 Runtime Environment.

The XL Fortran Runtime Environment is upward-compatible. Programs that are compiled and linked with a given level of the runtime environment and a given

level of the operating system require the same or higher levels of both the runtime environment and the operating system to run.

External names in the runtime environment

Runtime 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 runtime subprograms called by Fortran object code.

The names of these runtime subprograms are external symbols. When object code that is produced by the XL Fortran compiler calls a runtime 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 runtime subprogram call with the subprogram definition.

You should avoid using names in your XL Fortran program that conflict with names of runtime 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`” on page 162, 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. If a program gives unexpected, incorrect, or unacceptable results when compiled with this option, use `-qfloat=hssngl` instead.

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.

Using `-qfloat=hsflt` can show a performance benefit for applications that perform COMPLEX division and floating-point conversions. Additionally, specifying `-qfloat=hsflt` when compiling applications targeting common, POWER, and POWER2 architectures, can achieve a broader range of performance improvements unique to those targets.

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, `POINTERS`, `TARGETS`, 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.

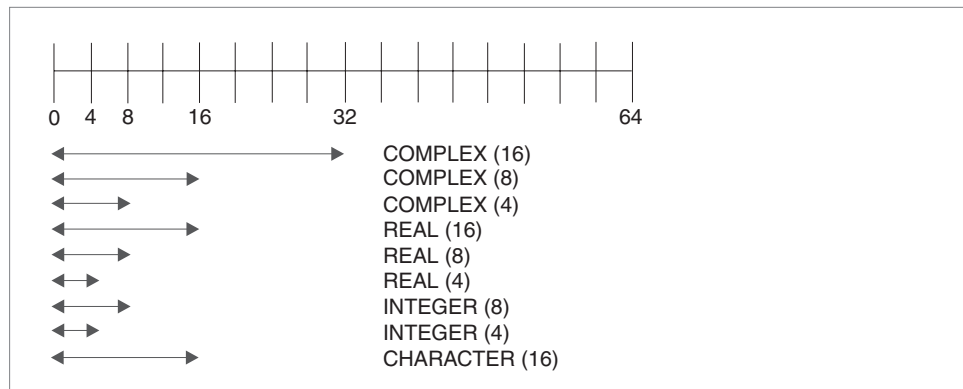


Figure 7. Storage relationships without the -qautodbl option

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
```

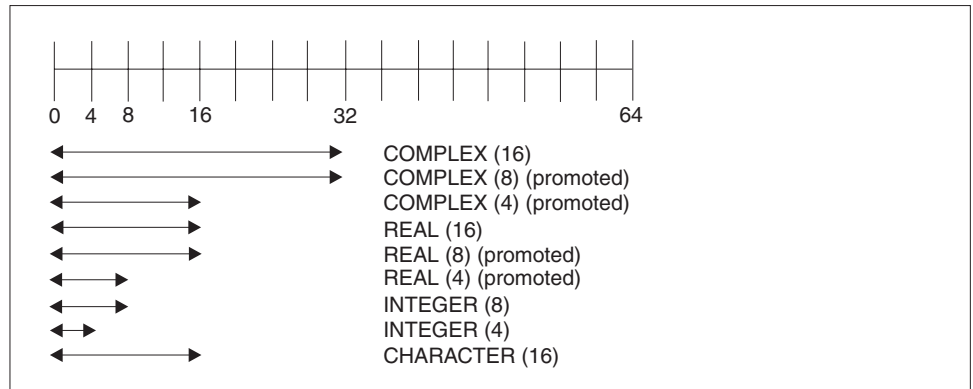


Figure 8. Storage relationships with `-qautodbl=dbl`

```

@process autodbl(db1)
  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

```

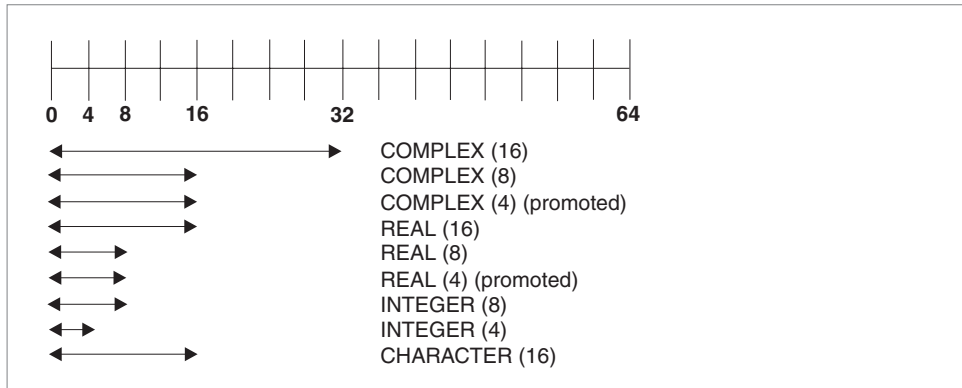


Figure 9. Storage relationships with `-qautobl=dbl4`

```
@process autodb1(db14)
  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
```

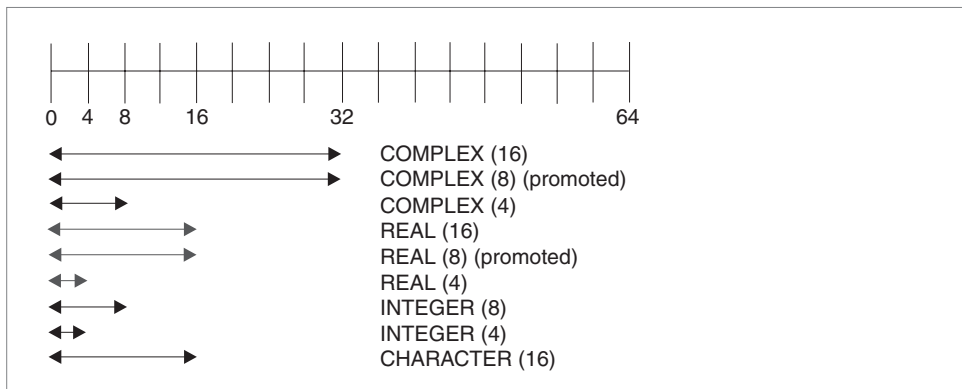


Figure 10. Storage relationships with `-qautodbl=dbl8`

```
@process autodb1(db18)
  complex(8) x16  /(1.123456789123456789d0,2.123456789123456789d0)/
  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 = (1.123456789123456789q0,2.123456789123456789q0)
!
! x8 = upper 8 bytes of r8(1)                ! promotion did not occur
! r8(1) = 1.123456789123456789q0           ! promotion occurred
! r8(2) = 2.123456789123456789q0           ! promotion occurred
end
```

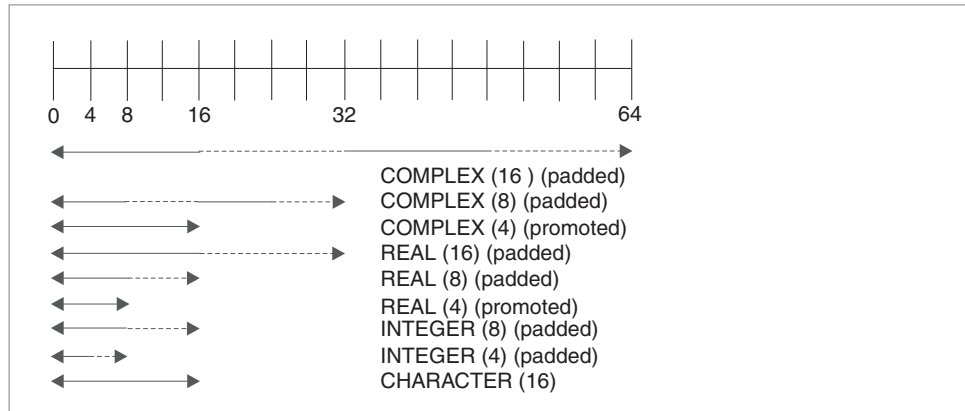


Figure 11. Storage relationships with `-qautodbl=dblpad4`

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
```

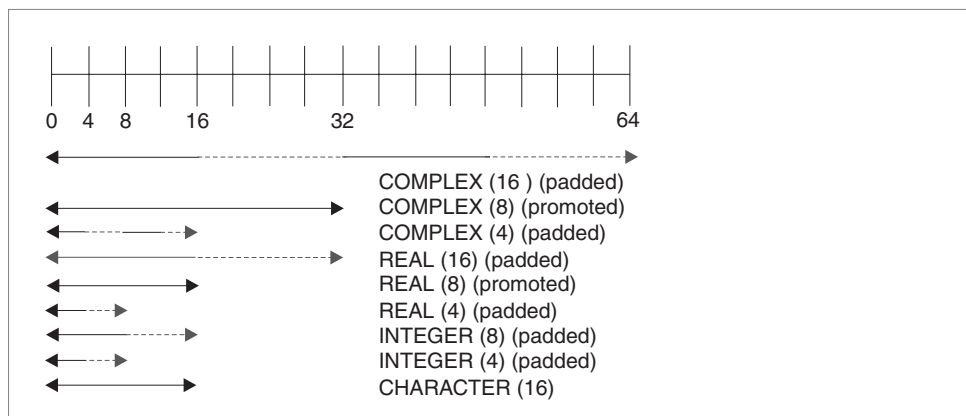


Figure 12. Storage relationships with `-qautodbl=dblpad8`

In the figure above, the dashed lines represent the padding.

```
@process autodbl(dblpad8)
  complex(8) x16 /(1.123456789123456789d0,2.123456789123456789d0)/
  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)
!
! x8 = upper 8 bytes of r8(1) ! promotion occurred
! r8(1) = real(x16) ! padding 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

```

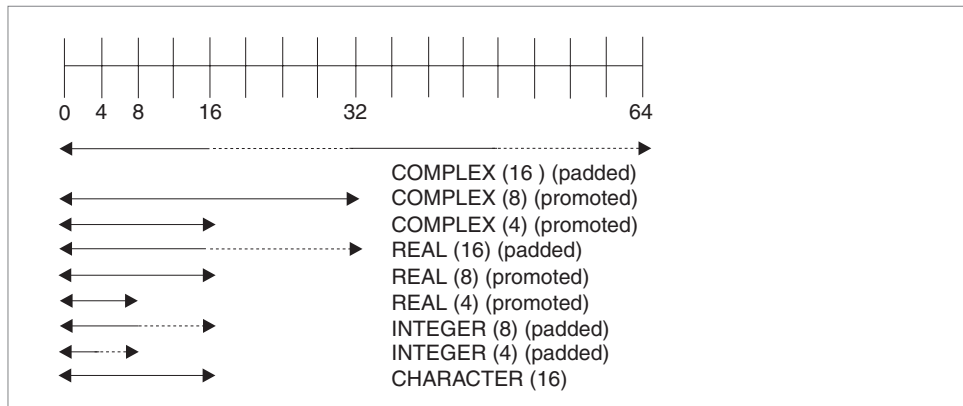


Figure 13. Storage relationships with `-qautodbl=dblpad`

In the figure above, the dashed lines represent the padding.

```

@process autodbl(db1pad)
  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(<i>n</i>) for <i>n</i> = 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 runtime 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 runtime 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	2 000 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 runtime 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 Terminology* web site.

A

abstract interface. An **ABSTRACT INTERFACE** consists of procedure characteristics and names of dummy arguments. Used to declare the interfaces for procedures and deferred bindings.

abstract type. A type that has the **ABSTRACT** attribute. A nonpolymorphic object cannot be declared to be of abstract type. A polymorphic object cannot be constructed or allocated to have a dynamic type that is abstract.

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 a **SELECT TYPE** or **ASSOCIATE** construct is known within the construct.

assumed-size array. A dummy array whose size is assumed from the associated actual argument. Its last upper bound is specified by an asterisk.

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

base type. An extensible type that is not an extension of another type.

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.

binding label. A value of type default character that uniquely identifies how a variable, common block, subroutine, or function is known to a companion processor.

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.

bounds_remapping. Allows a user to view a flat, rank-1 array as a multi-dimensional array.

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.

class. A set of types comprised of a base type and all types extended from it.

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.

component. A constituent of a derived type.

component order. The ordering of the components of a derived type that is used for intrinsic formatted input/output and for structure constructors.

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.

decimal symbol. The symbol that separates the whole and fractional parts of a real number.

declared type. The type that a data entity is declared to have. May differ from the type during execution (the dynamic type) for polymorphic data entities.

default initialization. The initialization of an object with a value specified as part of a derived type definition.

deferred binding . A binding with the **DEFERRED** attribute. A deferred binding can only appear in an abstract 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.

dynamic type. The type of a data entity during execution of a program. The dynamic type of a data entity that is not polymorphic is the same as its declared type.

E

edit descriptor. An abbreviated keyword that controls the formatting of integer, real, or complex data.

effective item . A scalar object resulting from expanding an input/output list.

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.

extended type. An extensible type that is an extension of another type. A type that is declared with the **EXTENDS** attribute.

extensible type. A type from which new types may be derived using the **EXTENDS** attribute. A nonsequence type that does not have the **BIND** attribute.

extension type. A base type is an extension type of itself only. An extended type is an extension type of itself and of all types for which its parent type is an extension.

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*.

final subroutine. A subroutine that is called automatically during finalization.

finalizable. A type that has final subroutines, or that has a finalizable component. An object of finalizable type.

finalization. The process of calling user-defined final subroutines immediately before destroying an object.

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 *nH*, 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.

inherit. To acquire from a parent. Components or procedure bindings of an extended type that are automatically acquired from its parent type without explicit declaration in the extended type are said to be inherited.

inheritance association . The relationship between the inherited components and the parent component in an extended type.

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*, *signaling 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.

parent component. The component of an entity of extended type that corresponds to its inherited portion.

parent type. The extensible type from which an extended type is derived.

passed-object dummy argument . The dummy argument of a type-bound procedure or procedure pointer component that becomes associated with the object through which the procedure was invoked.

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.

polymorphic. Able to be of differing types during program execution. An object declared with the **CLASS** keyword is polymorphic.

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.

procedure binding. See type-bound procedure.

procedure pointer. A procedure entity that has the **EXTERNAL** and **POINTER** attributes. It can be pointer associated with an external procedure, a module procedure, a dummy procedure or another procedure pointer.

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*, *signaling 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 made up of one to 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.

subject. 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.

procedure. A procedure binding in a type definition. The procedure may be referenced by the binding-name via any object of that dynamic type, as a defined operator, by defined assignment, or as part of the finalization process.

type compatible. All entities are type compatible with other entities of the same type. Unlimited polymorphic entities are type compatible with all entities; other polymorphic entities are type compatible with entities whose dynamic type is an extension type of the polymorphic entity's declared type.

type declaration statement. A statement that specifies the type, length, and attributes of an object or function. Objects can be assigned initial values.

type parameter. A parameter of a data type. **KIND** and **LEN** are the type parameters of intrinsic types.

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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