# Using GNU Fortran

For GCC version 4.4.7

(GCC)

The gfortran team

Published by the Free Software Foundation 51 Franklin Street, Fifth Floor Boston, MA 02110-1301, USA

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## 1 Introduction

This manual documents the use of gfortran, the GNU Fortran compiler. You can find in this manual how to invoke gfortran, as well as its features and incompatibilities.

The GNU Fortran compiler front end was designed initially as a free replacement for, or alternative to, the unix f95 command; gfortran is the command you'll use to invoke the compiler.

## 1.1 About GNU Fortran

The GNU Fortran compiler is still in an early state of development. It can generate code for most constructs and expressions, but much work remains to be done.

When the GNU Fortran compiler is finished, it will do everything you expect from any decent compiler:

- Read a user's program, stored in a file and containing instructions written in Fortran 77, Fortran 90, Fortran 95, Fortran 2003 or Fortran 2008. This file contains source code.
- Translate the user's program into instructions a computer can carry out more quickly than it takes to translate the instructions in the first place. The result after compilation of a program is *machine code*, code designed to be efficiently translated and processed by a machine such as your computer. Humans usually aren't as good writing machine code as they are at writing Fortran (or C++, Ada, or Java), because it is easy to make tiny mistakes writing machine code.
- Provide the user with information about the reasons why the compiler is unable to create a binary from the source code. Usually this will be the case if the source code is flawed. The Fortran 90 standard requires that the compiler can point out mistakes to the user. An incorrect usage of the language causes an error message.
  - The compiler will also attempt to diagnose cases where the user's program contains a correct usage of the language, but instructs the computer to do something questionable. This kind of diagnostics message is called a warning message.
- Provide optional information about the translation passes from the source code to machine code. This can help a user of the compiler to find the cause of certain bugs which may not be obvious in the source code, but may be more easily found at a lower level compiler output. It also helps developers to find bugs in the compiler itself.
- Provide information in the generated machine code that can make it easier to find bugs in the program (using a debugging tool, called a *debugger*, such as the GNU Debugger gdb).
- Locate and gather machine code already generated to perform actions requested by statements in the user's program. This machine code is organized into *modules* and is located and *linked* to the user program.

The GNU Fortran compiler consists of several components:

• A version of the gcc command (which also might be installed as the system's cc command) that also understands and accepts Fortran source code. The gcc command is the *driver* program for all the languages in the GNU Compiler Collection (GCC); With

gcc, you can compile the source code of any language for which a front end is available in GCC.

- The gfortran command itself, which also might be installed as the system's f95 command. gfortran is just another driver program, but specifically for the Fortran compiler only. The difference with gcc is that gfortran will automatically link the correct libraries to your program.
- A collection of run-time libraries. These libraries contain the machine code needed to support capabilities of the Fortran language that are not directly provided by the machine code generated by the gfortran compilation phase, such as intrinsic functions and subroutines, and routines for interaction with files and the operating system.
- The Fortran compiler itself, (f951). This is the GNU Fortran parser and code generator, linked to and interfaced with the GCC backend library. f951 "translates" the source code to assembler code. You would typically not use this program directly; instead, the gcc or gfortran driver programs will call it for you.

## 1.2 GNU Fortran and GCC

GNU Fortran is a part of GCC, the *GNU Compiler Collection*. GCC consists of a collection of front ends for various languages, which translate the source code into a language-independent form called *GENERIC*. This is then processed by a common middle end which provides optimization, and then passed to one of a collection of back ends which generate code for different computer architectures and operating systems.

Functionally, this is implemented with a driver program (gcc) which provides the command-line interface for the compiler. It calls the relevant compiler front-end program (e.g., f951 for Fortran) for each file in the source code, and then calls the assembler and linker as appropriate to produce the compiled output. In a copy of GCC which has been compiled with Fortran language support enabled, gcc will recognize files with '.f', '.for', '.ftn', '.f90', '.f95', '.f03' and '.f08' extensions as Fortran source code, and compile it accordingly. A gfortran driver program is also provided, which is identical to gcc except that it automatically links the Fortran runtime libraries into the compiled program.

Source files with '.f', '.for', '.fpp', '.ftn', '.F', '.FOR', '.FPP', and '.FTN' extensions are treated as fixed form. Source files with '.f90', '.f95', '.f03', '.f08', '.F90', '.F95', '.F03' and '.F08' extensions are treated as free form. The capitalized versions of either form are run through preprocessing. Source files with the lower case '.fpp' extension are also run through preprocessing.

This manual specifically documents the Fortran front end, which handles the programming language's syntax and semantics. The aspects of GCC which relate to the optimization passes and the back-end code generation are documented in the GCC manual; see Section "Introduction" in *Using the GNU Compiler Collection (GCC)*. The two manuals together provide a complete reference for the GNU Fortran compiler.

## 1.3 Preprocessing and conditional compilation

Many Fortran compilers including GNU Fortran allow passing the source code through a C preprocessor (CPP; sometimes also called the Fortran preprocessor, FPP) to allow for conditional compilation. In the case of GNU Fortran, this is the GNU C Preprocessor

in the traditional mode. On systems with case-preserving file names, the preprocessor is automatically invoked if the filename extension is .F, .FOR, .FTN, .fpp, .FPP, .F90, .F95, .F03 or .F08. To manually invoke the preprocessor on any file, use '-cpp', to disable preprocessing on files where the preprocessor is run automatically, use '-nocpp'.

If a preprocessed file includes another file with the Fortran INCLUDE statement, the included file is not preprocessed. To preprocess included files, use the equivalent preprocessor statement #include.

If GNU Fortran invokes the preprocessor, \_\_GFORTRAN\_\_ is defined and \_\_GNUC\_\_, \_ \_GNUC\_MINOR\_\_ and \_\_GNUC\_PATCHLEVEL\_\_ can be used to determine the version of the compiler. See Section "Overview" in *The C Preprocessor* for details.

While CPP is the de-facto standard for preprocessing Fortran code, Part 3 of the Fortran 95 standard (ISO/IEC 1539-3:1998) defines Conditional Compilation, which is not widely used and not directly supported by the GNU Fortran compiler. You can use the program coco to preprocess such files (http://users.erols.com/dnagle/coco.html).

## 1.4 GNU Fortran and G77

The GNU Fortran compiler is the successor to g77, the Fortran 77 front end included in GCC prior to version 4. It is an entirely new program that has been designed to provide Fortran 95 support and extensibility for future Fortran language standards, as well as providing backwards compatibility for Fortran 77 and nearly all of the GNU language extensions supported by g77.

## 1.5 Project Status

As soon as gfortran can parse all of the statements correctly, it will be in the "larva" state. When we generate code, the "puppa" state. When gfortran is done, we'll see if it will be a beautiful butterfly, or just a big bug....

-Andy Vaught, April 2000

The start of the GNU Fortran 95 project was announced on the GCC homepage in March 18, 2000 (even though Andy had already been working on it for a while, of course).

The GNU Fortran compiler is able to compile nearly all standard-compliant Fortran 95, Fortran 90, and Fortran 77 programs, including a number of standard and non-standard extensions, and can be used on real-world programs. In particular, the supported extensions include OpenMP, Cray-style pointers, and several Fortran 2003 and Fortran 2008 features such as enumeration, stream I/O, and some of the enhancements to allocatable array support from TR 15581. However, it is still under development and has a few remaining rough edges.

At present, the GNU Fortran compiler passes the NIST Fortran 77 Test Suite, and produces acceptable results on the LAPACK Test Suite. It also provides respectable performance on the Polyhedron Fortran compiler benchmarks and the Livermore Fortran Kernels test. It has been used to compile a number of large real-world programs, including the HIRLAM weather-forecasting code and the Tonto quantum chemistry package; see http://gcc.gnu.org/wiki/GfortranApps for an extended list.

Among other things, the GNU Fortran compiler is intended as a replacement for G77. At this point, nearly all programs that could be compiled with G77 can be compiled with GNU Fortran, although there are a few minor known regressions.

The primary work remaining to be done on GNU Fortran falls into three categories: bug fixing (primarily regarding the treatment of invalid code and providing useful error messages), improving the compiler optimizations and the performance of compiled code, and extending the compiler to support future standards—in particular, Fortran 2003.

## 1.6 Standards

The GNU Fortran compiler implements ISO/IEC 1539:1997 (Fortran 95). As such, it can also compile essentially all standard-compliant Fortran 90 and Fortran 77 programs. It also supports the ISO/IEC TR-15581 enhancements to allocatable arrays, and the OpenMP Application Program Interface v2.5 specification.

In the future, the GNU Fortran compiler will also support ISO/IEC 1539-1:2004 (Fortran 2003) and future Fortran standards. Partial support of that standard is already provided; the current status of Fortran 2003 support is reported in the Section 4.1 [Fortran 2003 status], page 29 section of the documentation.

The next version of the Fortran standard after Fortran 2003 is currently being developed and the GNU Fortran compiler supports some of its new features. This support is based on the latest draft of the standard (available from http://www.nag.co.uk/sc22wg5/) and no guarantee of future compatibility is made, as the final standard might differ from the draft. For more information, see the Section 4.2 [Fortran 2008 status], page 29 section.

# Part I: Invoking GNU Fortran

# 2 GNU Fortran Command Options

The gfortran command supports all the options supported by the gcc command. Only options specific to GNU Fortran are documented here.

See Section "GCC Command Options" in *Using the GNU Compiler Collection (GCC)*, for information on the non-Fortran-specific aspects of the gcc command (and, therefore, the gfortran command).

All GCC and GNU Fortran options are accepted both by gfortran and by gcc (as well as any other drivers built at the same time, such as g++), since adding GNU Fortran to the GCC distribution enables acceptance of GNU Fortran options by all of the relevant drivers.

In some cases, options have positive and negative forms; the negative form of '-ffoo' would be '-fno-foo'. This manual documents only one of these two forms, whichever one is not the default.

## 2.1 Option summary

Here is a summary of all the options specific to GNU Fortran, grouped by type. Explanations are in the following sections.

Fortran Language Options

```
See Section 2.2 [Options controlling Fortran dialect], page 8.
```

```
-fall-intrinsics -ffree-form -fno-fixed-form
-fdollar-ok -fimplicit-none -fmax-identifier-length
-std=std -fd-lines-as-code -fd-lines-as-comments
-ffixed-line-length-n -ffixed-line-length-none
-ffree-line-length-n -ffree-line-length-none
-fdefault-double-8 -fdefault-integer-8 -fdefault-real-8
-fcray-pointer -fopenmp -fno-range-check -fbackslash -fmodule-private
```

Preprocessing Options

See Section 2.3 [Enable and customize preprocessing], page 10.

```
-cpp -dD -dI -dM -dN -dU -fworking-directory -imultilib dir -iprefix file -isysroot dir -iquote -isystem dir -nocpp -nostdinc -undef -Aquestion=answer -A-question[=answer] -C -CC -Dmacro[=defn] -Umacro -H -P
```

Error and Warning Options

See Section 2.4 [Options to request or suppress errors and warnings], page 13.

```
-fmax-errors=n
-fsyntax-only -pedantic -pedantic-errors
-Wall -Waliasing -Wampersand -Warray-bounds -Wcharacter-truncation
-Wconversion -Wimplicit-interface -Wline-truncation -Wintrinsics-std
-Wsurprising -Wno-tabs -Wunderflow -Wunused-parameter -Wintrinsics-shadow
-Wno-align-commons
```

Debugging Options

See Section 2.5 [Options for debugging your program or GNU Fortran], page 16.

```
\begin{tabular}{ll} -f dump-parse-tree & -f fpe-trap=$list$\\ -f dump-core & -f backtrace \end{tabular}
```

Directory Options

See Section 2.6 [Options for directory search], page 17.

```
-Idir -Jdir -fintrinsic-modules-path dir
```

## Link Options

See Section 2.7 [Options for influencing the linking step], page 17.
-static-libgfortran

### Runtime Options

See Section 2.8 [Options for influencing runtime behavior], page 17.

-fconvert=conversion -fno-range-check -frecord-marker=length -fmax-subrecord-length=length -fsign-zero

## Code Generation Options

See Section 2.9 [Options for code generation conventions], page 18.

```
-fno-automatic -ff2c -fno-underscoring
-fsecond-underscore
-fbounds-check -fcheck-array-temporaries -fmax-array-constructor =n
-fmax-stack-var-size=n
-fpack-derived -frepack-arrays -fshort-enums -fexternal-blas
-fblas-matmul-limit=n -frecursive -finit-local-zero
-finit-integer=n -finit-real=<zero|inf|-inf|nan>
-finit-logical=<true|false> -finit-character=n -fno-align-commons
```

## 2.2 Options controlling Fortran dialect

The following options control the details of the Fortran dialect accepted by the compiler:

- -ffree-form
- -ffixed-form

Specify the layout used by the source file. The free form layout was introduced in Fortran 90. Fixed form was traditionally used in older Fortran programs. When neither option is specified, the source form is determined by the file extension.

### -fall-intrinsics

This option causes all intrinsic procedures (including the GNU-specific extensions) to be accepted. This can be useful with '-std=f95' to force standard-compliance but get access to the full range of intrinsics available with gfortran. As a consequence, '-Wintrinsics-std' will be ignored and no user-defined procedure with the same name as any intrinsic will be called except when it is explicitly declared EXTERNAL.

## -fd-lines-as-code

#### -fd-lines-as-comments

Enable special treatment for lines beginning with d or D in fixed form sources. If the '-fd-lines-as-code' option is given they are treated as if the first column contained a blank. If the '-fd-lines-as-comments' option is given, they are treated as comment lines.

## -fdefault-double-8

Set the DOUBLE PRECISION type to an 8 byte wide type. If '-fdefault-real-8' is given, DOUBLE PRECISION would instead be promoted to 16 bytes if possible, and '-fdefault-double-8' can be used to prevent this. The kind of real constants like 1.d0 will not be changed by '-fdefault-real-8' though, so also '-fdefault-double-8' does not affect it.

## -fdefault-integer-8

Set the default integer and logical types to an 8 byte wide type. Do nothing if this is already the default. This option also affects the kind of integer constants like 42.

### -fdefault-real-8

Set the default real type to an 8 byte wide type. Do nothing if this is already the default. This option also affects the kind of non-double real constants like 1.0, and does promote the default width of DOUBLE PRECISION to 16 bytes if possible, unless -fdefault-double-8 is given, too.

#### -fdollar-ok

Allow '\$' as a valid character in a symbol name.

#### -fbackslash

Change the interpretation of backslashes in string literals from a single backslash character to "C-style" escape characters. The following combinations are expanded  $\a$ ,  $\b$ ,  $\f$ ,  $\n$ ,  $\r$ ,  $\t$ ,  $\n$ ,  $\r$ ,  $\t$ ,  $\n$ ,

## -fmodule-private

Set the default accessibility of module entities to PRIVATE. Use-associated entities will not be accessible unless they are explicitly declared as PUBLIC.

## -ffixed-line-length-n

Set column after which characters are ignored in typical fixed-form lines in the source file, and through which spaces are assumed (as if padded to that length) after the ends of short fixed-form lines.

Popular values for *n* include 72 (the standard and the default), 80 (card image), and 132 (corresponding to "extended-source" options in some popular compilers). *n* may also be 'none', meaning that the entire line is meaningful and that continued character constants never have implicit spaces appended to them to fill out the line. '-ffixed-line-length-0' means the same thing as '-ffixed-line-length-none'.

#### -ffree-line-length-n

Set column after which characters are ignored in typical free-form lines in the source file. The default value is 132. n may be 'none', meaning that the entire line is meaningful. '-ffree-line-length-0' means the same thing as '-ffree-line-length-none'.

## -fmax-identifier-length=n

Specify the maximum allowed identifier length. Typical values are 31 (Fortran 95) and 63 (Fortran 2003 and Fortran 2008).

## -fimplicit-none

Specify that no implicit typing is allowed, unless overridden by explicit IMPLICIT statements. This is the equivalent of adding implicit none to the start of every procedure.

## -fcray-pointer

Enable the Cray pointer extension, which provides C-like pointer functionality.

-fopenmp Enable the OpenMP extensions. This includes OpenMP !\$omp directives in free form and c\$omp, \*\$omp and !\$omp directives in fixed form, !\$ conditional compilation sentinels in free form and c\$, \*\$ and !\$ sentinels in fixed form, and when linking arranges for the OpenMP runtime library to be linked in. The option '-fopenmp' implies '-frecursive'.

## -fno-range-check

Disable range checking on results of simplification of constant expressions during compilation. For example, GNU Fortran will give an error at compile time when simplifying a = 1. / 0. With this option, no error will be given and a will be assigned the value +Infinity. If an expression evaluates to a value outside of the relevant range of [-HUGE():HUGE()], then the expression will be replaced by -Inf or +Inf as appropriate. Similarly, DATA i/Z'FFFFFFF'/ will result in an integer overflow on most systems, but with '-fno-range-check' the value will "wrap around" and i will be initialized to -1 instead.

-std=std Specify the standard to which the program is expected to conform, which may be one of 'f95', 'f2003', 'f2008', 'gnu', or 'legacy'. The default value for std is 'gnu', which specifies a superset of the Fortran 95 standard that includes all of the extensions supported by GNU Fortran, although warnings will be given for obsolete extensions not recommended for use in new code. The 'legacy' value is equivalent but without the warnings for obsolete extensions, and may be useful for old non-standard programs. The 'f95', 'f2003' and 'f2008' values specify strict conformance to the Fortran 95, Fortran 2003 and Fortran 2008 standards, respectively; errors are given for all extensions beyond the relevant language standard, and warnings are given for the Fortran 77 features that are permitted but obsolescent in later standards.

## 2.3 Enable and customize preprocessing

Preprocessor related options. See section Section 1.3 [Preprocessing and conditional compilation], page 2 for more detailed information on preprocessing in gfortran.

-cpp

-nocpp

Enable preprocessing. The preprocessor is automatically invoked if the file extension is '.fpp', '.FPP', '.F', '.FOR', '.FTN', '.F90', '.F95', '.F03' or '.F08'. Use this option to manually enable preprocessing of any kind of Fortran file.

To disable preprocessing of files with any of the above listed extensions, use the negative form: '-nocpp'.

The preprocessor is run in traditional mode, be aware that any restrictions of the file-format, e.g. fixed-form line width, apply for preprocessed output as well. -dM Instead of the normal output, generate a list of '#define' directives for all the macros defined during the execution of the preprocessor, including predefined macros. This gives you a way of finding out what is predefined in your version of the preprocessor. Assuming you have no file 'foo.f90', the command

touch foo.f90; gfortran -cpp -dM foo.f90

will show all the predefined macros.

- -dD Like '-dM' except in two respects: it does not include the predefined macros, and it outputs both the #define directives and the result of preprocessing. Both kinds of output go to the standard output file.
- -dN Like '-dD', but emit only the macro names, not their expansions.
- -dU Like 'dD' except that only macros that are expanded, or whose definedness is tested in preprocessor directives, are output; the output is delayed until the use or test of the macro; and '#undef' directives are also output for macros tested but undefined at the time.
- -dI Output '#include' directives in addition to the result of preprocessing.

## -fworking-directory

Enable generation of linemarkers in the preprocessor output that will let the compiler know the current working directory at the time of preprocessing. When this option is enabled, the preprocessor will emit, after the initial linemarker, a second linemarker with the current working directory followed by two slashes. GCC will use this directory, when it's present in the preprocessed input, as the directory emitted as the current working directory in some debugging information formats. This option is implicitly enabled if debugging information is enabled, but this can be inhibited with the negated form '-fno-working-directory'. If the '-P' flag is present in the command line, this option has no effect, since no #line directives are emitted whatsoever.

#### -idirafter dir

Search *dir* for include files, but do it after all directories specified with '-I' and the standard system directories have been exhausted. *dir* is treated as a system include directory. If dir begins with =, then the = will be replaced by the sysroot prefix; see '--sysroot' and '-isysroot'.

## -imultilib dir

Use dir as a subdirectory of the directory containing target-specific C++ headers.

## -iprefix prefix

Specify *prefix* as the prefix for subsequent '-iwithprefix' options. If the *prefix* represents a directory, you should include the final '/'.

## -isysroot dir

This option is like the '--sysroot' option, but applies only to header files. See the '--sysroot' option for more information.

## -iquote dir

Search dir only for header files requested with #include "file"; they are not searched for #include <file>, before all directories specified by '-I' and before

the standard system directories. If *dir* begins with =, then the = will be replaced by the sysroot prefix; see '--sysroot' and '-isysroot'.

## -isystem dir

Search *dir* for header files, after all directories specified by '-I' but before the standard system directories. Mark it as a system directory, so that it gets the same special treatment as is applied to the standard system directories. If *dir* begins with =, then the = will be replaced by the sysroot prefix; see '--sysroot' and '-isysroot'.

#### -nostdinc

Do not search the standard system directories for header files. Only the directories you have specified with '-I' options (and the directory of the current file, if appropriate) are searched.

-undef Do not predefine any system-specific or GCC-specific macros. The standard predefined macros remain defined.

## -Apredicate=answer

Make an assertion with the predicate *predicate* and answer answer. This form is preferred to the older form -A predicate(answer), which is still supported, because it does not use shell special characters.

## -A-predicate=answer

Cancel an assertion with the predicate predicate and answer answer.

-C Do not discard comments. All comments are passed through to the output file, except for comments in processed directives, which are deleted along with the directive.

You should be prepared for side effects when using '-C'; it causes the preprocessor to treat comments as tokens in their own right. For example, comments appearing at the start of what would be a directive line have the effect of turning that line into an ordinary source line, since the first token on the line is no longer a '#'.

Warning: this currently handles C-Style comments only. The preprocessor does not yet recognize Fortran-style comments.

-CC Do not discard comments, including during macro expansion. This is like '-C', except that comments contained within macros are also passed through to the output file where the macro is expanded.

In addition to the side-effects of the '-C' option, the '-CC' option causes all C++-style comments inside a macro to be converted to C-style comments. This is to prevent later use of that macro from inadvertently commenting out the remainder of the source line. The '-CC' option is generally used to support lint comments.

Warning: this currently handles C- and C++-Style comments only. The preprocessor does not yet recognize Fortran-style comments.

-Dname Predefine name as a macro, with definition 1.

## -Dname=definition

The contents of *definition* are tokenized and processed as if they appeared during translation phase three in a '#define' directive. In particular, the definition will be truncated by embedded newline characters.

If you are invoking the preprocessor from a shell or shell-like program you may need to use the shell's quoting syntax to protect characters such as spaces that have a meaning in the shell syntax.

If you wish to define a function-like macro on the command line, write its argument list with surrounding parentheses before the equals sign (if any). Parentheses are meaningful to most shells, so you will need to quote the option. With sh and csh, -D'name(args...)=definition' works.

'-D' and '-U' options are processed in the order they are given on the command line. All -imacros file and -include file options are processed after all -D and -U options.

- -H Print the name of each header file used, in addition to other normal activities. Each name is indented to show how deep in the '#include' stack it is.
- -P Inhibit generation of linemarkers in the output from the preprocessor. This might be useful when running the preprocessor on something that is not C code, and will be sent to a program which might be confused by the linemarkers.
- -Uname Cancel any previous definition of name, either built in or provided with a '-D' option.

## 2.4 Options to request or suppress errors and warnings

Errors are diagnostic messages that report that the GNU Fortran compiler cannot compile the relevant piece of source code. The compiler will continue to process the program in an attempt to report further errors to aid in debugging, but will not produce any compiled output.

Warnings are diagnostic messages that report constructions which are not inherently erroneous but which are risky or suggest there is likely to be a bug in the program. Unless '-Werror' is specified, they do not prevent compilation of the program.

You can request many specific warnings with options beginning '-W', for example '-Wimplicit' to request warnings on implicit declarations. Each of these specific warning options also has a negative form beginning '-Wno-' to turn off warnings; for example, '-Wno-implicit'. This manual lists only one of the two forms, whichever is not the default.

These options control the amount and kinds of errors and warnings produced by GNU Fortran:

## -fmax-errors=n

Limits the maximum number of error messages to n, at which point GNU Fortran bails out rather than attempting to continue processing the source code. If n is 0, there is no limit on the number of error messages produced.

## -fsyntax-only

Check the code for syntax errors, but don't actually compile it. This will generate module files for each module present in the code, but no other output file.

### -pedantic

Issue warnings for uses of extensions to Fortran 95. '-pedantic' also applies to C-language constructs where they occur in GNU Fortran source files, such as use of '\e' in a character constant within a directive like #include.

Valid Fortran 95 programs should compile properly with or without this option. However, without this option, certain GNU extensions and traditional Fortran features are supported as well. With this option, many of them are rejected.

Some users try to use '-pedantic' to check programs for conformance. They soon find that it does not do quite what they want—it finds some nonstandard practices, but not all. However, improvements to GNU Fortran in this area are welcome.

This should be used in conjunction with '-std=f95', '-std=f2003' or '-std=f2008'.

## -pedantic-errors

Like '-pedantic', except that errors are produced rather than warnings.

-Wall Enables commonly used warning options pertaining to usage that we recommend avoiding and that we believe are easy to avoid. This currently includes '-Waliasing', '-Wampersand', '-Wsurprising', '-Wintrinsics-std', '-Wno-tabs', '-Wintrinsic-shadow' and '-Wline-truncation'.

## -Waliasing

Warn about possible aliasing of dummy arguments. Specifically, it warns if the same actual argument is associated with a dummy argument with INTENT(IN) and a dummy argument with INTENT(OUT) in a call with an explicit interface.

The following example will trigger the warning.

```
interface
  subroutine bar(a,b)
    integer, intent(in) :: a
    integer, intent(out) :: b
  end subroutine
end interface
integer :: a

call bar(a,a)
```

#### -Wampersand

Warn about missing ampersand in continued character constants. The warning is given with '-Wampersand', '-pedantic', '-std=f95', '-std=f2003' and '-std=f2008'. Note: With no ampersand given in a continued character constant, GNU Fortran assumes continuation at the first non-comment, non-whitespace character after the ampersand that initiated the continuation.

## -Warray-temporaries

Warn about array temporaries generated by the compiler. The information generated by this warning is sometimes useful in optimization, in order to avoid such temporaries.

#### -Wcharacter-truncation

Warn when a character assignment will truncate the assigned string.

#### -Wline-truncation

Warn when a source code line will be truncated.

## -Wconversion

Warn about implicit conversions between different types.

## -Wimplicit-interface

Warn if a procedure is called without an explicit interface. Note this only checks that an explicit interface is present. It does not check that the declared interfaces are consistent across program units.

#### -Wintrinsics-std

Warn if gfortran finds a procedure named like an intrinsic not available in the currently selected standard (with '-std') and treats it as EXTERNAL procedure because of this. '-fall-intrinsics' can be used to never trigger this behaviour and always link to the intrinsic regardless of the selected standard.

## -Wsurprising

Produce a warning when "suspicious" code constructs are encountered. While technically legal these usually indicate that an error has been made.

This currently produces a warning under the following circumstances:

- An INTEGER SELECT construct has a CASE that can never be matched as its lower value is greater than its upper value.
- A LOGICAL SELECT construct has three CASE statements.
- A TRANSFER specifies a source that is shorter than the destination.
- The type of a function result is declared more than once with the same type. If '-pedantic' or standard-conforming mode is enabled, this is an error.

## -Wtabs

By default, tabs are accepted as whitespace, but tabs are not members of the Fortran Character Set. For continuation lines, a tab followed by a digit between 1 and 9 is supported. '-Wno-tabs' will cause a warning to be issued if a tab is encountered. Note, '-Wno-tabs' is active for '-pedantic', '-std=f95', '-std=f2003', '-std=f2008' and '-Wall'.

### -Wunderflow

Produce a warning when numerical constant expressions are encountered, which yield an UNDERFLOW during compilation.

#### -Wintrinsic-shadow

Warn if a user-defined procedure or module procedure has the same name as an intrinsic; in this case, an explicit interface or EXTERNAL or INTRINSIC declaration might be needed to get calls later resolved to the desired intrinsic/procedure.

## -Wunused-parameter

Contrary to gcc's meaning of '-Wunused-parameter', gfortran's implementation of this option does not warn about unused dummy arguments, but about unused PARAMETER values. '-Wunused-parameter' is not included in '-Wall' but is implied by '-Wall -Wextra'.

## -Walign-commons

By default, gfortran warns about any occasion of variables being padded for proper alignment inside a COMMON block. This warning can be turned off via '-Wno-align-commons'. See also '-falign-commons'.

-Werror Turns all warnings into errors.

See Section "Options to Request or Suppress Errors and Warnings" in *Using the GNU Compiler Collection (GCC)*, for information on more options offered by the GBE shared by gfortran, gcc and other GNU compilers.

Some of these have no effect when compiling programs written in Fortran.

# 2.5 Options for debugging your program or GNU Fortran

GNU Fortran has various special options that are used for debugging either your program or the GNU Fortran compiler.

## -fdump-parse-tree

Output the internal parse tree before starting code generation. Only really useful for debugging the GNU Fortran compiler itself.

## -ffpe-trap=list

Specify a list of IEEE exceptions when a Floating Point Exception (FPE) should be raised. On most systems, this will result in a SIGFPE signal being sent and the program being interrupted, producing a core file useful for debugging. *list* is a (possibly empty) comma-separated list of the following IEEE exceptions: 'invalid' (invalid floating point operation, such as SQRT(-1.0)), 'zero' (division by zero), 'overflow' (overflow in a floating point operation), 'underflow' (underflow in a floating point operation), 'precision' (loss of precision during operation) and 'denormal' (operation produced a denormal value).

Some of the routines in the Fortran runtime library, like 'CPU\_TIME', are likely to trigger floating point exceptions when ffpe-trap=precision is used. For this reason, the use of ffpe-trap=precision is not recommended.

#### -fbacktrace

Specify that, when a runtime error is encountered or a deadly signal is emitted (segmentation fault, illegal instruction, bus error or floating-point exception), the Fortran runtime library should output a backtrace of the error. This option only has influence for compilation of the Fortran main program.

## -fdump-core

Request that a core-dump file is written to disk when a runtime error is encountered on systems that support core dumps. This option is only effective for the compilation of the Fortran main program.

See Section "Options for Debugging Your Program or GCC" in *Using the GNU Compiler Collection (GCC)*, for more information on debugging options.

## 2.6 Options for directory search

These options affect how GNU Fortran searches for files specified by the INCLUDE directive and where it searches for previously compiled modules.

It also affects the search paths used by cpp when used to preprocess Fortran source.

These affect interpretation of the INCLUDE directive (as well as of the #include directive of the cpp preprocessor).

Also note that the general behavior of '-I' and INCLUDE is pretty much the same as of '-I' with #include in the cpp preprocessor, with regard to looking for 'header.gcc' files and other such things.

This path is also used to search for '.mod' files when previously compiled modules are required by a USE statement.

See Section "Options for Directory Search" in *Using the GNU Compiler Collection (GCC)*, for information on the '-I' option.

-Jdir This option specifies where to put '.mod' files for compiled modules. It is also added to the list of directories to searched by an USE statement.

The default is the current directory.

## -fintrinsic-modules-path dir

This option specifies the location of pre-compiled intrinsic modules, if they are not in the default location expected by the compiler.

## 2.7 Influencing the linking step

These options come into play when the compiler links object files into an executable output file. They are meaningless if the compiler is not doing a link step.

## -static-libgfortran

On systems that provide 'libgfortran' as a shared and a static library, this option forces the use of the static version. If no shared version of 'libgfortran' was built when the compiler was configured, this option has no effect.

## 2.8 Influencing runtime behavior

These options affect the runtime behavior of programs compiled with GNU Fortran.

## -fconvert=conversion

Specify the representation of data for unformatted files. Valid values for conversion are: 'native', the default; 'swap', swap between big- and little-endian; 'big-endian', use big-endian representation for unformatted files; 'little-endian', use little-endian representation for unformatted files.

This option has an effect only when used in the main program. The CONVERT specifier and the GFORTRAN\_CONVERT\_UNIT environment variable override the default specified by '-fconvert'.

## -fno-range-check

Disable range checking of input values during integer READ operations. For example, GNU Fortran will give an error if an input value is outside of the relevant range of [-HUGE():HUGE()]. In other words, with INTEGER (kind=4) :: i, attempting to read -2147483648 will give an error unless '-fno-range-check' is given.

## -frecord-marker=length

Specify the length of record markers for unformatted files. Valid values for length are 4 and 8. Default is 4. This is different from previous versions of gfortran, which specified a default record marker length of 8 on most systems. If you want to read or write files compatible with earlier versions of gfortran, use '-frecord-marker=8'.

## -fmax-subrecord-length=length

Specify the maximum length for a subrecord. The maximum permitted value for length is 2147483639, which is also the default. Only really useful for use by the gfortran testsuite.

## -fsign-zero

When writing zero values, show the negative sign if the sign bit is set. fno-sign-zero does not print the negative sign of zero values for compatibility with F77. Default behavior is to show the negative sign.

## 2.9 Options for code generation conventions

These machine-independent options control the interface conventions used in code generation.

Most of them have both positive and negative forms; the negative form of '-ffoo' would be '-fno-foo'. In the table below, only one of the forms is listed—the one which is not the default. You can figure out the other form by either removing 'no-' or adding it.

#### -fno-automatic

Treat each program unit (except those marked as RECURSIVE) as if the SAVE statement were specified for every local variable and array referenced in it. Does not affect common blocks. (Some Fortran compilers provide this option under the name '-static' or '-save'.) The default, which is '-fautomatic', uses the stack for local variables smaller than the value given by '-fmax-stack-var-size'. Use the option '-frecursive' to use no static memory.

The calling conventions used by g77 (originally implemented in f2c) require functions that return type default REAL to actually return the C type double, and functions that return type COMPLEX to return the values via an extra argument in the calling sequence that points to where to store the return value. Under the default GNU calling conventions, such functions simply return their results as they would in GNU C—default REAL functions return the C type float, and COMPLEX functions return the GNU C type complex.

Additionally, this option implies the '-fsecond-underscore' option, unless '-fno-second-underscore' is explicitly requested.

This does not affect the generation of code that interfaces with the libgfortran library.

Caution: It is not a good idea to mix Fortran code compiled with '-ff2c' with code compiled with the default '-fno-f2c' calling conventions as, calling COMPLEX or default REAL functions between program parts which were compiled with different calling conventions will break at execution time.

Caution: This will break code which passes intrinsic functions of type default REAL or COMPLEX as actual arguments, as the library implementations use the '-fno-f2c' calling conventions.

## -fno-underscoring

Do not transform names of entities specified in the Fortran source file by appending underscores to them.

With '-funderscoring' in effect, GNU Fortran appends one underscore to external names with no underscores. This is done to ensure compatibility with code produced by many UNIX Fortran compilers.

Caution: The default behavior of GNU Fortran is incompatible with f2c and g77, please use the '-ff2c' option if you want object files compiled with GNU Fortran to be compatible with object code created with these tools.

Use of '-fno-underscoring' is not recommended unless you are experimenting with issues such as integration of GNU Fortran into existing system environments (vis-à-vis existing libraries, tools, and so on).

For example, with '-funderscoring', and assuming other defaults like '-fcase-lower' and that j() and max\_count() are external functions while my\_var and lvar are local variables, a statement like

```
I = J() + MAX_COUNT (MY_VAR, LVAR)
```

is implemented as something akin to:

```
i = j_() + max_count__(&my_var__, &lvar);
```

With '-fno-underscoring', the same statement is implemented as:

```
i = j() + max_count(&my_var, &lvar);
```

Use of '-fno-underscoring' allows direct specification of user-defined names while debugging and when interfacing GNU Fortran code with other languages.

Note that just because the names match does *not* mean that the interface implemented by GNU Fortran for an external name matches the interface implemented by some other language for that same name. That is, getting code produced by GNU Fortran to link to code produced by some other compiler using this or any other method can be only a small part of the overall solution—getting the code generated by both compilers to agree on issues other than naming can require significant effort, and, unlike naming disagreements, linkers normally cannot detect disagreements in these other areas.

Also, note that with '-fno-underscoring', the lack of appended underscores introduces the very real possibility that a user-defined external name will conflict with a name in a system library, which could make finding unresolved-reference

bugs quite difficult in some cases—they might occur at program run time, and show up only as buggy behavior at run time.

In future versions of GNU Fortran we hope to improve naming and linking issues so that debugging always involves using the names as they appear in the source, even if the names as seen by the linker are mangled to prevent accidental linking between procedures with incompatible interfaces.

#### -fsecond-underscore

By default, GNU Fortran appends an underscore to external names. If this option is used GNU Fortran appends two underscores to names with underscores and one underscore to external names with no underscores. GNU Fortran also appends two underscores to internal names with underscores to avoid naming collisions with external names.

This option has no effect if '-fno-underscoring' is in effect. It is implied by the '-ff2c' option.

Otherwise, with this option, an external name such as MAX\_COUNT is implemented as a reference to the link-time external symbol max\_count\_\_, instead of max\_count\_\_. This is required for compatibility with g77 and f2c, and is implied by use of the '-ff2c' option.

### -fbounds-check

Enable generation of run-time checks for array subscripts and against the declared minimum and maximum values. It also checks array indices for assumed and deferred shape arrays against the actual allocated bounds and ensures that all string lengths are equal for character array constructors without an explicit typespec.

Some checks require that '-fbounds-check' is set for the compilation of the main program.

Note: In the future this may also include other forms of checking, e.g., checking substring references.

## fcheck-array-temporaries

Warns at run time when for passing an actual argument a temporary array had to be generated. The information generated by this warning is sometimes useful in optimization, in order to avoid such temporaries.

Note: The warning is only printed once per location.

## -fmax-array-constructor=n

This option can be used to increase the upper limit permitted in array constructors. The code below requires this option to expand the array at compile time.

```
program test
implicit none
integer j
integer, parameter :: n = 100000
integer, parameter :: i(n) = (/ (2*j, j = 1, n) /)
print '(10(I0,1X))', i
end program test
```

Caution: This option can lead to long compile times and excessively large object files.

The default value for n is 65535.

### -fmax-stack-var-size=n

This option specifies the size in bytes of the largest array that will be put on the stack; if the size is exceeded static memory is used (except in procedures marked as RECURSIVE). Use the option '-frecursive' to allow for recursive procedures which do not have a RECURSIVE attribute or for parallel programs. Use '-fno-automatic' to never use the stack.

This option currently only affects local arrays declared with constant bounds, and may not apply to all character variables. Future versions of GNU Fortran may improve this behavior.

The default value for n is 32768.

## -fpack-derived

This option tells GNU Fortran to pack derived type members as closely as possible. Code compiled with this option is likely to be incompatible with code compiled without this option, and may execute slower.

## -frepack-arrays

In some circumstances GNU Fortran may pass assumed shape array sections via a descriptor describing a noncontiguous area of memory. This option adds code to the function prologue to repack the data into a contiguous block at runtime.

This should result in faster accesses to the array. However it can introduce significant overhead to the function call, especially when the passed data is noncontiguous.

## -fshort-enums

This option is provided for interoperability with C code that was compiled with the '-fshort-enums' option. It will make GNU Fortran choose the smallest INTEGER kind a given enumerator set will fit in, and give all its enumerators this kind.

#### -fexternal-blas

This option will make gfortran generate calls to BLAS functions for some matrix operations like MATMUL, instead of using our own algorithms, if the size of the matrices involved is larger than a given limit (see '-fblas-matmul-limit'). This may be profitable if an optimized vendor BLAS library is available. The BLAS library will have to be specified at link time.

## -fblas-matmul-limit=n

Only significant when '-fexternal-blas' is in effect. Matrix multiplication of matrices with size larger than (or equal to) n will be performed by calls to BLAS functions, while others will be handled by gfortran internal algorithms. If the matrices involved are not square, the size comparison is performed using the geometric mean of the dimensions of the argument and result matrices.

The default value for n is 30.

#### -frecursive

Allow indirect recursion by forcing all local arrays to be allocated on the stack. This flag cannot be used together with '-fmax-stack-var-size=' or '-fno-automatic'.

- -finit-local-zero
- -finit-integer=n
- -finit-real=<zero|inf|-inf|nan>
- -finit-logical=<true|false>
- -finit-character=n

The '-finit-local-zero' option instructs the compiler to initialize local INTEGER, REAL, and COMPLEX variables to zero, LOGICAL variables to false, and CHARACTER variables to a string of null bytes. Finer-grained initialization options are provided by the '-finit-integer=n', '-finit-real=<zero|inf|-inf|nan>' (which also initializes the real and imaginary parts of local COMPLEX variables), '-finit-logical=<true|false>', and '-finit-character=n' (where n is an ASCII character value) options. These options do not initialize components of derived type variables, nor do they initialize variables that appear in an EQUIVALENCE statement. (This limitation may be removed in future releases).

Note that the '-finit-real=nan' option initializes REAL and COMPLEX variables with a quiet NaN.

## -falign-commons

By default, gfortran enforces proper alignment of all variables in a COM-MON block by padding them as needed. On certain platforms this is mandatory, on others it increases performance. If a COMMON block is not declared with consistent data types everywhere, this padding can cause trouble, and '-fno-align-commons' can be used to disable automatic alignment. The same form of this option should be used for all files that share a COMMON block. To avoid potential alignment issues in COMMON blocks, it is recommended to order objects from largests to smallest.

See Section "Options for Code Generation Conventions" in *Using the GNU Compiler Collection (GCC)*, for information on more options offered by the GBE shared by gfortran, gcc, and other GNU compilers.

## 2.10 Environment variables affecting gfortran

The gfortran compiler currently does not make use of any environment variables to control its operation above and beyond those that affect the operation of gcc.

See Section "Environment Variables Affecting GCC" in *Using the GNU Compiler Collection (GCC)*, for information on environment variables.

See Chapter 3 [Runtime], page 23, for environment variables that affect the run-time behavior of programs compiled with GNU Fortran.

# 3 Runtime: Influencing runtime behavior with environment variables

The behavior of the gfortran can be influenced by environment variables.

Malformed environment variables are silently ignored.

## 3.1 GFORTRAN\_STDIN\_UNIT—Unit number for standard input

This environment variable can be used to select the unit number preconnected to standard input. This must be a positive integer. The default value is 5.

# 3.2 GFORTRAN\_STDOUT\_UNIT—Unit number for standard output

This environment variable can be used to select the unit number preconnected to standard output. This must be a positive integer. The default value is 6.

## 3.3 GFORTRAN\_STDERR\_UNIT—Unit number for standard error

This environment variable can be used to select the unit number preconnected to standard error. This must be a positive integer. The default value is 0.

# 3.4 GFORTRAN\_USE\_STDERR—Send library output to standard error

This environment variable controls where library output is sent. If the first letter is 'y', 'Y' or '1', standard error is used. If the first letter is 'n', 'N' or '0', standard output is used.

# 3.5 GFORTRAN\_TMPDIR—Directory for scratch files

This environment variable controls where scratch files are created. If this environment variable is missing, GNU Fortran searches for the environment variable TMP. If this is also missing, the default is '/tmp'.

# 3.6 GFORTRAN\_UNBUFFERED\_ALL—Don't buffer I/O on all units

This environment variable controls whether all I/O is unbuffered. If the first letter is 'y', 'Y' or '1', all I/O is unbuffered. This will slow down small sequential reads and writes. If the first letter is 'n', 'N' or '0', I/O is buffered. This is the default.

# 3.7 GFORTRAN\_UNBUFFERED\_PRECONNECTED—Don't buffer I/O on preconnected units

The environment variable named GFORTRAN\_UNBUFFERED\_PRECONNECTED controls whether I/O on a preconnected unit (i.e. STDOUT or STDERR) is unbuffered. If the first letter is 'y', 'Y' or '1', I/O is unbuffered. This will slow down small sequential reads and writes. If the first letter is 'n', 'N' or '0', I/O is buffered. This is the default.

## 3.8 GFORTRAN\_SHOW\_LOCUS—Show location for runtime errors

If the first letter is 'y', 'Y' or '1', filename and line numbers for runtime errors are printed. If the first letter is 'n', 'N' or '0', don't print filename and line numbers for runtime errors. The default is to print the location.

# 3.9 GFORTRAN\_OPTIONAL\_PLUS—Print leading + where permitted

If the first letter is 'y', 'Y' or '1', a plus sign is printed where permitted by the Fortran standard. If the first letter is 'n', 'N' or '0', a plus sign is not printed in most cases. Default is not to print plus signs.

# 3.10 GFORTRAN\_DEFAULT\_RECL—Default record length for new files

This environment variable specifies the default record length, in bytes, for files which are opened without a RECL tag in the OPEN statement. This must be a positive integer. The default value is 1073741824 bytes (1 GB).

## 3.11 GFORTRAN\_LIST\_SEPARATOR—Separator for list output

This environment variable specifies the separator when writing list-directed output. It may contain any number of spaces and at most one comma. If you specify this on the command line, be sure to quote spaces, as in

```
$ GFORTRAN_LIST_SEPARATOR=' , './a.out
```

when a.out is the compiled Fortran program that you want to run. Default is a single space.

# 3.12 GFORTRAN\_CONVERT\_UNIT—Set endianness for unformatted I/O

By setting the GFORTRAN\_CONVERT\_UNIT variable, it is possible to change the representation of data for unformatted files. The syntax for the GFORTRAN\_CONVERT\_UNIT variable is:

```
GFORTRAN_CONVERT_UNIT: mode | mode ';' exception | exception ;
mode: 'native' | 'swap' | 'big_endian' | 'little_endian' ;
exception: mode ':' unit_list | unit_list ;
unit_list: unit_spec | unit_list unit_spec ;
unit_spec: INTEGER | INTEGER '-' INTEGER ;
```

The variable consists of an optional default mode, followed by a list of optional exceptions, which are separated by semicolons from the preceding default and each other. Each exception consists of a format and a comma-separated list of units. Valid values for the modes are the same as for the CONVERT specifier:

NATIVE Use the native format. This is the default.

SWAP Swap between little- and big-endian.

LITTLE\_ENDIAN Use the little-endian format for unformatted files.

BIG\_ENDIAN Use the big-endian format for unformatted files.

A missing mode for an exception is taken to mean BIG\_ENDIAN. Examples of values for GFORTRAN\_CONVERT\_UNIT are:

'big\_endian' Do all unformatted I/O in big\_endian mode.

'little\_endian; native: 10-20,25' Do all unformatted I/O in little\_endian mode, except for units 10 to 20 and 25, which are in native format.

'10-20' Units 10 to 20 are big-endian, the rest is native.

Setting the environment variables should be done on the command line or via the export command for sh-compatible shells and via setenv for csh-compatible shells.

Example for sh:

```
$ gfortran foo.f90
$ GFORTRAN_CONVERT_UNIT='big_endian; native:10-20' ./a.out
Example code for csh:
% gfortran foo.f90
% setenv GFORTRAN_CONVERT_UNIT 'big_endian; native:10-20'
% ./a.out
```

Using anything but the native representation for unformatted data carries a significant speed overhead. If speed in this area matters to you, it is best if you use this only for data that needs to be portable.

See Section 6.1.14 [CONVERT specifier], page 39, for an alternative way to specify the data representation for unformatted files. See Section 2.8 [Runtime Options], page 17, for setting a default data representation for the whole program. The CONVERT specifier overrides the '-fconvert' compile options.

Note that the values specified via the GFORTRAN\_CONVERT\_UNIT environment variable will override the CONVERT specifier in the open statement. This is to give control over data formats to users who do not have the source code of their program available.

# 3.13 GFORTRAN\_ERROR\_DUMPCORE—Dump core on run-time errors

If the GFORTRAN\_ERROR\_DUMPCORE variable is set to 'y', 'Y' or '1' (only the first letter is relevant) then library run-time errors cause core dumps. To disable the core dumps, set the variable to 'n', 'N', '0'. Default is not to core dump unless the '-fdump-core' compile option was used.

# 3.14 GFORTRAN\_ERROR\_BACKTRACE—Show backtrace on run-time errors

If the GFORTRAN\_ERROR\_BACKTRACE variable is set to 'y', 'Y' or '1' (only the first letter is relevant) then a backtrace is printed when a run-time error occurs. To disable the backtracing, set the variable to 'n', 'N', '0'. Default is not to print a backtrace unless the '-fbacktrace' compile option was used.

# Part II: Language Reference

## 4 Fortran 2003 and 2008 Status

#### 4.1 Fortran 2003 status

Although GNU Fortran focuses on implementing the Fortran 95 standard for the time being, a few Fortran 2003 features are currently available.

- Intrinsics command\_argument\_count, get\_command, get\_command\_argument, get\_environment\_variable, and move\_alloc.
- Array constructors using square brackets. That is, [...] rather than (/.../).
- FLUSH statement.
- $\bullet$  IOMSG= specifier for I/O statements.
- Support for the declaration of enumeration constants via the ENUM and ENUMERATOR statements. Interoperability with gcc is guaranteed also for the case where the -fshort-enums command line option is given.
- TR 15581:
  - ALLOCATABLE dummy arguments.
  - ALLOCATABLE function results
  - ALLOCATABLE components of derived types
- The OPEN statement supports the ACCESS='STREAM' specifier, allowing I/O without any record structure.
- Namelist input/output for internal files.
- The PROTECTED statement and attribute.
- The VALUE statement and attribute.
- The VOLATILE statement and attribute.
- The IMPORT statement, allowing to import host-associated derived types.
- USE statement with INTRINSIC and NON\_INTRINSIC attribute; supported intrinsic modules: ISO\_FORTRAN\_ENV, OMP\_LIB and OMP\_LIB\_KINDS.
- Renaming of operators in the USE statement.
- Interoperability with C (ISO C Bindings)
- BOZ as argument of INT, REAL, DBLE and CMPLX.

#### 4.2 Fortran 2008 status

The next version of the Fortran standard after Fortran 2003 is currently being worked on by the Working Group 5 of Sub-Committee 22 of the Joint Technical Committee 1 of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). This group is known at WG5. The next revision of the Fortran standard is informally referred to as Fortran 2008, reflecting its planned release year. The GNU Fortran compiler has support for some of the new features in Fortran 2008. This support is based on the latest draft, available from http://www.nag.co.uk/sc22wg5/. However, as the final standard may differ from the drafts, no guarantee of backward compatibility can be made and you should only use it for experimental purposes.

# 5 Compiler Characteristics

This chapter describes certain characteristics of the GNU Fortran compiler, that are not specified by the Fortran standard, but which might in some way or another become visible to the programmer.

## 5.1 KIND Type Parameters

The KIND type parameters supported by GNU Fortran for the primitive data types are:

```
INTEGER 1, 2, 4, 8*, 16*, default: 4 (1) 

LOGICAL 1, 2, 4, 8*, 16*, default: 4 (1) 

REAL 4, 8, 10^{**}, 16^{**}, default: 4 (2) 

COMPLEX 4, 8, 10^{**}, 16^{**}, default: 4 (2) 

CHARACTER 1, 4, default: 1
```

\* = not available on all systems

- (1) Unless -fdefault-integer-8 is used
- (2) Unless -fdefault-real-8 is used

The KIND value matches the storage size in bytes, except for COMPLEX where the storage size is twice as much (or both real and imaginary part are a real value of the given size). It is recommended to use the SELECT\_\*\_KIND intrinsics instead of the concrete values.

# 5.2 Internal representation of LOGICAL variables

The Fortran standard does not specify how variables of LOGICAL type are represented, beyond requiring that LOGICAL variables of default kind have the same storage size as default INTEGER and REAL variables. The GNU Fortran internal representation is as follows.

A LOGICAL(KIND=N) variable is represented as an INTEGER(KIND=N) variable, however, with only two permissible values: 1 for .TRUE. and 0 for .FALSE.. Any other integer value results in undefined behavior.

Note that for mixed-language programming using the ISO\_C\_BINDING feature, there is a C\_BOOL kind that can be used to create LOGICAL(KIND=C\_BOOL) variables which are interoperable with the C99 \_Bool type. The C99 \_Bool type has an internal representation described in the C99 standard, which is identical to the above description, i.e. with 1 for true and 0 for false being the only permissible values. Thus the internal representation of LOGICAL variables in GNU Fortran is identical to C99 \_Bool, except for a possible difference in storage size depending on the kind.

<sup>\*\*</sup> = not available on all systems; additionally 10 and 16 are never available at the same time

## 6 Extensions

The two sections below detail the extensions to standard Fortran that are implemented in GNU Fortran, as well as some of the popular or historically important extensions that are not (or not yet) implemented. For the latter case, we explain the alternatives available to GNU Fortran users, including replacement by standard-conforming code or GNU extensions.

## 6.1 Extensions implemented in GNU Fortran

GNU Fortran implements a number of extensions over standard Fortran. This chapter contains information on their syntax and meaning. There are currently two categories of GNU Fortran extensions, those that provide functionality beyond that provided by any standard, and those that are supported by GNU Fortran purely for backward compatibility with legacy compilers. By default, '-std=gnu' allows the compiler to accept both types of extensions, but to warn about the use of the latter. Specifying either '-std=f95', '-std=f2003' or '-std=f2008' disables both types of extensions, and '-std=legacy' allows both without warning.

## 6.1.1 Old-style kind specifications

GNU Fortran allows old-style kind specifications in declarations. These look like:

```
TYPESPEC*size x,y,z
```

where TYPESPEC is a basic type (INTEGER, REAL, etc.), and where  $\mathtt{size}$  is a byte count corresponding to the storage size of a valid kind for that type. (For COMPLEX variables,  $\mathtt{size}$  is the total size of the real and imaginary parts.) The statement then declares  $\mathtt{x}$ ,  $\mathtt{y}$  and  $\mathtt{z}$  to be of type TYPESPEC with the appropriate kind. This is equivalent to the standard-conforming declaration

```
TYPESPEC(k) x,y,z
```

where k is the kind parameter suitable for the intended precision. As kind parameters are implementation-dependent, use the KIND, SELECTED\_INT\_KIND and SELECTED\_REAL\_KIND intrinsics to retrieve the correct value, for instance REAL\*8 x can be replaced by:

```
INTEGER, PARAMETER :: dbl = KIND(1.0d0)
REAL(KIND=dbl) :: x
```

### 6.1.2 Old-style variable initialization

GNU Fortran allows old-style initialization of variables of the form:

```
INTEGER i/1/,j/2/
REAL x(2,2) /3*0.,1./
```

The syntax for the initializers is as for the DATA statement, but unlike in a DATA statement, an initializer only applies to the variable immediately preceding the initialization. In other words, something like INTEGER I, J/2, 3/ is not valid. This style of initialization is only allowed in declarations without double colons (::); the double colons were introduced in Fortran 90, which also introduced a standard syntax for initializing variables in type declarations.

Examples of standard-conforming code equivalent to the above example are:

```
Fortran 90

INTEGER :: i = 1, j = 2

REAL :: x(2,2) = RESHAPE((/0.,0.,0.,1./),SHAPE(x))
```

```
! Fortran 77
    INTEGER i, j
    REAL x(2,2)
    DATA i/1/, j/2/, x/3*0.,1./
```

Note that variables which are explicitly initialized in declarations or in DATA statements automatically acquire the SAVE attribute.

#### 6.1.3 Extensions to namelist

GNU Fortran fully supports the Fortran 95 standard for namelist I/O including array qualifiers, substrings and fully qualified derived types. The output from a namelist write is compatible with namelist read. The output has all names in upper case and indentation to column 1 after the namelist name. Two extensions are permitted:

```
Old-style use of '$' instead of '&'

$MYNML

X(:)%Y(2) = 1.0 2.0 3.0

CH(1:4) = "abcd"

$END
```

It should be noted that the default terminator is '/' rather than '&END'.

Querying of the namelist when inputting from stdin. After at least one space, entering '?' sends to stdout the namelist name and the names of the variables in the namelist:

```
&mynml
x
x%y
ch
&end
```

Entering '=?' outputs the namelist to stdout, as if WRITE(\*,NML = mynml) had been called:

```
&MYNML

X(1)%Y= 0.000000 , 1.000000 , 0.000000 ,

X(2)%Y= 0.000000 , 2.000000 , 0.000000 ,

X(3)%Y= 0.000000 , 3.000000 , 0.000000 ,

CH=abcd, /
```

To aid this dialog, when input is from stdin, errors send their messages to stderr and execution continues, even if IOSTAT is set.

PRINT namelist is permitted. This causes an error if '-std=f95' is used.

```
PROGRAM test_print

REAL, dimension (4) :: x = (/1.0, 2.0, 3.0, 4.0/)

NAMELIST /mynml/ x

PRINT mynml

END PROGRAM test_print
```

Expanded namelist reads are permitted. This causes an error if '-std=f95' is used. In the following example, the first element of the array will be given the value 0.00 and the two succeeding elements will be given the values 1.00 and 2.00.

```
&MYNML X(1,1) = 0.00 , 1.00 , 2.00
```

#### 6.1.4 X format descriptor without count field

To support legacy codes, GNU Fortran permits the count field of the X edit descriptor in FORMAT statements to be omitted. When omitted, the count is implicitly assumed to be one.

```
PRINT 10, 2, 3
10 FORMAT (I1, X, I1)
```

#### 6.1.5 Commas in FORMAT specifications

To support legacy codes, GNU Fortran allows the comma separator to be omitted immediately before and after character string edit descriptors in FORMAT statements.

```
PRINT 10, 2, 3
10 FORMAT ('FOO='I1' BAR='I2)
```

#### 6.1.6 Missing period in FORMAT specifications

To support legacy codes, GNU Fortran allows missing periods in format specifications if and only if '-std=legacy' is given on the command line. This is considered non-conforming code and is discouraged.

```
REAL :: value
READ(*,10) value
10 FORMAT ('F4')
```

#### 6.1.7 I/O item lists

To support legacy codes, GNU Fortran allows the input item list of the READ statement, and the output item lists of the WRITE and PRINT statements, to start with a comma.

#### 6.1.8 BOZ literal constants

Besides decimal constants, Fortran also supports binary (b), octal (o) and hexadecimal (z) integer constants. The syntax is: 'prefix quote digits quote', were the prefix is either b, o or z, quote is either ' or " and the digits are for binary 0 or 1, for octal between 0 and 7, and for hexadecimal between 0 and F. (Example: b'01011101'.)

Up to Fortran 95, BOZ literals were only allowed to initialize integer variables in DATA statements. Since Fortran 2003 BOZ literals are also allowed as argument of REAL, DBLE, INT and CMPLX; the result is the same as if the integer BOZ literal had been converted by TRANSFER to, respectively, real, double precision, integer or complex. As GNU Fortran extension the intrinsic procedures FLOAT, DFLOAT, COMPLEX and DCMPLX are treated alike.

As an extension, GNU Fortran allows hexadecimal BOZ literal constants to be specified using the X prefix, in addition to the standard Z prefix. The BOZ literal can also be specified by adding a suffix to the string, for example, Z'ABC' and 'ABC'Z are equivalent.

Furthermore, GNU Fortran allows using BOZ literal constants outside DATA statements and the four intrinsic functions allowed by Fortran 2003. In DATA statements, in direct assignments, where the right-hand side only contains a BOZ literal constant, and for old-style initializers of the form integer i /o'0173'/, the constant is transferred as if TRANSFER had been used; for COMPLEX numbers, only the real part is initialized unless CMPLX is used. In all other cases, the BOZ literal constant is converted to an INTEGER value with the largest decimal representation. This value is then converted numerically to the type and kind of the variable in question. (For instance real :: r = b'00000001' + 1 initializes r with 2.0.) As

different compilers implement the extension differently, one should be careful when doing bitwise initialization of non-integer variables.

Note that initializing an INTEGER variable with a statement such as DATA i/Z'FFFFFFFF'/ will give an integer overflow error rather than the desired result of -1 when i is a 32-bit integer on a system that supports 64-bit integers. The '-fno-range-check' option can be used as a workaround for legacy code that initializes integers in this manner.

### 6.1.9 Real array indices

As an extension, GNU Fortran allows the use of REAL expressions or variables as array indices.

#### 6.1.10 Unary operators

As an extension, GNU Fortran allows unary plus and unary minus operators to appear as the second operand of binary arithmetic operators without the need for parenthesis.

$$X = Y * -Z$$

#### 6.1.11 Implicitly convert LOGICAL and INTEGER values

As an extension for backwards compatibility with other compilers, GNU Fortran allows the implicit conversion of LOGICAL values to INTEGER values and vice versa. When converting from a LOGICAL to an INTEGER, .FALSE. is interpreted as zero, and .TRUE. is interpreted as one. When converting from INTEGER to LOGICAL, the value zero is interpreted as .FALSE. and any nonzero value is interpreted as .TRUE..

```
LOGICAL :: 1
1 = 1
INTEGER :: i
i = .TRUE.
```

However, there is no implicit conversion of INTEGER values in if-statements, nor of LOGICAL or INTEGER values in I/O operations.

## 6.1.12 Hollerith constants support

GNU Fortran supports Hollerith constants in assignments, function arguments, and DATA and ASSIGN statements. A Hollerith constant is written as a string of characters preceded by an integer constant indicating the character count, and the letter H or h, and stored in bytewise fashion in a numeric (INTEGER, REAL, or complex) or LOGICAL variable. The constant will be padded or truncated to fit the size of the variable in which it is stored.

Examples of valid uses of Hollerith constants:

```
complex*16 x(2)
data x /16Habcdefghijklmnop, 16Hqrstuvwxyz012345/
x(1) = 16HABCDEFGHIJKLMNOP
call foo (4h abc)
```

Invalid Hollerith constants examples:

```
integer*4 a
a = 8H12345678 ! Valid, but the Hollerith constant will be truncated.
a = OH ! At least one character is needed.
```

In general, Hollerith constants were used to provide a rudimentary facility for handling character strings in early Fortran compilers, prior to the introduction of CHARACTER variables

in Fortran 77; in those cases, the standard-compliant equivalent is to convert the program to use proper character strings. On occasion, there may be a case where the intent is specifically to initialize a numeric variable with a given byte sequence. In these cases, the same result can be obtained by using the TRANSFER statement, as in this example.

#### 6.1.13 Cray pointers

Cray pointers are part of a non-standard extension that provides a C-like pointer in Fortran. This is accomplished through a pair of variables: an integer "pointer" that holds a memory address, and a "pointee" that is used to dereference the pointer.

Pointer/pointee pairs are declared in statements of the form:

```
pointer ( <pointer> , <pointee> )
or,
pointer ( <pointer1> , <pointee1> ), ( <pointer2> , <pointee2> ), ...
```

The pointer is an integer that is intended to hold a memory address. The pointee may be an array or scalar. A pointee can be an assumed size array—that is, the last dimension may be left unspecified by using a \* in place of a value—but a pointee cannot be an assumed shape array. No space is allocated for the pointee.

The pointee may have its type declared before or after the pointer statement, and its array specification (if any) may be declared before, during, or after the pointer statement. The pointer may be declared as an integer prior to the pointer statement. However, some machines have default integer sizes that are different than the size of a pointer, and so the following code is not portable:

```
integer ipt
pointer (ipt, iarr)
```

If a pointer is declared with a kind that is too small, the compiler will issue a warning; the resulting binary will probably not work correctly, because the memory addresses stored in the pointers may be truncated. It is safer to omit the first line of the above example; if explicit declaration of ipt's type is omitted, then the compiler will ensure that ipt is an integer variable large enough to hold a pointer.

Pointer arithmetic is valid with Cray pointers, but it is not the same as C pointer arithmetic. Cray pointers are just ordinary integers, so the user is responsible for determining how many bytes to add to a pointer in order to increment it. Consider the following example:

```
real target(10)
real pointee(10)
pointer (ipt, pointee)
ipt = loc (target)
ipt = ipt + 1
```

The last statement does not set ipt to the address of target(1), as it would in C pointer arithmetic. Adding 1 to ipt just adds one byte to the address stored in ipt.

Any expression involving the pointee will be translated to use the value stored in the pointer as the base address.

To get the address of elements, this extension provides an intrinsic function LOC(). The LOC() function is equivalent to the & operator in C, except the address is cast to an integer type:

```
real ar(10)
pointer(ipt, arpte(10))
real arpte
ipt = loc(ar) ! Makes arpte is an alias for ar
arpte(1) = 1.0 ! Sets ar(1) to 1.0
```

The pointer can also be set by a call to the MALLOC intrinsic (see Section 7.145 [MALLOC], page 126).

Cray pointees often are used to alias an existing variable. For example:

```
integer target(10)
integer iarr(10)
pointer (ipt, iarr)
ipt = loc(target)
```

As long as ipt remains unchanged, iarr is now an alias for target. The optimizer, however, will not detect this aliasing, so it is unsafe to use iarr and target simultaneously. Using a pointee in any way that violates the Fortran aliasing rules or assumptions is illegal. It is the user's responsibility to avoid doing this; the compiler works under the assumption that no such aliasing occurs.

Cray pointers will work correctly when there is no aliasing (i.e., when they are used to access a dynamically allocated block of memory), and also in any routine where a pointee is used, but any variable with which it shares storage is not used. Code that violates these rules may not run as the user intends. This is not a bug in the optimizer; any code that violates the aliasing rules is illegal. (Note that this is not unique to GNU Fortran; any Fortran compiler that supports Cray pointers will "incorrectly" optimize code with illegal aliasing.)

There are a number of restrictions on the attributes that can be applied to Cray pointers and pointees. Pointees may not have the ALLOCATABLE, INTENT, OPTIONAL, DUMMY, TARGET, INTRINSIC, or POINTER attributes. Pointers may not have the DIMENSION, POINTER, TARGET, ALLOCATABLE, EXTERNAL, or INTRINSIC attributes. Pointees may not occur in more than one pointer statement. A pointee cannot be a pointer. Pointees cannot occur in equivalence, common, or data statements.

A Cray pointer may also point to a function or a subroutine. For example, the following excerpt is valid:

```
implicit none
external sub
pointer (subptr,subpte)
external subpte
subptr = loc(sub)
call subpte()
[...]
subroutine sub
[...]
end subroutine sub
```

A pointer may be modified during the course of a program, and this will change the location to which the pointee refers. However, when pointees are passed as arguments, they are treated as ordinary variables in the invoked function. Subsequent changes to the pointer will not change the base address of the array that was passed.

#### 6.1.14 CONVERT specifier

GNU Fortran allows the conversion of unformatted data between little- and big-endian representation to facilitate moving of data between different systems. The conversion can be indicated with the CONVERT specifier on the OPEN statement. See Section 3.12 [GFORTRAN\_CONVERT\_UNIT], page 24, for an alternative way of specifying the data format via an environment variable.

Valid values for CONVERT are:

CONVERT='NATIVE' Use the native format. This is the default.

CONVERT='SWAP' Swap between little- and big-endian.

CONVERT='LITTLE\_ENDIAN' Use the little-endian representation for unformatted files.

CONVERT='BIG\_ENDIAN' Use the big-endian representation for unformatted files.

Using the option could look like this:

The value of the conversion can be queried by using INQUIRE(CONVERT=ch). The values returned are 'BIG\_ENDIAN' and 'LITTLE\_ENDIAN'.

CONVERT works between big- and little-endian for INTEGER values of all supported kinds and for REAL on IEEE systems of kinds 4 and 8. Conversion between different "extended double" types on different architectures such as m68k and x86\_64, which GNU Fortran supports as REAL(KIND=10) and REAL(KIND=16), will probably not work.

Note that the values specified via the GFORTRAN\_CONVERT\_UNIT environment variable will override the CONVERT specifier in the open statement. This is to give control over data formats to users who do not have the source code of their program available.

Using anything but the native representation for unformatted data carries a significant speed overhead. If speed in this area matters to you, it is best if you use this only for data that needs to be portable.

## 6.1.15 OpenMP

OpenMP (Open Multi-Processing) is an application programming interface (API) that supports multi-platform shared memory multiprocessing programming in C/C++ and Fortran on many architectures, including Unix and Microsoft Windows platforms. It consists of a set of compiler directives, library routines, and environment variables that influence run-time behavior.

GNU Fortran strives to be compatible to the OpenMP Application Program Interface v2.5.

To enable the processing of the OpenMP directive !\$omp in free-form source code; the c\$omp, \*\$omp and !\$omp directives in fixed form; the !\$ conditional compilation sentinels in free form; and the c\$, \*\$ and !\$ sentinels in fixed form, gfortran needs to be invoked with the '-fopenmp'. This also arranges for automatic linking of the GNU OpenMP runtime library Section "libgomp" in GNU OpenMP runtime library.

The OpenMP Fortran runtime library routines are provided both in a form of a Fortran 90 module named omp\_lib and in a form of a Fortran include file named 'omp\_lib.h'.

An example of a parallelized loop taken from Appendix A.1 of the OpenMP Application Program Interface v2.5:

```
SUBROUTINE A1(N, A, B)
INTEGER I, N
REAL B(N), A(N)
!$OMP PARALLEL DO !I is private by default
DO I=2,N
B(I) = (A(I) + A(I-1)) / 2.0
ENDDO
!$OMP END PARALLEL DO
END SUBROUTINE A1
```

Please note:

- '-fopenmp' implies '-frecursive', i.e., all local arrays will be allocated on the stack. When porting existing code to OpenMP, this may lead to surprising results, especially to segmentation faults if the stacksize is limited.
- On glibc-based systems, OpenMP enabled applications can not be statically linked due to limitations of the underlying pthreads-implementation. It might be possible to get a working solution if -Wl,--whole-archive -lpthread -Wl,--no-whole-archive is added to the command line. However, this is not supported by gcc and thus not recommended.

#### 6.1.16 Argument list functions %VAL, %REF and %LOC

GNU Fortran supports argument list functions %VAL, %REF and %LOC statements, for backward compatibility with g77. It is recommended that these should be used only for code that is accessing facilities outside of GNU Fortran, such as operating system or windowing facilities. It is best to constrain such uses to isolated portions of a program—portions that deal specifically and exclusively with low-level, system-dependent facilities. Such portions might well provide a portable interface for use by the program as a whole, but are themselves not portable, and should be thoroughly tested each time they are rebuilt using a new compiler or version of a compiler.

%VAL passes a scalar argument by value, %REF passes it by reference and %LOC passes its memory location. Since gfortran already passes scalar arguments by reference, %REF is in effect a do-nothing. %LOC has the same effect as a fortran pointer.

An example of passing an argument by value to a C subroutine foo.:

```
C C prototype void foo_ (float x);
C external foo real*4 x x = 3.14159 call foo (%VAL (x))
```

For details refer to the g77 manual http://gcc.gnu.org/onlinedocs/gcc-3.4.6/g77/index.html#Top.

Also, the gfortran testsuite c\_by\_val.f and its partner c\_by\_val.c are worth a look.

# 6.2 Extensions not implemented in GNU Fortran

The long history of the Fortran language, its wide use and broad userbase, the large number of different compiler vendors and the lack of some features crucial to users in the first standards have lead to the existence of a number of important extensions to the language. While some of the most useful or popular extensions are supported by the GNU Fortran

compiler, not all existing extensions are supported. This section aims at listing these extensions and offering advice on how best make code that uses them running with the GNU Fortran compiler.

#### 6.2.1 STRUCTURE and RECORD

Structures are user-defined aggregate data types; this functionality was standardized in Fortran 90 with an different syntax, under the name of "derived types". Here is an example of code using the non portable structure syntax:

```
! Declaring a structure named ''item'' and containing three fields:
     ! an integer ID, an description string and a floating-point price.
     STRUCTURE /item/
       INTEGER id
      CHARACTER(LEN=200) description
      REAL price
     END STRUCTURE
     ! Define two variables, an single record of type ''item''
     ! named ''pear'', and an array of items named ''store_catalog''
     RECORD /item/ pear, store_catalog(100)
     ! We can directly access the fields of both variables
     pear.id = 92316
    pear.description = "juicy D'Anjou pear"
     pear.price = 0.15
     store_catalog(7).id = 7831
     store_catalog(7).description = "milk bottle"
     store_catalog(7).price = 1.2
     ! We can also manipulate the whole structure
     store_catalog(12) = pear
    print *, store_catalog(12)
This code can easily be rewritten in the Fortran 90 syntax as following:
     ! 'STRUCTURE /name/ ... END STRUCTURE'' becomes
     ! ''TYPE name ... END TYPE''
     TYPE item
       INTEGER id
      CHARACTER(LEN=200) description
      REAL price
     END TYPE
     ! "RECORD /name/ variable" becomes "TYPE(name) variable"
     TYPE(item) pear, store_catalog(100)
     ! Instead of using a dot (.) to access fields of a record, the
     ! standard syntax uses a percent sign (%)
     pear%id = 92316
```

```
pear%description = "juicy D'Anjou pear"
pear%price = 0.15
store_catalog(7)%id = 7831
store_catalog(7)%description = "milk bottle"
store_catalog(7)%price = 1.2
! Assignments of a whole variable don't change store_catalog(12) = pear
print *, store_catalog(12)
```

#### 6.2.2 ENCODE and DECODE statements

GNU Fortran doesn't support the ENCODE and DECODE statements. These statements are best replaced by READ and WRITE statements involving internal files (CHARACTER variables and arrays), which have been part of the Fortran standard since Fortran 77. For example, replace a code fragment like

```
INTEGER*1 LINE(80)
           REAL A, B, C
            ... Code that sets LINE
           DECODE (80, 9000, LINE) A, B, C
      9000 FORMAT (1X, 3(F10.5))
with the following:
            CHARACTER(LEN=80) LINE
           REAL A, B, C
           ... Code that sets LINE
            READ (UNIT=LINE, FMT=9000) A, B, C
      9000 FORMAT (1X, 3(F10.5))
   Similarly, replace a code fragment like
            INTEGER*1 LINE(80)
           REAL A, B, C
            ... Code that sets A, B and C
           ENCODE (80, 9000, LINE) A, B, C
      9000 FORMAT (1X, 'OUTPUT IS ', 3(F10.5))
with the following:
            INTEGER*1 LINE(80)
           REAL A, B, C
            ... Code that sets A, B and C
           WRITE (UNIT=LINE, FMT=9000) A, B, C
      9000 FORMAT (1X, 'OUTPUT IS ', 3(F10.5))
```

# 7 Intrinsic Procedures

## 7.1 Introduction to intrinsic procedures

The intrinsic procedures provided by GNU Fortran include all of the intrinsic procedures required by the Fortran 95 standard, a set of intrinsic procedures for backwards compatibility with G77, and a selection of intrinsic procedures from the Fortran 2003 and Fortran 2008 standards. Any conflict between a description here and a description in either the Fortran 95 standard, the Fortran 2003 standard or the Fortran 2008 standard is unintentional, and the standard(s) should be considered authoritative.

The enumeration of the KIND type parameter is processor defined in the Fortran 95 standard. GNU Fortran defines the default integer type and default real type by INTEGER(KIND=4) and REAL(KIND=4), respectively. The standard mandates that both data types shall have another kind, which have more precision. On typical target architectures supported by gfortran, this kind type parameter is KIND=8. Hence, REAL(KIND=8) and DOUBLE PRECISION are equivalent. In the description of generic intrinsic procedures, the kind type parameter will be specified by KIND=\*, and in the description of specific names for an intrinsic procedure the kind type parameter will be explicitly given (e.g., REAL(KIND=4) or REAL(KIND=8)). Finally, for brevity the optional KIND= syntax will be omitted.

Many of the intrinsic procedures take one or more optional arguments. This document follows the convention used in the Fortran 95 standard, and denotes such arguments by square brackets.

GNU Fortran offers the '-std=f95' and '-std=gnu' options, which can be used to restrict the set of intrinsic procedures to a given standard. By default, gfortran sets the '-std=gnu' option, and so all intrinsic procedures described here are accepted. There is one caveat. For a select group of intrinsic procedures, g77 implemented both a function and a subroutine. Both classes have been implemented in gfortran for backwards compatibility with g77. It is noted here that these functions and subroutines cannot be intermixed in a given subprogram. In the descriptions that follow, the applicable standard for each intrinsic procedure is noted.

# 7.2 ABORT — Abort the program

Description:

ABORT causes immediate termination of the program. On operating systems that support a core dump, ABORT will produce a core dump even if the option '-fno-dump-core' is in effect, which is suitable for debugging purposes.

Standard: GNU extension

Class: Subroutine

Syntax: CALL ABORT

Return value:

Does not return.

Example:

```
program test_abort
  integer :: i = 1, j = 2
  if (i /= j) call abort
end program test_abort
```

See also: Section 7.68 [EXIT], page 85, Section 7.124 [KILL], page 115

### 7.3 ABS — Absolute value

Description:

ABS(A) computes the absolute value of A.

Standard: Fortran 77 and later, has overloads that are GNU extensions

Class: Elemental function
Syntax: RESULT = ABS(A)

Arguments:

A The type of the argument shall be an INTEGER, REAL, or

COMPLEX.

Return value:

The return value is of the same type and kind as the argument except the return value is REAL for a COMPLEX argument.

Example:

```
program test_abs
  integer :: i = -1
  real :: x = -1.e0
  complex :: z = (-1.e0,0.e0)
  i = abs(i)
  x = abs(x)
  x = abs(z)
end program test_abs
```

#### Specific names:

Name	Argument	Return type	Standard
CABS(A)	COMPLEX(4) Z	REAL(4)	Fortran 77 and later
DABS(A)	REAL(8) X	REAL(8)	Fortran 77 and later
IABS(A)	INTEGER(4) I	INTEGER(4)	Fortran 77 and later
ZABS(A)	COMPLEX(8) Z	COMPLEX(8)	GNU extension
CDABS(A)	COMPLEX(8) Z	COMPLEX(8)	GNU extension

## 7.4 ACCESS — Checks file access modes

Description:

ACCESS (NAME, MODE) checks whether the file NAME exists, is readable, writable or executable. Except for the executable check, ACCESS can be replaced by Fortran 95's INQUIRE.

Standard: GNU extension
Class: Inquiry function

Syntax: RESULT = ACCESS(NAME, MODE)

Arguments:

NAME Scalar CHARACTER of default kind with the file name. Tailing

blank are ignored unless the character achar(0) is present, then all characters up to and excluding achar(0) are used as

file name.

MODE Scalar CHARACTER of default kind with the file access mode,

may be any concatenation of "r" (readable), "w" (writable)

and "x" (executable), or " " to check for existence.

Return value:

Returns a scalar INTEGER, which is 0 if the file is accessible in the given mode; otherwise or if an invalid argument has been given for MODE the value 1 is returned.

Example:

```
program access_test
  implicit none
  character(len=*), parameter :: file = 'test.dat'
  character(len=*), parameter :: file2 = 'test.dat '//achar(0)
  if(access(file,' ') == 0) print *, trim(file),' is exists'
  if(access(file,'r') == 0) print *, trim(file),' is readable'
  if(access(file,'w') == 0) print *, trim(file),' is writable'
  if(access(file,'x') == 0) print *, trim(file),' is executable'
  if(access(file2,'rwx') == 0) &
    print *, trim(file2),' is readable, writable and executable'
end program access_test
```

Specific names:

See also:

# 7.5 ACHAR — Character in ASCII collating sequence

Description:

ACHAR(I) returns the character located at position I in the ASCII collating sequence.

Standard: Fortran 77 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = ACHAR(I [, KIND])

*Arguments*:

I The type shall be INTEGER.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type CHARACTER with a length of one. If the KIND argument is present, the return value is of the specified kind and of the default kind otherwise.

Example:

program test\_achar
 character c
 c = achar(32)
end program test\_achar

Note: See Section 7.107 [ICHAR], page 106 for a discussion of converting between

numerical values and formatted string representations.

See also: Section 7.39 [CHAR], page 66, Section 7.101 [IACHAR], page 103, Section 7.107

[ICHAR], page 106

#### 7.6 ACOS — Arccosine function

Description:

ACOS(X) computes the arccosine of X (inverse of COS(X)).

Standard: Fortran 77 and later
Class: Elemental function
Syntax: RESULT = ACOS(X)

Arguments:

X The type shall be REAL with a magnitude that is less than or

equal to one.

Return value:

The return value is of type REAL and it lies in the range  $0 \le a\cos(x) \le \pi$ . The return value if of the same kind as X.

Example:

program test\_acos
 real(8) :: x = 0.866\_8
 x = acos(x)
end program test\_acos

Specific names:

Name Argument Return type Standard

DACOS(X) REAL(8) X REAL(8) Fortran 77 and later

See also: Inverse function: Section 7.46 [COS], page 70

# 7.7 ACOSH — Hyperbolic arccosine function

Description:

ACOSH(X) computes the hyperbolic arccosine of X (inverse of COSH(X)).

Standard: Fortran 2008 and later

Class: Elemental function
Syntax: RESULT = ACOSH(X)

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value has the same type and kind as X

Example:

PROGRAM test\_acosh

REAL(8), DIMENSION(3) :: x = (/ 1.0, 2.0, 3.0 /)

WRITE (\*,\*) ACOSH(x)

END PROGRAM

Specific names:

Name Argument Return type Standard
DACOSH(X) REAL(8) X REAL(8) GNU extension

See also: Inverse function: Section 7.47 [COSH], page 71

## 7.8 ADJUSTL — Left adjust a string

Description:

ADJUSTL(STRING) will left adjust a string by removing leading spaces. Spaces are inserted at the end of the string as needed.

Standard: Fortran 90 and later

Class: Elemental function

Syntax: RESULT = ADJUSTL(STRING)

Arguments:

STRING The type shall be CHARACTER.

Return value:

The return value is of type CHARACTER and of the same kind as *STRING* where leading spaces are removed and the same number of spaces are inserted on the end of *STRING*.

Example:

```
program test_adjustl
  character(len=20) :: str = ' gfortran'
  str = adjustl(str)
  print *, str
end program test_adjustl
```

See also: Section 7.9 [ADJUSTR], page 47, Section 7.219 [TRIM], page 166

# 7.9 ADJUSTR — Right adjust a string

Description:

ADJUSTR(STRING) will right adjust a string by removing trailing spaces. Spaces are inserted at the start of the string as needed.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = ADJUSTR(STRING)

Arguments:

STR The type shall be CHARACTER.

Return value:

The return value is of type CHARACTER and of the same kind as *STRING* where trailing spaces are removed and the same number of spaces are inserted at the start of *STRING*.

Example:

```
program test_adjustr
  character(len=20) :: str = 'gfortran'
  str = adjustr(str)
  print *, str
end program test_adjustr
```

See also: Section 7.8 [ADJUSTL], page 47, Section 7.219 [TRIM], page 166

## 7.10 AIMAG — Imaginary part of complex number

Description:

AIMAG(Z) yields the imaginary part of complex argument Z. The IMAG(Z) and IMAGPART(Z) intrinsic functions are provided for compatibility with g77, and their use in new code is strongly discouraged.

Standard: Fortran 77 and later, has overloads that are GNU extensions

Class: Elemental function
Syntax: RESULT = AIMAG(Z)

*Arguments*:

Z The type of the argument shall be COMPLEX.

Return value:

The return value is of type REAL with the kind type parameter of the argument.

Example:

```
program test_aimag
  complex(4) z4
  complex(8) z8
  z4 = cmplx(1.e0_4, 0.e0_4)
  z8 = cmplx(0.e0_8, 1.e0_8)
  print *, aimag(z4), dimag(z8)
end program test_aimag
```

Specific names:

Name	Argument	Return type	Standard
DIMAG(Z)	COMPLEX(8) Z	REAL(8)	GNU extension
IMAG(Z)	COMPLEX Z	REAL	GNU extension
IMAGPART(Z)	COMPLEX Z	REAL	GNU extension

#### 7.11 AINT — Truncate to a whole number

Description:

AINT(A [, KIND]) truncates its argument to a whole number.

Standard: Fortran 77 and later
Class: Elemental function

Syntax: RESULT = AINT(A [, KIND])

Arguments:

A The type of the argument shall be REAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

#### Return value:

The return value is of type REAL with the kind type parameter of the argument if the optional KIND is absent; otherwise, the kind type parameter will be given by KIND. If the magnitude of X is less than one, AINT(X) returns zero. If the magnitude is equal to or greater than one then it returns the largest whole number that does not exceed its magnitude. The sign is the same as the sign of X.

#### Example:

```
program test_aint
  real(4) x4
  real(8) x8
  x4 = 1.234E0_4
  x8 = 4.321_8
  print *, aint(x4), dint(x8)
  x8 = aint(x4,8)
end program test_aint
```

Specific names:

Name Argument Return type Standard

DINT(X) REAL(8) X REAL(8) Fortran 77 and later

# 7.12 ALARM — Execute a routine after a given delay

#### Description:

ALARM(SECONDS, HANDLER [, STATUS]) causes external subroutine *HANDLER* to be executed after a delay of *SECONDS* by using alarm(2) to set up a signal and signal(2) to catch it. If *STATUS* is supplied, it will be returned with the number of seconds remaining until any previously scheduled alarm was due to be delivered, or zero if there was no previously scheduled alarm.

Standard: GNU extension

Class: Subroutine

Syntax: CALL ALARM(SECONDS, HANDLER [, STATUS])

Arguments:

SECONDS The type of the argument shall be a scalar INTEGER. It is

INTENT(IN).

HANDLER Signal handler (INTEGER FUNCTION or SUBROUTINE) or

dummy/global INTEGER scalar. The scalar values may be either SIG\_IGN=1 to ignore the alarm generated or SIG\_DFL=0

to set the default action. It is INTENT(IN).

STATUS (Optional) STATUS shall be a scalar variable of the default

INTEGER kind. It is INTENT(OUT).

#### Example:

```
program test_alarm
  external handler_print
  integer i
  call alarm (3, handler_print, i)
  print *, i
  call sleep(10)
end program test_alarm
```

This will cause the external routine handler\_print to be called after 3 seconds.

## 7.13 ALL — All values in MASK along DIM are true

#### Description:

ALL(MASK [, DIM]) determines if all the values are true in MASK in the array along dimension DIM.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = ALL(MASK [, DIM])

Arguments:

MASK The type of the argument shall be LOGICAL and it shall not

be scalar.

DIM (Optional) DIM shall be a scalar integer with a value that

lies between one and the rank of MASK.

#### Return value:

ALL(MASK) returns a scalar value of type LOGICAL where the kind type parameter is the same as the kind type parameter of MASK. If DIM is present, then ALL(MASK, DIM) returns an array with the rank of MASK minus 1. The shape is determined from the shape of MASK where the DIM dimension is elided.

- (A) ALL(MASK) is true if all elements of MASK are true. It also is true if MASK has zero size; otherwise, it is false.
- (B) If the rank of MASK is one, then ALL(MASK,DIM) is equivalent to ALL(MASK). If the rank is greater than one, then ALL(MASK,DIM) is determined by applying ALL to the array sections.

#### Example:

```
program test_all
  logical 1
  l = all((/.true., .true., .true./))
  print *, 1
  call section
  contains
   subroutine section
    integer a(2,3), b(2,3)
    a = 1
    b = 1
   b(2,2) = 2
  print *, all(a .eq. b, 1)
  print *, all(a .eq. b, 2)
```

end subroutine section
end program test\_all

## 7.14 ALLOCATED — Status of an allocatable entity

Description:

ALLOCATED (ARRAY) checks the status of whether X is allocated.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = ALLOCATED(ARRAY)

Arguments:

ARRAY The argument shall be an ALLOCATABLE array.

Return value:

The return value is a scalar LOGICAL with the default logical kind type parameter. If ARRAY is allocated, ALLOCATED(ARRAY) is .TRUE.; otherwise, it returns .FALSE.

Example:

```
program test_allocated
  integer :: i = 4
  real(4), allocatable :: x(:)
  if (.not. allocated(x)) allocate(x(i))
end program test_allocated
```

# 7.15 AND — Bitwise logical AND

Description:

Bitwise logical AND.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. For integer arguments, programmers should consider the use of the Section 7.102 [IAND], page 104 intrinsic defined by the Fortran standard.

Standard: GNU extension

Class: Function

Syntax: RESULT = AND(I, J)

Arguments:

I The type shall be either a scalar INTEGER type or a scalar

LOGICAL type.

J The type shall be the same as the type of I.

Return value:

The return type is either a scalar INTEGER or a scalar LOGICAL. If the kind type parameters differ, then the smaller kind type is implicitly converted to larger kind, and the return has the larger kind.

Example:

```
PROGRAM test_and

LOGICAL :: T = .TRUE., F = .FALSE.

INTEGER :: a, b

DATA a / Z'F' /, b / Z'3' /

WRITE (*,*) AND(T, T), AND(T, F), AND(F, T), AND(F, F)

WRITE (*,*) AND(a, b)

END PROGRAM
```

See also: Fortran 95 elemental function: Section 7.102 [IAND], page 104

#### 7.16 ANINT — Nearest whole number

Description:

ANINT(A [, KIND]) rounds its argument to the nearest whole number.

Standard: Fortran 77 and later
Class: Elemental function

Syntax: RESULT = ANINT(A [, KIND])

Arguments:

A The type of the argument shall be REAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type real with the kind type parameter of the argument if the optional KIND is absent; otherwise, the kind type parameter will be given by KIND. If A is greater than zero, ANINT(A) returns AINT(X+0.5). If A is less than or equal to zero then it returns AINT(X-0.5).

Example:

```
program test_anint
  real(4) x4
  real(8) x8
  x4 = 1.234E0_4
  x8 = 4.321_8
  print *, anint(x4), dnint(x8)
  x8 = anint(x4,8)
end program test_anint
```

Specific names:

Name Argument Return type Standard

DNINT(A) REAL(8) A REAL(8) Fortran 77 and later

# 7.17 ANY — Any value in MASK along DIM is true

Description:

ANY (MASK [, DIM]) determines if any of the values in the logical array MASK along dimension DIM are .TRUE..

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = ANY(MASK [, DIM])

Arguments:

MASK The type of the argument shall be LOGICAL and it shall not

be scalar.

DIM (Optional) DIM shall be a scalar integer with a value that

lies between one and the rank of MASK.

#### Return value:

ANY (MASK) returns a scalar value of type LOGICAL where the kind type parameter is the same as the kind type parameter of MASK. If DIM is present, then ANY (MASK, DIM) returns an array with the rank of MASK minus 1. The shape is determined from the shape of MASK where the DIM dimension is elided.

- (A) ANY (MASK) is true if any element of MASK is true; otherwise, it is false. It also is false if MASK has zero size.
- (B) If the rank of MASK is one, then ANY(MASK,DIM) is equivalent to ANY(MASK). If the rank is greater than one, then ANY(MASK,DIM) is determined by applying ANY to the array sections.

Example:

```
program test_any
  logical 1
  l = any((/.true., .true., .true./))
  print *, 1
  call section
  contains
    subroutine section
      integer a(2,3), b(2,3)
      a = 1
      b = 1
      b(2,2) = 2
      print *, any(a .eq. b, 1)
      print *, any(a .eq. b, 2)
  end subroutine section
end program test_any
```

### 7.18 ASIN — Arcsine function

Description:

ASIN(X) computes the arcsine of its X (inverse of SIN(X)).

Standard: Fortran 77 and later
Class: Elemental function
Syntax: RESULT = ASIN(X)

Arguments:

X The type shall be REAL, and a magnitude that is less than or

equal to one.

Return value:

The return value is of type REAL and it lies in the range  $-\pi/2 \le a\sin(x) \le \pi/2$ . The kind type parameter is the same as X.

Example:

program test\_asin
 real(8) :: x = 0.866\_8
 x = asin(x)
end program test\_asin

Specific names:

Name Argument Return type Standard

DASIN(X) REAL(8) X REAL(8) Fortran 77 and later

See also: Inverse function: Section 7.196 [SIN], page 154

## 7.19 ASINH — Hyperbolic arcsine function

Description:

ASINH(X) computes the hyperbolic arcsine of X (inverse of SINH(X)).

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = ASINH(X)

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value is of the same type and kind as X.

Example:

PROGRAM test\_asinh
REAL(8), DIMENSION(3) :: x = (/ -1.0, 0.0, 1.0 /)
WRITE (\*,\*) ASINH(x)
END PROGRAM

 $Specific\ names:$ 

Name Argument Return type Standard
DASINH(X) REAL(8) X REAL(8) GNU extension.

See also: Inverse function: Section 7.197 [SINH], page 154

# 7.20 ASSOCIATED — Status of a pointer or pointer/target pair

Description:

ASSOCIATED (POINTER [, TARGET]) determines the status of the pointer POINTER or if POINTER is associated with the target TARGET.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = ASSOCIATED(POINTER [, TARGET])

Arguments:

POINTER POINTER shall have the POINTER attribute and it can be of

any type.

TARGET (Optional) TARGET shall be a pointer or a target. It must have the same type, kind type parameter, and array rank as POINTER.

The association status of neither *POINTER* nor *TARGET* shall be undefined.

#### Return value:

ASSOCIATED (POINTER) returns a scalar value of type LOGICAL(4). There are several cases:

- (A) When the optional *TARGET* is not present then ASSOCIATED(POINTER) is true if *POINTER* is associated with a target; otherwise, it returns false.
- (B) If TARGET is present and a scalar target, the result is true if TARGET is not a zero-sized storage sequence and the target associated with POINTER occupies the same storage units. If POINTER is disassociated, the result is false.
- (C) If TARGET is present and an array target, the result is true if

  TARGET and POINTER have the same shape, are not zero-sized arrays, are arrays whose elements are not zero-sized storage sequences, and TARGET and POINTER occupy the same storage units in array element order. As in case(B), the result is false, if POINTER is disassociated.
- (D) If TARGET is present and an scalar pointer, the result is true if TARGET is associated with POINTER, the target associated with TARGET are not zero-sized storage sequences and occupy the same storage units. The result is false, if either TARGET or POINTER is disassociated.
- (E) If TARGET is present and an array pointer, the result is true if target associated with POINTER and the target associated with TARGET have the same shape, are not zero-sized arrays, are arrays whose elements are not zero-sized storage sequences, and TARGET and POINTER occupy the same storage units in array element order. The result is false, if either TARGET or POINTER is disassociated.

#### Example:

See also: Section 7.166 [NULL], page 137

## 7.21 ATAN — Arctangent function

Description:

ATAN(X) computes the arctangent of X.

Standard: Fortran 77 and later Class: Elemental function

Syntax: RESULT = ATAN(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL and it lies in the range  $-\pi/2 \le atan(x) \le \pi/2$ .

Example:

program test\_atan
 real(8) :: x = 2.866\_8
 x = atan(x)
end program test\_atan

Specific names:

Name Argument Return type Standard

DATAN(X) REAL(8) X REAL(8) Fortran 77 and later

See also: Inverse function: Section 7.211 [TAN], page 163

# 7.22 ATAN2 — Arctangent function

Description:

ATAN2(Y, X) computes the arctangent of the complex number X + iY.

Standard: Fortran 77 and later
Class: Elemental function

Syntax: RESULT = ATAN2(Y, X)

Arguments:

Y The type shall be REAL.

X The type and kind type parameter shall be the same as Y. If

Y is zero, then X must be nonzero.

Return value:

The return value has the same type and kind type parameter as Y. It is the principal value of the complex number X + iY. If X is nonzero, then it lies in the range  $-\pi \le \operatorname{atan}(x) \le \pi$ . The sign is positive if Y is positive. If Y is zero, then the return value is zero if X is positive and  $\pi$  if X is negative. Finally, if X is zero, then the magnitude of the result is  $\pi/2$ .

Example:

```
program test_atan2
  real(4) :: x = 1.e0_4, y = 0.5e0_4
  x = atan2(y,x)
end program test_atan2
```

Specific names:

Name Argument Return type Standard

DATAN2(X) REAL(8) X REAL(8) Fortran 77 and later

## 7.23 ATANH — Hyperbolic arctangent function

Description:

ATANH(X) computes the hyperbolic arctangent of X (inverse of TANH(X)).

Standard: Fortran 2008 and later

Class: Elemental function
Syntax: RESULT = ATANH(X)

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value has same type and kind as X.

Example:

PROGRAM test\_atanh

REAL, DIMENSION(3) :: x = (/ -1.0, 0.0, 1.0 /)

WRITE (\*,\*) ATANH(x)

END PROGRAM

Specific names:

Name Argument Return type Standard
DATANH(X) REAL(8) X REAL(8) GNU extension

See also: Inverse function: Section 7.212 [TANH], page 163

# 7.24 BESSEL\_J0 — Bessel function of the first kind of order 0

Description:

BESSEL\_JO(X) computes the Bessel function of the first kind of order 0 of X. This function is available under the name BESJO as a GNU extension.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = BESSEL\_JO(X)

Arguments:

X The type shall be REAL, and it shall be scalar.

Return value:

The return value is of type REAL and lies in the range  $-0.4027... \le Bessel(0, x) \le 1$ . It has the same kind as X.

Example:

program test\_besj0
 real(8) :: x = 0.0\_8
 x = bessel\_j0(x)
end program test\_besj0

Specific names:

Name Argument Return type Standard
DBESJO(X) REAL(8) X REAL(8) GNU extension

#### 7.25 BESSEL\_J1 — Bessel function of the first kind of order 1

Description:

BESSEL\_J1(X) computes the Bessel function of the first kind of order 1 of X. This function is available under the name BESJ1 as a GNU extension.

Standard: Fortran 2008

Class: Elemental function

Syntax: RESULT = BESSEL\_J1(X)

*Arguments*:

X The type shall be REAL, and it shall be scalar.

Return value:

The return value is of type REAL and it lies in the range  $-0.5818... \le Bessel(0, x) \le 0.5818$ . It has the same kind as X.

Example:

program test\_besj1
 real(8) :: x = 1.0\_8
 x = bessel\_j1(x)
end program test\_besj1

Specific names:

Name Argument Return type Standard
DBESJ1(X) REAL(8) X REAL(8) GNU extension

# 7.26 BESSEL\_JN — Bessel function of the first kind

Description:

BESSEL\_JN(N, X) computes the Bessel function of the first kind of order N of X. This function is available under the name BESJN as a GNU extension.

If both arguments are arrays, their ranks and shapes shall conform.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = BESSEL\_JN(N, X)

*Arguments*:

N Shall be a scalar or an array of type INTEGER.
X Shall be a scalar or an array of type REAL.

Return value:

The return value is a scalar of type REAL. It has the same kind as X.

Example:

program test\_besjn
 real(8) :: x = 1.0\_8
 x = bessel\_jn(5,x)
end program test\_besjn

Specific names:

Name Argument Return type Standard
DBESJN(X) INTEGER N REAL(8) GNU extension

REAL(8) X

# 7.27 BESSEL\_Y0 — Bessel function of the second kind of order 0

Description:

BESSEL\_Y0(X) computes the Bessel function of the second kind of order 0 of X. This function is available under the name BESY0 as a GNU extension.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = BESSEL\_YO(X)

Arguments:

X The type shall be REAL, and it shall be scalar.

Return value:

The return value is a scalar of type REAL. It has the same kind as X.

Example:

program test\_besy0
 real(8) :: x = 0.0\_8
 x = bessel\_y0(x)
end program test\_besy0

Specific names:

Name Argument Return type Standard
DBESYO(X) REAL(8) X REAL(8) GNU extension

# 7.28 BESSEL\_Y1 — Bessel function of the second kind of order 1

Description:

BESSEL\_Y1(X) computes the Bessel function of the second kind of order 1 of X. This function is available under the name BESY1 as a GNU extension.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = BESSEL\_Y1(X)

Arguments:

X The type shall be REAL, and it shall be scalar.

Return value:

The return value is a scalar of type REAL. It has the same kind as X.

Example:

program test\_besy1
 real(8) :: x = 1.0\_8
 x = bessel\_y1(x)
end program test\_besy1

Specific names:

Name Argument Return type Standard
DBESY1(X) REAL(8) X REAL(8) GNU extension

## 7.29 BESSEL\_YN — Bessel function of the second kind

Description:

BESSEL\_YN(N, X) computes the Bessel function of the second kind of order N of X. This function is available under the name BESYN as a GNU extension.

If both arguments are arrays, their ranks and shapes shall conform.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = BESSEL\_YN(N, X)

*Arguments*:

N Shall be a scalar or an array of type INTEGER.
X Shall be a scalar or an array of type REAL.

Return value:

The return value is a scalar of type REAL. It has the same kind as X.

Example:

program test\_besyn
 real(8) :: x = 1.0\_8
 x = bessel\_yn(5,x)
end program test\_besyn

Specific names:

Name Argument Return type Standard
DBESYN(N,X) INTEGER N REAL(8) GNU extension
REAL(8) X

# 7.30 BIT\_SIZE — Bit size inquiry function

Description:

BIT\_SIZE(I) returns the number of bits (integer precision plus sign bit) represented by the type of I. The result of BIT\_SIZE(I) is independent of the actual value of I.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = BIT\_SIZE(I)

Arguments:

I The type shall be INTEGER.

Return value:

The return value is of type INTEGER

Example:

```
program test_bit_size
   integer :: i = 123
   integer :: size
   size = bit_size(i)
   print *, size
end program test_bit_size
```

## 7.31 BTEST — Bit test function

Description:

BTEST(I,POS) returns logical .TRUE. if the bit at POS in I is set. The counting of the bits starts at 0.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = BTEST(I, POS)

Arguments:

I The type shall be INTEGER. POS The type shall be INTEGER.

Return value:

The return value is of type LOGICAL

Example:

```
program test_btest
   integer :: i = 32768 + 1024 + 64
   integer :: pos
   logical :: bool
   do pos=0,16
        bool = btest(i, pos)
        print *, pos, bool
   end do
end program test_btest
```

## 7.32 C\_ASSOCIATED — Status of a C pointer

Description:

C\_ASSOCIATED(c\_prt\_1[, c\_ptr\_2]) determines the status of the C pointer  $c_ptr_1$  or if  $c_ptr_1$  is associated with the target  $c_ptr_2$ .

Standard: Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = C\_ASSOCIATED(c\_prt\_1[, c\_ptr\_2])

### Arguments:

 $c\_ptr\_1$  Scalar of the type C\_PTR or C\_FUNPTR.  $c\_ptr\_2$  (Optional) Scalar of the same type as  $c\_ptr\_1$ .

#### Return value:

The return value is of type LOGICAL; it is .false. if either  $c_-ptr_-1$  is a C NULL pointer or if  $c_-ptr_-1$  and  $c_-ptr_-2$  point to different addresses.

#### Example:

```
subroutine association_test(a,b)
  use iso_c_binding, only: c_associated, c_loc, c_ptr
  implicit none
  real, pointer :: a
  type(c_ptr) :: b
  if(c_associated(b, c_loc(a))) &
    stop 'b and a do not point to same target'
end subroutine association_test
```

See also: Section 7.36 [C\_LOC], page 64, Section 7.33 [C\_FUNLOC], page 62

# 7.33 C\_FUNLOC — Obtain the C address of a procedure

#### Description:

C\_FUNLOC(x) determines the C address of the argument.

Standard: Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = C\_FUNLOC(x)

Arguments:

Interoperable function or pointer to such function.

#### Return value:

The return value is of type C\_FUNPTR and contains the C address of the argument.

```
module x
 use iso_c_binding
 implicit none
contains
  subroutine sub(a) bind(c)
   real(c_float) :: a
   a = sqrt(a) + 5.0
  end subroutine sub
end module x
program main
 use iso_c_binding
 use x
  implicit none
  interface
    subroutine my_routine(p) bind(c,name='myC_func')
      import :: c_funptr
      type(c_funptr), intent(in) :: p
    end subroutine
```

```
end interface
  call my_routine(c_funloc(sub))
end program main
```

See also: Section 7.32 [C\_ASSOCIATED], page 61, Section 7.36 [C\_LOC], page 64, Section 7.35 [C\_F\_POINTER], page 63, Section 7.34 [C\_F\_PROCPOINTER], page 63

# 7.34 C\_F\_PROCPOINTER — Convert C into Fortran procedure pointer

Description:

C\_F\_PROCPOINTER(CPTR, FPTR) Assign the target of the C function pointer CPTR to the Fortran procedure pointer FPTR.

Note: Due to the currently lacking support of procedure pointers in GNU Fortran this function is not fully operable.

Standard: Fortran 2003 and later

Class: Subroutine

Syntax: CALL C\_F\_PROCPOINTER(cptr, fptr)

*Arguments*:

CPTR scalar of the type C\_FUNPTR. It is INTENT(IN).

FPTR procedure pointer interoperable with cptr. It is INTENT(OUT).

Example:

```
program main
  use iso_c_binding
  implicit none
 abstract interface
   function func(a)
      import :: c_float
     real(c_float), intent(in) :: a
     real(c_float) :: func
   end function
  end interface
  interface
     function getIterFunc() bind(c,name="getIterFunc")
       import :: c_funptr
       type(c_funptr) :: getIterFunc
     end function
  end interface
  type(c_funptr) :: cfunptr
  procedure(func), pointer :: myFunc
  cfunptr = getIterFunc()
  call c_f_procpointer(cfunptr, myFunc)
end program main
```

See also: Section 7.36 [C\_LOC], page 64, Section 7.35 [C\_F\_POINTER], page 63

# 7.35 C\_F\_POINTER — Convert C into Fortran pointer

Description:

C\_F\_POINTER(CPTR, FPTR[, SHAPE]) Assign the target the C pointer CPTR to the Fortran pointer FPTR and specify its shape.

Standard: Fortran 2003 and later

Class: Subroutine

Syntax: CALL C\_F\_POINTER(CPTR, FPTR[, SHAPE])

Arguments:

CPTR scalar of the type C\_PTR. It is INTENT(IN).

FPTR pointer interoperable with cptr. It is INTENT(OUT).

SHAPE (Optional) Rank-one array of type INTEGER with INTENT(IN).

It shall be present if and only if fptr is an array. The size must

be equal to the rank of fptr.

Example:

```
program main
  use iso_c_binding
  implicit none
  interface
    subroutine my_routine(p) bind(c,name='myC_func')
    import :: c_ptr
       type(c_ptr), intent(out) :: p
    end subroutine
  end interface
  type(c_ptr) :: cptr
  real,pointer :: a(:)
  call my_routine(cptr)
  call c_f_pointer(cptr, a, [12])
end program main
```

See also: Section 7.36 [C\_LOC], page 64, Section 7.34 [C\_F\_PROCPOINTER], page 63

# 7.36 C\_LOC — Obtain the C address of an object

Description:

C\_LOC(X) determines the C address of the argument.

Standard: Fortran 2003 and later

Class: Inquiry function
Syntax: RESULT = C\_LOC(X)

Arguments:

X Associated scalar pointer or interoperable scalar or allocated

allocatable variable with TARGET attribute.

Return value:

The return value is of type C\_PTR and contains the C address of the argument.

```
subroutine association_test(a,b)
  use iso_c_binding, only: c_associated, c_loc, c_ptr
  implicit none
  real, pointer :: a
  type(c_ptr) :: b
  if(c_associated(b, c_loc(a))) &
    stop 'b and a do not point to same target'
end subroutine association_test
```

See also: Section 7.32 [C\_ASSOCIATED], page 61, Section 7.33 [C\_FUNLOC], page 62, Section 7.35 [C\_F\_POINTER], page 63, Section 7.34 [C\_F\_PROCPOINTER],

page 63

# 7.37 C\_SIZEOF — Size in bytes of an expression

Description:

C\_SIZEOF(X) calculates the number of bytes of storage the expression X occupies.

Standard: Fortran 2008

Class: Intrinsic function

Syntax: N = C\_SIZEOF(X)

Arguments:

X The argument shall be of any type, rank or shape.

Return value:

The return value is of type integer and of the system-dependent kind  $C\_SIZE\_T$  (from the  $ISO\_C\_BINDING$  module). Its value is the number of bytes occupied by the argument. If the argument has the POINTER attribute, the number of bytes of the storage area pointed to is returned. If the argument is of a derived type with POINTER or ALLOCATABLE components, the return value doesn't account for the sizes of the data pointed to by these components.

Example:

```
use iso_c_binding
integer(c_int) :: i
real(c_float) :: r, s(5)
print *, (c_sizeof(s)/c_sizeof(r) == 5)
end
```

The example will print .TRUE. unless you are using a platform where default REAL variables are unusually padded.

See also: Section 7.199 [SIZEOF], page 156

# 7.38 CEILING — Integer ceiling function

Description:

CEILING(A) returns the least integer greater than or equal to A.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = CEILING(A [, KIND])

Arguments:

A The type shall be REAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER(KIND) if KIND is present and a default-kind INTEGER otherwise.

Example:

```
program test_ceiling
   real :: x = 63.29
   real :: y = -63.59
   print *, ceiling(x) ! returns 64
   print *, ceiling(y) ! returns -63
end program test_ceiling
```

See also: Section 7.75 [FLOOR], page 89, Section 7.164 [NINT], page 136

## 7.39 CHAR — Character conversion function

Description:

CHAR(I [, KIND]) returns the character represented by the integer I.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = CHAR(I [, KIND])

Arguments:

I The type shall be INTEGER.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type CHARACTER(1)

Example:

```
program test_char
   integer :: i = 74
   character(1) :: c
   c = char(i)
   print *, i, c ! returns 'J'
end program test_char
```

Note: See Section 7.107 [ICHAR], page 106 for a discussion of converting between

numerical values and formatted string representations.

See also: Section 7.5 [ACHAR], page 45, Section 7.101 [IACHAR], page 103, Section 7.107

[ICHAR], page 106

# 7.40 CHDIR — Change working directory

Description:

Change current working directory to a specified path.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL CHDIR(NAME [, STATUS])
STATUS = CHDIR(NAME)

Arguments:

NAME The type shall be CHARACTER of default kind and shall specify

a valid path within the file system.

STATUS (Optional) INTEGER status flag of the default kind. Returns

0 on success, and a system specific and nonzero error code

otherwise.

Example:

PROGRAM test\_chdir
CHARACTER(len=255) :: path
CALL getcwd(path)
WRITE(\*,\*) TRIM(path)
CALL chdir("/tmp")
CALL getcwd(path)
WRITE(\*,\*) TRIM(path)
END PROGRAM

See also: Section 7.90 [GETCWD], page 98

# 7.41 CHMOD — Change access permissions of files

Description:

CHMOD changes the permissions of a file. This function invokes /bin/chmod and might therefore not work on all platforms.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL CHMOD(NAME, MODE[, STATUS])
STATUS = CHMOD(NAME, MODE)

Arguments:

NAME Scalar CHARACTER of default kind with the file name. Trailing

blanks are ignored unless the character achar(0) is present, then all characters up to and excluding achar(0) are used as

the file name.

MODE Scalar CHARACTER of default kind giving the file permission.

MODE uses the same syntax as the MODE argument of

/bin/chmod.

STATUS (optional) scalar INTEGER, which is 0 on success and nonzero otherwise.

Return value:

In either syntax, STATUS is set to 0 on success and nonzero otherwise.

Example: CHMOD as subroutine

```
program chmod_test
    implicit none
    integer :: status
    call chmod('test.dat','u+x',status)
    print *, 'Status: ', status
    end program chmod_test

CHMOD as function:

program chmod_test
    implicit none
    integer :: status
    status = chmod('test.dat','u+x')
    print *, 'Status: ', status
    end program chmod_test
```

## 7.42 CMPLX — Complex conversion function

Description:

CMPLX(X [, Y [, KIND]]) returns a complex number where X is converted to the real component. If Y is present it is converted to the imaginary component. If Y is not present then the imaginary component is set to 0.0. If X is complex then Y must not be present.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = CMPLX(X [, Y [, KIND]])

Arguments:

X The type may be INTEGER, REAL, or COMPLEX.

Y (Optional; only allowed if X is not COMPLEX.) May be INTEGER

or REAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of COMPLEX type, with a kind equal to KIND if it is specified. If KIND is not specified, the result is of the default COMPLEX kind, regardless of the kinds of X and Y.

```
program test_cmplx
  integer :: i = 42
  real :: x = 3.14
  complex :: z
  z = cmplx(i, x)
  print *, z, cmplx(x)
end program test_cmplx
```

See also: Section 7.44 [COMPLEX], page 69

# 7.43 COMMAND\_ARGUMENT\_COUNT — Get number of command line arguments

Description:

COMMAND\_ARGUMENT\_COUNT() returns the number of arguments passed on the command line when the containing program was invoked.

Standard: Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = COMMAND\_ARGUMENT\_COUNT()

Arguments:

None

Return value:

The return value is of type INTEGER(4)

Example:

```
program test_command_argument_count
   integer :: count
   count = command_argument_count()
   print *, count
end program test_command_argument_count
```

See also: Section 7.88 [GET\_COMMAND], page 97, Section 7.89 [GET\_COMMAND\_ARGUMENT],

page 97

# 7.44 COMPLEX — Complex conversion function

Description:

COMPLEX(X, Y) returns a complex number where X is converted to the real component and Y is converted to the imaginary component.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = COMPLEX(X, Y)

Arguments:

X The type may be INTEGER or REAL. Y The type may be INTEGER or REAL.

Return value:

If X and Y are both of INTEGER type, then the return value is of default COMPLEX type.

If X and Y are of REAL type, or one is of REAL type and one is of INTEGER type, then the return value is of COMPLEX type with a kind equal to that of the REAL argument with the highest precision.

```
program test_complex
   integer :: i = 42
   real :: x = 3.14
   print *, complex(i, x)
end program test_complex
```

See also: Section 7.42 [CMPLX], page 68

## 7.45 CONJG — Complex conjugate function

Description:

CONJG(Z) returns the conjugate of Z. If Z is (x, y) then the result is (x, -y)

Standard: Fortran 77 and later, has overloads that are GNU extensions

Class: Elemental function

Syntax: Z = CONJG(Z)

Arguments:

Z The type shall be COMPLEX.

Return value:

The return value is of type COMPLEX.

Example:

```
program test_conjg
   complex :: z = (2.0, 3.0)
   complex(8) :: dz = (2.71_8, -3.14_8)
   z= conjg(z)
   print *, z
   dz = dconjg(dz)
   print *, dz
end program test_conjg
```

Specific names:

Name Argument Return type Standard DCONJG(Z) COMPLEX(8) Z COMPLEX(8) GNU extension

#### 7.46 COS — Cosine function

Description:

COS(X) computes the cosine of X.

Standard: Fortran 77 and later, has overloads that are GNU extensions

Class: Elemental function
Syntax: RESULT = COS(X)

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value is of type REAL and it lies in the range  $-1 \le \cos(x) \le 1$ . The kind type parameter is the same as X.

program test\_cos
 real :: x = 0.0
 x = cos(x)
end program test\_cos

Specific names:

Name	Argument	Return type	Standard
DCOS(X)	REAL(8) X	REAL(8)	Fortran 77 and later
CCOS(X)	COMPLEX(4) X	COMPLEX(4)	Fortran 77 and later
ZCOS(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension
CDCOS(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension

See also: Inverse function: Section 7.6 [ACOS], page 46

# 7.47 COSH — Hyperbolic cosine function

Description:

COSH(X) computes the hyperbolic cosine of X.

Standard: Fortran 77 and later
Class: Elemental function

Syntax: X = COSH(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL and it is positive  $(\cosh(x) \ge 0)$ . For a REAL argument X,  $\cosh(x) \ge 1$ . The return value is of the same kind as X.

Example:

program test\_cosh
 real(8) :: x = 1.0\_8
 x = cosh(x)
end program test\_cosh

Specific names:

Name Argument Return type Standard

DCOSH(X) REAL(8) X REAL(8) Fortran 77 and later

See also: Inverse function: Section 7.7 [ACOSH], page 46

#### 7.48 COUNT — Count function

Description:

COUNT(MASK [, DIM [, KIND]]) counts the number of .TRUE. elements of MASK along the dimension of DIM. If DIM is omitted it is taken to be 1. DIM is a scalar of type INTEGER in the range of 1/leqDIM/leqn) where n is the rank of MASK.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Transformational function

Syntax: RESULT = COUNT(MASK [, DIM [, KIND]])

Arguments:

MASK The type shall be LOGICAL.

DIM (Optional) The type shall be INTEGER.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

#### Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind. The result has a rank equal to that of MASK.

#### Example:

```
program test_count
   integer, dimension(2,3) :: a, b
   logical, dimension(2,3) :: mask
   a = reshape((/1, 2, 3, 4, 5, 6/), (/2, 3/))
    b = reshape( (/ 0, 7, 3, 4, 5, 8 /), (/ 2, 3 /))
   print '(3i3)', a(1,:)
   print '(3i3)', a(2,:)
   print *
   print '(3i3)', b(1,:)
   print '(3i3)', b(2,:)
   print *
   mask = a.ne.b
   print '(313)', mask(1,:)
   print '(313)', mask(2,:)
   print '(3i3)', count(mask)
   print '(3i3)', count(mask, 1)
   print *
   print '(3i3)', count(mask, 2)
end program test_count
```

# 7.49 CPU\_TIME — CPU elapsed time in seconds

#### Description:

Returns a REAL value representing the elapsed CPU time in seconds. This is useful for testing segments of code to determine execution time.

If a time source is available, time will be reported with microsecond resolution. If no time source is available, TIME is set to -1.0.

Note that *TIME* may contain a, system dependent, arbitrary offset and may not start with 0.0. For CPU\_TIME, the absolute value is meaningless, only differences between subsequent calls to this subroutine, as shown in the example below, should be used.

Standard: Fortran 95 and later

Class: Subroutine

Syntax: CALL CPU\_TIME(TIME)

Arguments:

TIME The type shall be REAL with INTENT(OUT).

Return value:

None

Example:

```
program test_cpu_time
    real :: start, finish
    call cpu_time(start)
        ! put code to test here
    call cpu_time(finish)
    print '("Time = ",f6.3," seconds.")',finish-start
end program test_cpu_time
```

See also: Section 7.210 [SYSTEM\_CLOCK], page 162, Section 7.52 [DATE\_AND\_TIME], page 74

## 7.50 CSHIFT — Circular shift elements of an array

Description:

CSHIFT (ARRAY, SHIFT [, DIM]) performs a circular shift on elements of AR-RAY along the dimension of DIM. If DIM is omitted it is taken to be 1. DIM is a scalar of type INTEGER in the range of 1/leqDIM/leqn) where n is the rank of ARRAY. If the rank of ARRAY is one, then all elements of ARRAY are shifted by SHIFT places. If rank is greater than one, then all complete rank one sections of ARRAY along the given dimension are shifted. Elements shifted out one end of each rank one section are shifted back in the other end.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = CSHIFT(ARRAY, SHIFT [, DIM])

Arguments:

ARRAY Shall be an array of any type.

SHIFT The type shall be INTEGER.

DIM The type shall be INTEGER.

Return value:

Returns an array of same type and rank as the ARRAY argument.

```
program test_cshift
  integer, dimension(3,3) :: a
  a = reshape( (/ 1, 2, 3, 4, 5, 6, 7, 8, 9 /), (/ 3, 3 /))
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print '(3i3)', a(3,:)
  a = cshift(a, SHIFT=(/1, 2, -1/), DIM=2)
  print *
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print '(3i3)', a(3,:)
end program test_cshift
```

## 7.51 CTIME — Convert a time into a string

Description:

CTIME converts a system time value, such as returned by TIME8(), to a string of the form 'Sat Aug 19 18:13:14 1995'.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL CTIME (TIME, RESULT).

RESULT = CTIME(TIME), (not recommended).

Arguments:

TIME The type shall be of type INTEGER(KIND=8).

RESULT The type shall be of type CHARACTER and of default kind.

Return value:

The converted date and time as a string.

Example:

```
program test_ctime
   integer(8) :: i
   character(len=30) :: date
   i = time8()

! Do something, main part of the program
   call ctime(i,date)
   print *, 'Program was started on ', date
end program test_ctime
```

See Also: Section 7.97 [GMTIME], page 101, Section 7.144 [LTIME], page 125, Section 7.213 [TIME], page 164, Section 7.214 [TIME8], page 164

# 7.52 DATE\_AND\_TIME — Date and time subroutine

Description:

DATE\_AND\_TIME(DATE, TIME, ZONE, VALUES) gets the corresponding date and time information from the real-time system clock. *DATE* is INTENT(OUT) and has form ccyymmdd. *TIME* is INTENT(OUT) and has form hhmmss.sss. *ZONE* is INTENT(OUT) and has form (+-)hhmm, representing the difference with respect to Coordinated Universal Time (UTC). Unavailable time and date parameters return blanks.

*VALUES* is INTENT(OUT) and provides the following:

VALUE(1): The year VALUE(2): The month

VALUE(3): The day of the month

VALUE(4): Time difference with UTC in

minutes

VALUE(5): The hour of the day
VALUE(6): The minutes of the hour
VALUE(7): The seconds of the minute
VALUE(8): The milliseconds of the second

Standard: Fortran 95 and later

Class: Subroutine

Syntax: CALL DATE\_AND\_TIME([DATE, TIME, ZONE, VALUES])

Arguments:

DATE (Optional) The type shall be CHARACTER(LEN=8) or larger,

and of default kind.

TIME (Optional) The type shall be CHARACTER(LEN=10) or larger,

and of default kind.

ZONE (Optional) The type shall be CHARACTER(LEN=5) or larger,

and of default kind.

VALUES (Optional) The type shall be INTEGER(8).

Return value:

None

Example:

```
program test_time_and_date
    character(8) :: date
    character(10) :: time
    character(5) :: zone
    integer,dimension(8) :: values
    ! using keyword arguments
    call date_and_time(date,time,zone,values)
    call date_and_time(DATE=date,ZONE=zone)
    call date_and_time(TIME=time)
    call date_and_time(VALUES=values)
    print '(a,2x,a,2x,a)', date, time, zone
    print '(8i5))', values
end program test_time_and_date
```

See also: Section 7.49 [CPU\_TIME], page 72, Section 7.210 [SYSTEM\_CLOCK], page 162

#### 7.53 DBLE — Double conversion function

Description:

DBLE(A) Converts A to double precision real type.

Standard: Fortran 77 and later

Class: Elemental function
Syntax: RESULT = DBLE(A)

*Arguments*:

A The type shall be INTEGER, REAL, or COMPLEX.

Return value:

The return value is of type double precision real.

Example:

See also: Section 7.55 [DFLOAT], page 76, Section 7.72 [FLOAT], page 87, Section 7.179

[REAL], page 145

# 7.54 DCMPLX — Double complex conversion function

Description:

DCMPLX(X [,Y]) returns a double complex number where X is converted to the real component. If Y is present it is converted to the imaginary component. If Y is not present then the imaginary component is set to 0.0. If X is complex then Y must not be present.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = DCMPLX(X [, Y])

Arguments:

X The type may be INTEGER, REAL, or COMPLEX.

Y (Optional if X is not COMPLEX.) May be INTEGER or REAL.

Return value:

The return value is of type COMPLEX(8)

Example:

```
program test_dcmplx
   integer :: i = 42
   real :: x = 3.14
   complex :: z
   z = cmplx(i, x)
   print *, dcmplx(i)
   print *, dcmplx(x)
   print *, dcmplx(z)
   print *, dcmplx(x,i)
end program test_dcmplx
```

## 7.55 DFLOAT — Double conversion function

Description:

DFLOAT(A) Converts A to double precision real type.

Standard: GNU extension

Class: Elemental function
Syntax: RESULT = DFLOAT(A)

Arguments:

A The type shall be INTEGER.

Return value:

The return value is of type double precision real.

Example:

```
program test_dfloat
    integer :: i = 5
    print *, dfloat(i)
end program test_dfloat
```

See also:

Section 7.53 [DBLE], page 75, Section 7.72 [FLOAT], page 87, Section 7.179 [REAL], page 145

# 7.56 DIGITS — Significant binary digits function

Description:

DIGITS(X) returns the number of significant binary digits of the internal model representation of X. For example, on a system using a 32-bit floating point representation, a default real number would likely return 24.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = DIGITS(X)

Arguments:

X The type may be INTEGER or REAL.

Return value:

The return value is of type INTEGER.

Example:

```
program test_digits
   integer :: i = 12345
   real :: x = 3.143
   real(8) :: y = 2.33
   print *, digits(i)
   print *, digits(x)
   print *, digits(y)
end program test_digits
```

#### 7.57 DIM — Positive difference

Description:

DIM(X,Y) returns the difference X-Y if the result is positive; otherwise returns zero.

Standard: Fortran 77 and later

Class: Elemental function
Syntax: RESULT = DIM(X, Y)

Arguments:

X The type shall be INTEGER or REAL

Y The type shall be the same type and kind as X.

#### Return value:

The return value is of type INTEGER or REAL.

#### Example:

```
program test_dim
   integer :: i
   real(8) :: x
   i = dim(4, 15)
   x = dim(4.345_8, 2.111_8)
   print *, i
   print *, x
end program test_dim
```

#### Specific names:

Name	Argument	Return type	Standard
IDIM(X,Y)	INTEGER(4)	INTEGER(4)	Fortran 77 and later
	Х, Y		
DDIM(X,Y)	REAL(8) X,Y	REAL(8)	Fortran 77 and later

# 7.58 DOT\_PRODUCT — Dot product function

#### Description:

DOT\_PRODUCT(VECTOR\_A, VECTOR\_B) computes the dot product multiplication of two vectors  $VECTOR_A$  and  $VECTOR_B$ . The two vectors may be either numeric or logical and must be arrays of rank one and of equal size. If the vectors are INTEGER or REAL, the result is SUM(VECTOR\_A\*VECTOR\_B). If the vectors are COMPLEX, the result is SUM(CONJG(VECTOR\_A)\*VECTOR\_B). If the vectors are LOGICAL, the result is ANY(VECTOR\_A .AND. VECTOR\_B).

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = DOT\_PRODUCT(VECTOR\_A, VECTOR\_B)

Arguments:

VECTOR\_A The type shall be numeric or LOGICAL, rank 1.

 $VECTOR\_B$  The type shall be numeric if  $VECTOR\_A$  is of numeric type

or LOGICAL if VECTOR\_A is of type LOGICAL. VECTOR\_B

shall be a rank-one array.

#### Return value:

If the arguments are numeric, the return value is a scalar of numeric type, INTEGER, REAL, or COMPLEX. If the arguments are LOGICAL, the return value is .TRUE. or .FALSE..

```
program test_dot_prod
  integer, dimension(3) :: a, b
  a = (/ 1, 2, 3 /)
  b = (/ 4, 5, 6 /)
  print '(3i3)', a
  print *
  print '(3i3)', b
```

```
print *
print *, dot_product(a,b)
end program test_dot_prod
```

# 7.59 DPROD — Double product function

Description:

DPROD(X,Y) returns the product X\*Y.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = DPROD(X, Y)

Arguments:

X The type shall be REAL. Y The type shall be REAL.

Return value:

The return value is of type REAL(8).

Example:

```
program test_dprod
    real :: x = 5.2
    real :: y = 2.3
    real(8) :: d
    d = dprod(x,y)
    print *, d
end program test_dprod
```

# 7.60 DREAL — Double real part function

Description:

DREAL(Z) returns the real part of complex variable Z.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = DREAL(A)

Arguments:

A The type shall be COMPLEX(8).

Return value:

The return value is of type REAL(8).

Example:

```
program test_dreal
   complex(8) :: z = (1.3_8,7.2_8)
   print *, dreal(z)
end program test_dreal
```

See also: Section 7.10 [AIMAG], page 48

## 7.61 DTIME — Execution time subroutine (or function)

#### Description:

DTIME(TARRAY, RESULT) initially returns the number of seconds of runtime since the start of the process's execution in *RESULT*. *TARRAY* returns the user and system components of this time in TARRAY(1) and TARRAY(2) respectively. *RESULT* is equal to TARRAY(1) + TARRAY(2).

Subsequent invocations of DTIME return values accumulated since the previous invocation.

On some systems, the underlying timings are represented using types with sufficiently small limits that overflows (wrap around) are possible, such as 32-bit types. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

Please note, that this implementation is thread safe if used within OpenMP directives, i.e., its state will be consistent while called from multiple threads. However, if DTIME is called from multiple threads, the result is still the time since the last invocation. This may not give the intended results. If possible, use CPU\_TIME instead.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

TARRAY and RESULT are INTENT(OUT) and provide the following:

TARRAY(1): User time in seconds.
TARRAY(2): System time in seconds.

RESULT: Run time since start in seconds.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL DTIME (TARRAY, RESULT).

RESULT = DTIME(TARRAY), (not recommended).

Arguments:

TARRAY The type shall be REAL, DIMENSION(2).

RESULT The type shall be REAL.

Return value:

Elapsed time in seconds since the last invocation or since the start of program execution if not called before.

```
program test_dtime
   integer(8) :: i, j
   real, dimension(2) :: tarray
   real :: result
   call dtime(tarray, result)
   print *, result
   print *, tarray(1)
```

```
print *, tarray(2)
do i=1,100000000 ! Just a delay
    j = i * i - i
    end do
    call dtime(tarray, result)
    print *, result
    print *, tarray(1)
    print *, tarray(2)
end program test_dtime
```

See also: Section 7.49 [CPU\_TIME], page 72

## 7.62 EOSHIFT — End-off shift elements of an array

Description:

EOSHIFT (ARRAY, SHIFT [, BOUNDARY, DIM]) performs an end-off shift on elements of ARRAY along the dimension of DIM. If DIM is omitted it is taken to be 1. DIM is a scalar of type INTEGER in the range of 1/leqDIM/leqn) where n is the rank of ARRAY. If the rank of ARRAY is one, then all elements of ARRAY are shifted by SHIFT places. If rank is greater than one, then all complete rank one sections of ARRAY along the given dimension are shifted. Elements shifted out one end of each rank one section are dropped. If BOUND-ARY is present then the corresponding value of from BOUNDARY is copied back in the other end. If BOUNDARY is not present then the following are copied in depending on the type of ARRAY.

Array Type Boundary Value

Numeric 0 of the type and kind of ARRAY.

Logical .FALSE.. Character(len) len blanks.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = EOSHIFT(ARRAY, SHIFT [, BOUNDARY, DIM])

*Arguments*:

ARRAY May be any type, not scalar.

SHIFT The type shall be INTEGER.

BOUNDARY Same type as ARRAY.

DIM The type shall be INTEGER.

Return value:

Returns an array of same type and rank as the ARRAY argument.

```
program test_eoshift
  integer, dimension(3,3) :: a
  a = reshape( (/ 1, 2, 3, 4, 5, 6, 7, 8, 9 /), (/ 3, 3 /))
  print '(3i3)', a(1,:)
  print '(3i3)', a(2,:)
  print '(3i3)', a(3,:)
  a = EOSHIFT(a, SHIFT=(/1, 2, 1/), BOUNDARY=-5, DIM=2)
  print *
```

```
print '(3i3)', a(1,:)
print '(3i3)', a(2,:)
print '(3i3)', a(3,:)
end program test_eoshift
```

# 7.63 EPSILON — Epsilon function

Description:

EPSILON(X) returns the smallest number E of the same kind as X such that 1 + E > 1.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = EPSILON(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of same type as the argument.

Example:

```
program test_epsilon
  real :: x = 3.143
  real(8) :: y = 2.33
  print *, EPSILON(x)
  print *, EPSILON(y)
end program test_epsilon
```

## 7.64 ERF — Error function

Description:

ERF(X) computes the error function of X.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = ERF(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL, of the same kind as X and lies in the range  $-1 \le erf(x) \le 1$ .

Example:

```
program test_erf
  real(8) :: x = 0.17_8
  x = erf(x)
end program test_erf
```

Specific names:

Name Argument Return type Standard
DERF(X) REAL(8) X REAL(8) GNU extension

## 7.65 ERFC — Error function

Description:

 $\mathsf{ERFC}(\mathsf{X})$  computes the complementary error function of X.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = ERFC(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL and of the same kind as X. It lies in the range  $0 \le erfc(x) \le 2$ .

Example:

program test\_erfc
 real(8) :: x = 0.17\_8
 x = erfc(x)
end program test\_erfc

Specific names:

Name Argument Return type Standard
DERFC(X) REAL(8) X REAL(8) GNU extension

## 7.66 ERFC\_SCALED — Error function

Description:

 $\mathtt{ERFC\_SCALED}(\mathtt{X})$  computes the exponentially-scaled complementary error function of X.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = ERFC\_SCALED(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL and of the same kind as X.

Example:

program test\_erfc\_scaled
 real(8) :: x = 0.17\_8
 x = erfc\_scaled(x)
end program test\_erfc\_scaled

## 7.67 ETIME — Execution time subroutine (or function)

Description:

ETIME(TARRAY, RESULT) returns the number of seconds of runtime since the start of the process's execution in *RESULT*. *TARRAY* returns the user and system components of this time in TARRAY(1) and TARRAY(2) respectively. *RESULT* is equal to TARRAY(1) + TARRAY(2).

On some systems, the underlying timings are represented using types with sufficiently small limits that overflows (wrap around) are possible, such as 32-bit types. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

TARRAY and RESULT are INTENT (OUT) and provide the following:

TARRAY(1): User time in seconds.
TARRAY(2): System time in seconds.

RESULT: Run time since start in seconds.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL ETIME (TARRAY, RESULT).

RESULT = ETIME(TARRAY), (not recommended).

Arguments:

TARRAY The type shall be REAL, DIMENSION(2).

RESULT The type shall be REAL.

Return value:

Elapsed time in seconds since the start of program execution.

Example:

```
program test_etime
   integer(8) :: i, j
   real, dimension(2) :: tarray
   real :: result
   call ETIME(tarray, result)
   print *, result
   print *, tarray(1)
   print *, tarray(2)
    do i=1,100000000
                        ! Just a delay
        j = i * i - i
    call ETIME(tarray, result)
   print *, result
   print *, tarray(1)
   print *, tarray(2)
end program test_etime
```

See also: Section 7.49 [CPU\_TIME], page 72

# 7.68 EXIT — Exit the program with status.

Description:

EXIT causes immediate termination of the program with status. If status is omitted it returns the canonical *success* for the system. All Fortran I/O units are closed.

Standard: GNU extension

Class: Subroutine

Suntax: CALL EXIT([STATUS])

Arguments:

STATUS Shall be an INTEGER of the default kind.

Return value:

STATUS is passed to the parent process on exit.

Example:

```
program test_exit
  integer :: STATUS = 0
  print *, 'This program is going to exit.'
  call EXIT(STATUS)
end program test_exit
```

See also: Section 7.2 [ABORT], page 43, Section 7.124 [KILL], page 115

# 7.69 EXP — Exponential function

Description:

 $\mathsf{EXP}(\mathsf{X})$  computes the base e exponential of X.

Standard: Fortran 77 and later, has overloads that are GNU extensions

Class: Elemental function
Syntax: RESULT = EXP(X)

*Arguments*:

X The type shall be REAL or COMPLEX.

Return value:

The return value has same type and kind as X.

Example:

```
program test_exp
  real :: x = 1.0
  x = exp(x)
end program test_exp
```

Specific names:

Name	Argument	Return type	Standard
DEXP(X)	REAL(8) X	REAL(8)	Fortran 77 and later
CEXP(X)	COMPLEX(4) X	COMPLEX(4)	Fortran 77 and later
ZEXP(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension
CDEXP(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension

## 7.70 EXPONENT — Exponent function

Description:

 $\mathtt{EXPONENT}(\mathtt{X})$  returns the value of the exponent part of X. If X is zero the value

returned is zero.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = EXPONENT(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type default INTEGER.

Example:

```
program test_exponent
  real :: x = 1.0
  integer :: i
  i = exponent(x)
  print *, i
  print *, exponent(0.0)
end program test_exponent
```

# 7.71 FDATE — Get the current time as a string

Description:

FDATE(DATE) returns the current date (using the same format as CTIME) in DATE. It is equivalent to CALL CTIME(DATE, TIME()).

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

DATE is an INTENT (OUT) CHARACTER variable of the default kind.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL FDATE(DATE).

DATE = FDATE(), (not recommended).

Arguments:

DATE The type shall be of type CHARACTER of the default kind

Return value:

The current date as a string.

```
program test_fdate
  integer(8) :: i, j
  character(len=30) :: date
  call fdate(date)
```

```
print *, 'Program started on ', date
do i = 1, 100000000 ! Just a delay
    j = i * i - i
  end do
  call fdate(date)
  print *, 'Program ended on ', date
end program test_fdate
```

# 7.72 FLOAT — Convert integer to default real

Description:

FLOAT(A) converts the integer A to a default real value.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = FLOAT(A)

Arguments:

A

The type shall be INTEGER.

Return value:

The return value is of type default REAL.

Example:

```
program test_float
   integer :: i = 1
   if (float(i) /= 1.) call abort
end program test_float
```

See also:

Section 7.53 [DBLE], page 75, Section 7.55 [DFLOAT], page 76, Section 7.179 [REAL], page 145

# 7.73 FGET — Read a single character in stream mode from stdin

Description:

Read a single character in stream mode from stdin by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the FGET intrinsic is provided for backwards compatibility with g77. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 4.1 [Fortran 2003 status], page 29.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL FGET(C [, STATUS])

Arguments:

C The type shall be **CHARACTER** and of default kind.

STATUS (Optional) status flag of type INTEGER. Returns 0 on success,

-1 on end-of-file, and a system specific positive error code

otherwise.

Example:

```
PROGRAM test_fget

INTEGER, PARAMETER :: strlen = 100

INTEGER :: status, i = 1

CHARACTER(len=strlen) :: str = ""

WRITE (*,*) 'Enter text:'

DO

CALL fget(str(i:i), status)

if (status /= 0 .OR. i > strlen) exit

i = i + 1

END DO

WRITE (*,*) TRIM(str)

END PROGRAM
```

See also: Section 7.74 [FGETC], page 88, Section 7.78 [FPUT], page 90, Section 7.79 [FPUTC], page 91

## 7.74 FGETC — Read a single character in stream mode

Description:

Read a single character in stream mode by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the FGET intrinsic is provided for backwards compatibility with g77. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 4.1 [Fortran 2003 status], page 29.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL FGETC(UNIT, C [, STATUS])

Arguments:

UNIT The type shall be INTEGER.

C The type shall be CHARACTER and of default kind.

STATUS (Optional) status flag of type INTEGER. Returns 0 on suc-

cess, -1 on end-of-file and a system specific positive error code

otherwise.

```
PROGRAM test_fgetc
  INTEGER :: fd = 42, status
```

```
CHARACTER :: c

OPEN(UNIT=fd, FILE="/etc/passwd", ACTION="READ", STATUS = "OLD")

DO

CALL fgetc(fd, c, status)

IF (status /= 0) EXIT

call fput(c)

END DO

CLOSE(UNIT=fd)

END PROGRAM
```

See also: Section 7.73 [FGET], page 87, Section 7.78 [FPUT], page 90, Section 7.79 [FPUTC], page 91

# 7.75 FLOOR — Integer floor function

Description:

FLOOR(A) returns the greatest integer less than or equal to X.

Standard: Fortran 95 and later Class: Elemental function

Syntax: RESULT = FLOOR(A [, KIND])

Arguments:

A The type shall be REAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER(KIND) if KIND is present and of default-kind INTEGER otherwise.

Example:

```
program test_floor
    real :: x = 63.29
    real :: y = -63.59
    print *, floor(x) ! returns 63
    print *, floor(y) ! returns -64
end program test_floor
```

See also: Section 7.38 [CEILING], page 65, Section 7.164 [NINT], page 136

# 7.76 FLUSH — Flush I/O unit(s)

Description:

Flushes Fortran unit(s) currently open for output. Without the optional argument, all units are flushed, otherwise just the unit specified.

Standard: GNU extension

Class: Subroutine

Syntax: CALL FLUSH(UNIT)

Arguments:

UNIT (Optional) The type shall be INTEGER.

Note: Beginning with the Fortran 2003 standard, there is a FLUSH statement that

should be preferred over the FLUSH intrinsic.

## 7.77 FNUM — File number function

Description:

FNUM(UNIT) returns the POSIX file descriptor number corresponding to the

open Fortran I/O unit UNIT.

Standard: GNU extension

Class: Function

Syntax: RESULT = FNUM(UNIT)

Arguments:

UNIT The type shall be INTEGER.

Return value:

The return value is of type INTEGER

Example:

```
program test_fnum
  integer :: i
  open (unit=10, status = "scratch")
  i = fnum(10)
  print *, i
  close (10)
end program test_fnum
```

# 7.78 FPUT — Write a single character in stream mode to stdout

Description:

Write a single character in stream mode to stdout by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the FGET intrinsic is provided for backwards compatibility with g77. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 4.1 [Fortran 2003 status], page 29.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL FPUT(C [, STATUS])

Arguments:

C The type shall be CHARACTER and of default kind.

STATUS (Optional) status flag of type INTEGER. Returns 0 on suc-

cess, -1 on end-of-file and a system specific positive error code

otherwise.

Example:

```
PROGRAM test_fput
  CHARACTER(len=10) :: str = "gfortran"
  INTEGER :: i
  DO i = 1, len_trim(str)
    CALL fput(str(i:i))
  END DO
END PROGRAM
```

See also: Section 7.79 [FPUTC], page 91, Section 7.73 [FGET], page 87, Section 7.74

[FGETC], page 88

## 7.79 FPUTC — Write a single character in stream mode

Description:

Write a single character in stream mode by bypassing normal formatted output. Stream I/O should not be mixed with normal record-oriented (formatted or unformatted) I/O on the same unit; the results are unpredictable.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Note that the FGET intrinsic is provided for backwards compatibility with g77. GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 4.1 [Fortran 2003 status], page 29.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL FPUTC(UNIT, C [, STATUS])

Arguments:

UNIT The type shall be INTEGER.

C The type shall be CHARACTER and of default kind.

STATUS (Optional) status flag of type INTEGER. Returns 0 on suc-

cess, -1 on end-of-file and a system specific positive error code

otherwise.

Example:

```
PROGRAM test_fputc
  CHARACTER(len=10) :: str = "gfortran"
  INTEGER :: fd = 42, i

  OPEN(UNIT = fd, FILE = "out", ACTION = "WRITE", STATUS="NEW")
  DO i = 1, len_trim(str)
     CALL fputc(fd, str(i:i))
  END DO
  CLOSE(fd)
END PROGRAM
```

See also: Section 7.78 [FPUT], page 90, Section 7.73 [FGET], page 87, Section 7.74 [FGETC], page 88

## 7.80 FRACTION — Fractional part of the model representation

Description:

FRACTION(X) returns the fractional part of the model representation of X.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: Y = FRACTION(X)

Arguments:

X The type of the argument shall be a REAL.

Return value:

The return value is of the same type and kind as the argument. The fractional part of the model representation of X is returned; it is X \* RADIX(X) \*\*(-EXPONENT(X)).

Example:

```
program test_fraction
  real :: x
  x = 178.1387e-4
  print *, fraction(x), x * radix(x)**(-exponent(x))
end program test_fraction
```

## 7.81 FREE — Frees memory

Description:

Frees memory previously allocated by MALLOC(). The FREE intrinsic is an extension intended to be used with Cray pointers, and is provided in GNU Fortran to allow user to compile legacy code. For new code using Fortran 95 pointers, the memory de-allocation intrinsic is DEALLOCATE.

Standard: GNU extension

Class: Subroutine

Syntax: CALL FREE (PTR)

Arguments:

PTR The type shall be INTEGER. It represents the location of the

memory that should be de-allocated.

Return value:

None

Example: See MALLOC for an example.

See also: Section 7.145 [MALLOC], page 126

# 7.82 FSEEK — Low level file positioning subroutine

#### Description:

Moves UNIT to the specified OFFSET. If WHENCE is set to 0, the OFFSET is taken as an absolute value SEEK\_SET, if set to 1, OFFSET is taken to be

relative to the current position SEEK\_CUR, and if set to 2 relative to the end of the file SEEK\_END. On error, *STATUS* is set to a nonzero value. If *STATUS* the seek fails silently.

This intrinsic routine is not fully backwards compatible with g77. In g77, the FSEEK takes a statement label instead of a *STATUS* variable. If FSEEK is used in old code, change

```
CALL FSEEK(UNIT, OFFSET, WHENCE, *label)
to

INTEGER :: status
CALL FSEEK(UNIT, OFFSET, WHENCE, status)
IF (status /= 0) GOTO label
```

Please note that GNU Fortran provides the Fortran 2003 Stream facility. Programmers should consider the use of new stream IO feature in new code for future portability. See also Section 4.1 [Fortran 2003 status], page 29.

Standard: GNU extension

Class: Subroutine

Syntax: CALL FSEEK(UNIT, OFFSET, WHENCE[, STATUS])

Arguments:

UNIT Shall be a scalar of type INTEGER.

OFFSET Shall be a scalar of type INTEGER.

WHENCE Shall be a scalar of type INTEGER. Its value shall be either 0,

1 or 2.

STATUS (Optional) shall be a scalar of type INTEGER(4).

Example:

```
PROGRAM test_fseek
  INTEGER, PARAMETER :: SEEK_SET = 0, SEEK_CUR = 1, SEEK_END = 2
  INTEGER :: fd, offset, ierr
  ierr
         = 0
  offset = 5
        = 10
  OPEN(UNIT=fd, FILE="fseek.test")
  CALL FSEEK(fd, offset, SEEK_SET, ierr) ! move to OFFSET
  print *, FTELL(fd), ierr
  CALL FSEEK(fd, 0, SEEK_END, ierr)
                                          ! move to end
  print *, FTELL(fd), ierr
  CALL FSEEK(fd, 0, SEEK_SET, ierr)
                                          ! move to beginning
  print *, FTELL(fd), ierr
  CLOSE(UNIT=fd)
END PROGRAM
```

See also: Section 7.84 [FTELL], page 94

## 7.83 FSTAT — Get file status

Description:

FSTAT is identical to Section 7.206 [STAT], page 159, except that information about an already opened file is obtained.

The elements in BUFF are the same as described by Section 7.206 [STAT], page 159.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL FSTAT(UNIT, BUFF [, STATUS])

Arguments:

UNIT An open I/O unit number of type INTEGER.

BUFF The type shall be INTEGER(4), DIMENSION(13).

STATUS (Optional) status flag of type INTEGER(4). Returns 0 on suc-

cess and a system specific error code otherwise.

Example: See Section 7.206 [STAT], page 159 for an example.

See also: To stat a link: Section 7.143 [LSTAT], page 124, to stat a file: Section 7.206

[STAT], page 159

## 7.84 FTELL — Current stream position

Description:

Retrieves the current position within an open file.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL FTELL(UNIT, OFFSET)
OFFSET = FTELL(UNIT)

Arguments:

OFFSET Shall of type INTEGER.
UNIT Shall of type INTEGER.

Return value:

In either syntax, OFFSET is set to the current offset of unit number UNIT, or to -1 if the unit is not currently open.

Example:

PROGRAM test\_ftell INTEGER :: i

OPEN(10, FILE="temp.dat")
CALL ftell(10,i)
WRITE(\*,\*) i
END PROGRAM

See also: Section 7.82 [FSEEK], page 92

### 7.85 GAMMA — Gamma function

Description:

GAMMA(X) computes Gamma ( $\Gamma$ ) of X. For positive, integer values of X the Gamma function simplifies to the factorial function  $\Gamma(x) = (x-1)!$ .

$$\Gamma(x) = \int_0^\infty t^{x-1} e^{-t} dt$$

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: X = GAMMA(X)

Arguments:

X Shall be of type REAL and neither zero nor a negative integer.

Return value:

The return value is of type REAL of the same kind as X.

Example:

program test\_gamma
 real :: x = 1.0
 x = gamma(x) ! returns 1.0
end program test\_gamma

Specific names:

Name Argument Return type Standard
GAMMA(X) REAL(4) X REAL(4) GNU Extension
DGAMMA(X) REAL(8) X REAL(8) GNU Extension

See also: Logarithm of the Gamma function: Section 7.139 [LOG\_GAMMA], page 123

# 7.86 GERROR — Get last system error message

Description:

Returns the system error message corresponding to the last system error. This resembles the functionality of strerror(3) in C.

Standard: GNU extension

Class: Subroutine

Syntax: CALL GERROR (RESULT)

Arguments:

RESULT Shall of type CHARACTER and of default

#### Example:

```
PROGRAM test_gerror
CHARACTER(len=100) :: msg
CALL gerror(msg)
WRITE(*,*) msg
END PROGRAM
```

See also: Section 7.110 [IERRNO], page 108, Section 7.169 [PERROR], page 139

## 7.87 GETARG — Get command line arguments

#### Description:

Retrieve the *POS*-th argument that was passed on the command line when the containing program was invoked.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 7.89 [GET\_COMMAND\_ARGUMENT], page 97 intrinsic defined by the Fortran 2003 standard.

Standard: GNU extension

Class: Subroutine

Syntax: CALL GETARG (POS, VALUE)

Arguments:

POS Shall be of type INTEGER and not wider than the default in-

teger kind;  $POS \geq 0$ 

VALUE Shall be of type CHARACTER and of default kind.

VALUE Shall be of type CHARACTER.

#### Return value:

After GETARG returns, the VALUE argument holds the POSth command line argument. If VALUE can not hold the argument, it is truncated to fit the length of VALUE. If there are less than POS arguments specified at the command line, VALUE will be filled with blanks. If POS = 0, VALUE is set to the name of the program (on systems that support this feature).

#### Example:

```
PROGRAM test_getarg
  INTEGER :: i
  CHARACTER(len=32) :: arg

DO i = 1, iargc()
  CALL getarg(i, arg)
  WRITE (*,*) arg
  END DO
END PROGRAM
```

 $See \ also:$ 

GNU Fortran 77 compatibility function: Section 7.103 [IARGC], page 104 Fortran 2003 functions and subroutines: Section 7.88 [GET\_COMMAND], page 97, Section 7.89 [GET\_COMMAND\_ARGUMENT], page 97, Section 7.43 [COMMAND\_ARGUMENT\_COUNT], page 69

## 7.88 GET\_COMMAND — Get the entire command line

Description:

Retrieve the entire command line that was used to invoke the program.

Standard: Fortran 2003 and later

Class: Subroutine

Syntax: CALL GET\_COMMAND(COMMAND)

Arguments:

COMMAND Shall be of type CHARACTER and of default kind.

Return value:

Stores the entire command line that was used to invoke the program in COM-MAND. If COMMAND is not large enough, the command will be truncated.

Example:

PROGRAM test\_get\_command
CHARACTER(len=255) :: cmd
CALL get\_command(cmd)
WRITE (\*,\*) TRIM(cmd)
END PROGRAM

See also: Section 7.89 [GET\_COMMAND\_ARGUMENT], page 97, Section 7.43 [COM-

MAND\_ARGUMENT\_COUNT], page 69

## 7.89 GET\_COMMAND\_ARGUMENT — Get command line arguments

Description:

Retrieve the *NUMBER*-th argument that was passed on the command line when the containing program was invoked.

Standard: Fortran 2003 and later

Class: Subroutine

Syntax: CALL GET\_COMMAND\_ARGUMENT(NUMBER [, VALUE, LENGTH, STATUS])

Arguments:

NUMBER Shall be a scalar of type INTEGER(4), NUMBER  $\geq 0$ VALUE Shall be a scalar of type CHARACTER and of default kind.

LENGTH (Option) Shall be a scalar of type INTEGER(4).

STATUS (Option) Shall be a scalar of type INTEGER(4).

Return value:

After GET\_COMMAND\_ARGUMENT returns, the VALUE argument holds the NUMBER-th command line argument. If VALUE can not hold the argument, it is truncated to fit the length of VALUE. If there are less than NUMBER arguments specified at the command line, VALUE will be filled with blanks. If NUMBER = 0, VALUE is set to the name of the program (on systems that support this feature). The LENGTH argument contains the length of the NUMBER-th command line argument. If the argument retrieval fails, STATUS is a positive number; if VALUE contains a truncated command line argument, STATUS is -1; and otherwise the STATUS is zero.

#### Example:

```
PROGRAM test_get_command_argument
   INTEGER :: i
   CHARACTER(len=32) :: arg

i = 0
   DO
        CALL get_command_argument(i, arg)
        IF (LEN_TRIM(arg) == 0) EXIT

   WRITE (*,*) TRIM(arg)
        i = i+1
   END DO
END PROGRAM
```

See also: Section 7.88 [GET\_COMMAND], page 97, Section 7.43 [COMMAND\_ARGUMENT\_COUNT], page 69

## 7.90 GETCWD — Get current working directory

Description:

Get current working directory.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL GETCWD(C [, STATUS])

Arguments:

C The type shall be CHARACTER and of default kind.

STATUS (Optional) status flag. Returns 0 on success, a system specific

and nonzero error code otherwise.

Example:

```
PROGRAM test_getcwd
CHARACTER(len=255) :: cwd
CALL getcwd(cwd)
WRITE(*,*) TRIM(cwd)
END PROGRAM
```

See also: Section 7.40 [CHDIR], page 66

### 7.91 GETENV — Get an environmental variable

Description:

Get the VALUE of the environmental variable NAME.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 7.92 [GET\_ENVIRONMENT\_VARIABLE], page 99 intrinsic defined by the Fortran 2003 standard.

Standard: GNU extension

Class: Subroutine

Syntax: CALL GETENV (NAME, VALUE)

Arguments:

NAME Shall be of type CHARACTER and of default kind. VALUE Shall be of type CHARACTER and of default kind.

Return value:

Stores the value of *NAME* in *VALUE*. If *VALUE* is not large enough to hold the data, it is truncated. If *NAME* is not set, *VALUE* will be filled with blanks.

Example:

PROGRAM test\_getenv
CHARACTER(len=255) :: homedir
CALL getenv("HOME", homedir)
WRITE (\*,\*) TRIM(homedir)
END PROGRAM

See also: Section 7.92 [GET\_ENVIRONMENT\_VARIABLE], page 99

# 7.92 GET\_ENVIRONMENT\_VARIABLE — Get an environmental variable

Description:

Get the VALUE of the environmental variable NAME.

Standard: Fortran 2003 and later

Class: Subroutine

Syntax: CALL GET\_ENVIRONMENT\_VARIABLE(NAME[, VALUE, LENGTH, STATUS,

TRIM\_NAME)

Arguments:

NAME Shall be a scalar of type CHARACTER(1).

VALUE Shall be a scalar of type CHARACTER(1).

LENGTH Shall be a scalar of type INTEGER(4).

STATUS Shall be a scalar of type INTEGER(4).

TRIM\_NAME Shall be a scalar of type LOGICAL(4).

Return value:

Stores the value of NAME in VALUE. If VALUE is not large enough to hold the data, it is truncated. If NAME is not set, VALUE will be filled with blanks. Argument LENGTH contains the length needed for storing the environment variable NAME or zero if it is not present. STATUS is -1 if VALUE is present but too short for the environment variable; it is 1 if the environment variable does not exist and 2 if the processor does not support environment variables; in all other cases STATUS is zero. If TRIM\_NAME is present with the value .FALSE., the trailing blanks in NAME are significant; otherwise they are not part of the environment variable name.

Example:

```
PROGRAM test_getenv
CHARACTER(len=255) :: homedir
CALL get_environment_variable("HOME", homedir)
WRITE (*,*) TRIM(homedir)
END PROGRAM
```

# 7.93 GETGID — Group ID function

Description:

Returns the numerical group ID of the current process.

Standard: GNU extension

Class: Function

Syntax: RESULT = GETGID()

Return value:

The return value of GETGID is an INTEGER of the default kind.

Example: See GETPID for an example.

See also: Section 7.95 [GETPID], page 101, Section 7.96 [GETUID], page 101

# 7.94 GETLOG — Get login name

Description:

Gets the username under which the program is running.

Standard: GNU extension

Class: Subroutine

Syntax: CALL GETLOG(C)

Arguments:

C Shall be of type CHARACTER and of default kind.

Return value:

Stores the current user name in *LOGIN*. (On systems where POSIX functions geteuid and getpwuid are not available, and the getlogin function is not implemented either, this will return a blank string.)

Example:

PROGRAM TEST\_GETLOG
CHARACTER(32) :: login
CALL GETLOG(login)
WRITE(\*,\*) login
END PROGRAM

See also: Section 7.96 [GETUID], page 101

#### 7.95 GETPID — Process ID function

Description:

Returns the numerical process identifier of the current process.

Standard: GNU extension

Class: Function

Syntax: RESULT = GETPID()

Return value:

The return value of GETPID is an INTEGER of the default kind.

Example:

```
program info
  print *, "The current process ID is ", getpid()
  print *, "Your numerical user ID is ", getuid()
  print *, "Your numerical group ID is ", getgid()
end program info
```

See also: Section 7.93 [GETGID], page 100, Section 7.96 [GETUID], page 101

### 7.96 GETUID — User ID function

Description:

Returns the numerical user ID of the current process.

Standard: GNU extension

Class: Function

Syntax: RESULT = GETUID()

Return value:

The return value of GETUID is an INTEGER of the default kind.

Example: See GETPID for an example.

See also: Section 7.95 [GETPID], page 101, Section 7.94 [GETLOG], page 100

### 7.97 GMTIME — Convert time to GMT info

Description:

Given a system time value *TIME* (as provided by the TIME8() intrinsic), fills *VALUES* with values extracted from it appropriate to the UTC time zone (Universal Coordinated Time, also known in some countries as GMT, Greenwich Mean Time), using gmtime(3).

Standard: GNU extension

Class: Subroutine

Syntax: CALL GMTIME(TIME, VALUES)

Arguments:

TIME An INTEGER scalar expression corresponding to a system time,

with INTENT(IN).

VALUES A default INTEGER array with 9 elements, with INTENT (OUT).

#### Return value:

The elements of VALUES are assigned as follows:

- 1. Seconds after the minute, range 0–59 or 0–61 to allow for leap seconds
- 2. Minutes after the hour, range 0-59
- 3. Hours past midnight, range 0–23
- 4. Day of month, range 0-31
- 5. Number of months since January, range 0–12
- 6. Years since 1900
- 7. Number of days since Sunday, range 0-6
- 8. Days since January 1
- 9. Daylight savings indicator: positive if daylight savings is in effect, zero if not, and negative if the information is not available.

See also: Section 7.51 [CTIME], page 74, Section 7.144 [LTIME], page 125, Section 7.213 [TIME], page 164, Section 7.214 [TIME8], page 164

## 7.98 HOSTNM — Get system host name

#### Description:

Retrieves the host name of the system on which the program is running.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL HOSTNM(C [, STATUS])
STATUS = HOSTNM(NAME)

Arguments:

C Shall of type CHARACTER and of default kind.

STATUS (Optional) status flag of type INTEGER. Returns 0 on success,

or a system specific error code otherwise.

#### Return value:

In either syntax, *NAME* is set to the current hostname if it can be obtained, or to a blank string otherwise.

# 7.99 HUGE — Largest number of a kind

Description:

HUGE(X) returns the largest number that is not an infinity in the model of the type of X.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = HUGE(X)

*Arguments*:

X Shall be of type REAL or INTEGER.

Return value:

The return value is of the same type and kind as X

Example:

```
program test_huge_tiny
  print *, huge(0), huge(0.0), huge(0.0d0)
  print *, tiny(0.0), tiny(0.0d0)
end program test_huge_tiny
```

#### 7.100 HYPOT — Euclidean distance function

Description:

HYPOT(X,Y) is the Euclidean distance function. It is equal to  $\sqrt{X^2 + Y^2}$ , without undue underflow or overflow.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = HYPOT(X, Y)

Arguments:

X The type shall be REAL.

Y The type and kind type parameter shall be the same as X.

Return value:

The return value has the same type and kind type parameter as X.

Example:

```
program test_hypot
  real(4) :: x = 1.e0_4, y = 0.5e0_4
  x = hypot(x,y)
end program test_hypot
```

# 7.101 IACHAR — Code in ASCII collating sequence

Description:

IACHAR(C) returns the code for the ASCII character in the first character position of C.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = IACHAR(C [, KIND])

Arguments:

C Shall be a scalar CHARACTER, with INTENT(IN)

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

Example:

```
program test_iachar
  integer i
  i = iachar(' ')
end program test_iachar
```

Note: See Section 7.107 [ICHAR], page 106 for a discussion of converting between

numerical values and formatted string representations.

See also: Section 7.5 [ACHAR], page 45, Section 7.39 [CHAR], page 66, Section 7.107

[ICHAR], page 106

## 7.102 IAND — Bitwise logical and

Description:

Bitwise logical AND.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = IAND(I, J)

Arguments:

I The type shall be INTEGER.

J The type shall be INTEGER, of the same kind as I. (As a GNU

extension, different kinds are also permitted.)

Return value:

The return type is INTEGER, of the same kind as the arguments. (If the argument kinds differ, it is of the same kind as the larger argument.)

Example:

```
PROGRAM test_iand
INTEGER :: a, b
DATA a / Z'F' /, b / Z'3' /
WRITE (*,*) IAND(a, b)
END PROGRAM
```

See also:

Section 7.115 [IOR], page 111, Section 7.109 [IEOR], page 108, Section 7.105 [IBITS], page 105, Section 7.106 [IBSET], page 106, Section 7.104 [IBCLR], page 105, Section 7.165 [NOT], page 137

# 7.103 IARGC — Get the number of command line arguments

Description:

IARGC() returns the number of arguments passed on the command line when the containing program was invoked.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. In new code, programmers should consider the use of the Section 7.43

[COMMAND\_ARGUMENT\_COUNT], page 69 intrinsic defined by the Fortran 2003 standard.

Standard: GNU extension

Class: Function

Syntax: RESULT = IARGC()

Arguments:

None.

Return value:

The number of command line arguments, type INTEGER(4).

Example: See Section 7.87 [GETARG], page 96

See also: GNU Fortran 77 compatibility subroutine: Section 7.87 [GETARG], page 96

Fortran 2003 functions and subroutines: Section 7.88 [GET\_COMMAND], page 97, Section 7.89 [GET\_COMMAND\_ARGUMENT], page 97, Section 7.43

[COMMAND\_ARGUMENT\_COUNT], page 69

#### 7.104 IBCLR — Clear bit

Description:

IBCLR returns the value of I with the bit at position POS set to zero.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = IBCLR(I, POS)

Arguments:

I The type shall be INTEGER.

POS The type shall be INTEGER.

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.105 [IBITS], page 105, Section 7.106 [IBSET], page 106, Section 7.102

[IAND], page 104, Section 7.115 [IOR], page 111, Section 7.109 [IEOR],

page 108, Section 7.161 [MVBITS], page 135

#### 7.105 IBITS — Bit extraction

Description:

IBITS extracts a field of length *LEN* from *I*, starting from bit position *POS* and extending left for *LEN* bits. The result is right-justified and the remaining bits are zeroed. The value of POS+LEN must be less than or equal to the value BIT\_SIZE(I).

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = IBITS(I, POS, LEN)

Arguments:

I The type shall be INTEGER.

POS The type shall be INTEGER.

LEN The type shall be INTEGER.

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.30 [BIT\_SIZE], page 60, Section 7.104 [IBCLR], page 105, Section 7.106 [IBSET], page 106, Section 7.102 [IAND], page 104, Section 7.115 [IOR], page 111, Section 7.109 [IEOR], page 108

#### 7.106 IBSET — Set bit

Description:

IBSET returns the value of I with the bit at position POS set to one.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = IBSET(I, POS)

Arguments:

I The type shall be INTEGER. POS The type shall be INTEGER.

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.104 [IBCLR], page 105, Section 7.105 [IBITS], page 105, Section 7.102 [IAND], page 104, Section 7.115 [IOR], page 111, Section 7.109 [IEOR], page 108, Section 7.161 [MVBITS], page 135

# 7.107 ICHAR — Character-to-integer conversion function

Description:

ICHAR(C) returns the code for the character in the first character position of C in the system's native character set. The correspondence between characters and their codes is not necessarily the same across different GNU Fortran implementations.

Standard: Fortan 95 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = ICHAR(C [, KIND])

Arguments:

C Shall be a scalar CHARACTER, with INTENT(IN)

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

Example:

```
program test_ichar
  integer i
  i = ichar(' ')
end program test_ichar
```

Note:

No intrinsic exists to convert between a numeric value and a formatted character string representation – for instance, given the CHARACTER value '154', obtaining an INTEGER or REAL value with the value 154, or vice versa. Instead, this functionality is provided by internal-file I/O, as in the following example:

```
program read_val
  integer value
  character(len=10) string, string2
  string = '154'

! Convert a string to a numeric value
  read (string,'(I10)') value
  print *, value

! Convert a value to a formatted string
  write (string2,'(I10)') value
  print *, string2
end program read_val
```

See also: Section 7.5 [ACHAR], page 45, Section 7.39 [CHAR], page 66, Section 7.101 [IACHAR], page 103

# 7.108 IDATE — Get current local time subroutine (day/month/year)

Description:

IDATE(TARRAY) Fills TARRAY with the numerical values at the current local time. The day (in the range 1-31), month (in the range 1-12), and year appear in elements 1, 2, and 3 of TARRAY, respectively. The year has four significant digits.

Standard: GNU extension

Class: Subroutine

Syntax: CALL IDATE(VALUES)

Arguments:

VALUES The type shall be INTEGER, DIMENSION(3) and the kind shall

be the default integer kind.

Return value:

Does not return anything.

Example:

```
program test_idate
  integer, dimension(3) :: tarray
  call idate(tarray)
  print *, tarray(1)
  print *, tarray(2)
  print *, tarray(3)
end program test_idate
```

# 7.109 IEOR — Bitwise logical exclusive or

Description:

**IEOR** returns the bitwise boolean exclusive-OR of I and J.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = IEOR(I, J)

*Arguments*:

I The type shall be INTEGER.

J The type shall be INTEGER, of the same kind as I. (As a GNU

extension, different kinds are also permitted.)

Return value:

The return type is INTEGER, of the same kind as the arguments. (If the argument kinds differ, it is of the same kind as the larger argument.)

See also: Section 7.115 [IOR], page 111, Section 7.102 [IAND], page 104, Section 7.105 [IBITS], page 105, Section 7.106 [IBSET], page 106, Section 7.104 [IBCLR], page 105, Section 7.165 [NOT], page 137

## 7.110 IERRNO — Get the last system error number

Description:

Returns the last system error number, as given by the C errno() function.

Standard: GNU extension

Class: Function

Syntax: RESULT = IERRNO()

Arguments:

None.

Return value:

The return value is of type INTEGER and of the default integer kind.

See also: Section 7.169 [PERROR], page 139

## 7.111 INDEX — Position of a substring within a string

Description:

Returns the position of the start of the first occurrence of string SUBSTRING as a substring in STRING, counting from one. If SUBSTRING is not present in STRING, zero is returned. If the BACK argument is present and true, the return value is the start of the last occurrence rather than the first.

Standard: Fortran 77 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = INDEX(STRING, SUBSTRING [, BACK [, KIND]])

Arguments:

STRING Shall be a scalar CHARACTER, with INTENT(IN) SUBSTRING Shall be a scalar CHARACTER, with INTENT(IN)

BACK (Optional) Shall be a scalar LOGICAL, with INTENT(IN)
KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

See also: Section 7.186 [SCAN], page 148, Section 7.225 [VERIFY], page 169

## 7.112 INT — Convert to integer type

Description:

Convert to integer type

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = INT(A [, KIND))

Arguments:

A Shall be of type INTEGER, REAL, or COMPLEX.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

These functions return a INTEGER variable or array under the following rules:

- (A) If A is of type INTEGER, INT(A) = A
- (B) If A is of type REAL and |A| < 1, INT(A) equals 0. If  $|A| \ge 1$ , then INT(A) equals the largest integer that does not exceed the range of A and whose sign is the same as the sign of A.
- (C) If A is of type COMPLEX, rule B is applied to the real part of A.

Example:

```
program test_int
  integer :: i = 42
  complex :: z = (-3.7, 1.0)
  print *, int(i)
  print *, int(z), int(z,8)
end program
```

Specific names:

Name	Argument	Return type	Standard
IFIX(A)	REAL(4) A	INTEGER	Fortran 77 and later
IDINT(A)	REAL(8) A	INTEGER	Fortran 77 and later

## 7.113 INT2 — Convert to 16-bit integer type

Description:

Convert to a KIND=2 integer type. This is equivalent to the standard INT intrinsic with an optional argument of KIND=2, and is only included for backwards compatibility.

The SHORT intrinsic is equivalent to INT2.

Standard: GNU extension

Class: Elemental function
Syntax: RESULT = INT2(A)

Arguments:

A Shall be of type INTEGER, REAL, or COMPLEX.

Return value:

The return value is a INTEGER(2) variable.

See also: Section 7.112 [INT], page 109, Section 7.114 [INT8], page 110, Section 7.141 [LONG], page 124

# 7.114 INT8 — Convert to 64-bit integer type

Description:

Convert to a KIND=8 integer type. This is equivalent to the standard INT intrinsic with an optional argument of KIND=8, and is only included for backwards compatibility.

Standard: GNU extension

Class: Elemental function
Syntax: RESULT = INT8(A)

Arguments:

A Shall be of type INTEGER, REAL, or COMPLEX.

Return value:

The return value is a INTEGER(8) variable.

See also: Section 7.112 [INT], page 109, Section 7.113 [INT2], page 110, Section 7.141 [LONG], page 124

## 7.115 IOR — Bitwise logical or

Description:

IOR returns the bitwise boolean inclusive-OR of I and J.

Standard: Fortran 95 and later
Class: Elemental function
Syntax: RESULT = IOR(I, J)

Arguments:

I The type shall be INTEGER.

J The type shall be INTEGER, of the same kind as I. (As a GNU

extension, different kinds are also permitted.)

Return value:

The return type is INTEGER, of the same kind as the arguments. (If the argument kinds differ, it is of the same kind as the larger argument.)

See also:

Section 7.109 [IEOR], page 108, Section 7.102 [IAND], page 104, Section 7.105 [IBITS], page 105, Section 7.106 [IBSET], page 106, Section 7.104 [IBCLR], page 105, Section 7.165 [NOT], page 137

## 7.116 IRAND — Integer pseudo-random number

Description:

IRAND(FLAG) returns a pseudo-random number from a uniform distribution between 0 and a system-dependent limit (which is in most cases 2147483647). If FLAG is 0, the next number in the current sequence is returned; if FLAG is 1, the generator is restarted by CALL SRAND(0); if FLAG has any other value, it is used as a new seed with SRAND.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. It implements a simple modulo generator as provided by g77. For new code, one should consider the use of Section 7.176 [RANDOM\_NUMBER], page 143 as it implements a superior algorithm.

Standard: GNU extension

Class: Function

Syntax: RESULT = IRAND(I)

Arguments:

I Shall be a scalar INTEGER of kind 4.

Return value:

The return value is of INTEGER(kind=4) type.

Example:

```
program test_irand
  integer,parameter :: seed = 86456

call srand(seed)
  print *, irand(), irand(), irand()
  print *, irand(seed), irand(), irand()
end program test_irand
```

### 7.117 IS\_IOSTAT\_END — Test for end-of-file value

Description:

IS\_IOSTAT\_END tests whether an variable has the value of the I/O status "end of file". The function is equivalent to comparing the variable with the IOSTAT\_END parameter of the intrinsic module ISO\_FORTRAN\_ENV.

Standard: Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = IS\_IOSTAT\_END(I)

Arguments:

I Shall be of the type INTEGER.

Return value:

Returns a LOGICAL of the default kind, which .TRUE. if I has the value which indicates an end of file condition for IOSTAT= specifiers, and is .FALSE. otherwise.

Example:

```
PROGRAM iostat

IMPLICIT NONE

INTEGER :: stat, i

OPEN(88, FILE='test.dat')

READ(88, *, IOSTAT=stat) i

IF(IS_IOSTAT_END(stat)) STOP 'END OF FILE'

END PROGRAM
```

# 7.118 IS\_IOSTAT\_EOR — Test for end-of-record value

Description:

IS\_IOSTAT\_EOR tests whether an variable has the value of the I/O status "end of record". The function is equivalent to comparing the variable with the IOSTAT\_EOR parameter of the intrinsic module ISO\_FORTRAN\_ENV.

Standard: Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = IS\_IOSTAT\_EOR(I)

Arguments:

I Shall be of the type INTEGER.

Return value:

Returns a LOGICAL of the default kind, which .TRUE. if I has the value which indicates an end of file condition for IOSTAT= specifiers, and is .FALSE. otherwise.

Example:

```
PROGRAM iostat

IMPLICIT NONE

INTEGER :: stat, i(50)

OPEN(88, FILE='test.dat', FORM='UNFORMATTED')
```

```
READ(88, IOSTAT=stat) i
  IF(IS_IOSTAT_EOR(stat)) STOP 'END OF RECORD'
END PROGRAM
```

#### 7.119 ISATTY — Whether a unit is a terminal device.

Description:

Determine whether a unit is connected to a terminal device.

Standard: GNU extension

Class: Function

Syntax: RESULT = ISATTY(UNIT)

Arguments:

UNIT Shall be a scalar INTEGER.

Return value:

Returns .TRUE. if the *UNIT* is connected to a terminal device, .FALSE. otherwise.

Example:

```
PROGRAM test_isatty
INTEGER(kind=1) :: unit
DO unit = 1, 10
   write(*,*) isatty(unit=unit)
END DO
END PROGRAM
```

See also: Section 7.220 [TTYNAM], page 167

### 7.120 ISHFT — Shift bits

Description:

ISHFT returns a value corresponding to *I* with all of the bits shifted *SHIFT* places. A value of *SHIFT* greater than zero corresponds to a left shift, a value of zero corresponds to no shift, and a value less than zero corresponds to a right shift. If the absolute value of *SHIFT* is greater than BIT\_SIZE(I), the value is undefined. Bits shifted out from the left end or right end are lost; zeros are shifted in from the opposite end.

Standard: Fortran 95 and later
Class: Elemental function

Syntax: RESULT = ISHFT(I, SHIFT)

Arguments:

I The type shall be INTEGER.
SHIFT The type shall be INTEGER.

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.121 [ISHFTC], page 114

## 7.121 ISHFTC — Shift bits circularly

Description:

ISHFTC returns a value corresponding to *I* with the rightmost *SIZE* bits shifted circularly *SHIFT* places; that is, bits shifted out one end are shifted into the opposite end. A value of *SHIFT* greater than zero corresponds to a left shift, a value of zero corresponds to no shift, and a value less than zero corresponds to a right shift. The absolute value of *SHIFT* must be less than *SIZE*. If the *SIZE* argument is omitted, it is taken to be equivalent to BIT\_SIZE(I).

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = ISHFTC(I, SHIFT [, SIZE])

Arguments:

I The type shall be INTEGER. SHIFT The type shall be INTEGER.

SIZE (Optional) The type shall be INTEGER; the value must be

greater than zero and less than or equal to BIT\_SIZE(I).

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.120 [ISHFT], page 113

#### 7.122 ISNAN — Test for a NaN

Description:

ISNAN tests whether a floating-point value is an IEEE Not-a-Number (NaN).

Standard: GNU extension

Class: Elemental function

Syntax: ISNAN(X)

Arguments:

X Variable of the type REAL.

Return value:

Returns a default-kind LOGICAL. The returned value is TRUE if X is a NaN and FALSE otherwise.

Example:

```
program test_nan
  implicit none
  real :: x
  x = -1.0
  x = sqrt(x)
  if (isnan(x)) stop '"x" is a NaN'
end program test_nan
```

# 7.123 ITIME — Get current local time subroutine (hour/minutes/seconds)

Description:

IDATE(VALUES) Fills VALUES with the numerical values at the current local time. The hour (in the range 1-24), minute (in the range 1-60), and seconds (in the range 1-60) appear in elements 1, 2, and 3 of VALUES, respectively.

Standard: GNU extension

Class: Subroutine

Syntax: CALL ITIME (VALUES)

*Arguments*:

VALUES The type shall be INTEGER, DIMENSION(3) and the kind shall

be the default integer kind.

Return value:

Does not return anything.

Example:

```
program test_itime
  integer, dimension(3) :: tarray
  call itime(tarray)
  print *, tarray(1)
  print *, tarray(2)
  print *, tarray(3)
end program test_itime
```

# 7.124 KILL — Send a signal to a process

Description:

Standard: Sends the signal specified by SIGNAL to the process PID. See kill(2).

This intrinsic is provided in both subroutine and function forms; however, only

one form can be used in any given program unit.

Class: Subroutine, function

Syntax: CALL KILL(C, VALUE [, STATUS])

Arguments:

C Shall be a scalar INTEGER, with INTENT(IN)
VALUE Shall be a scalar INTEGER, with INTENT(IN)

STATUS (Optional) status flag of type INTEGER(4) or INTEGER(8).

Returns 0 on success, or a system-specific error code

otherwise.

See also: Section 7.2 [ABORT], page 43, Section 7.68 [EXIT], page 85

# 7.125 KIND — Kind of an entity

Description:

KIND(X) returns the kind value of the entity X.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: K = KIND(X)

Arguments:

X Shall be of type LOGICAL, INTEGER, REAL, COMPLEX or

CHARACTER.

Return value:

The return value is a scalar of type INTEGER and of the default integer kind.

Example:

```
program test_kind
  integer,parameter :: kc = kind(' ')
  integer,parameter :: kl = kind(.true.)

print *, "The default character kind is ", kc
  print *, "The default logical kind is ", kl
end program test_kind
```

## 7.126 LBOUND — Lower dimension bounds of an array

Description:

Returns the lower bounds of an array, or a single lower bound along the DIM dimension.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = LBOUND(ARRAY [, DIM [, KIND]])

Arguments:

ARRAY Shall be an array, of any type.

DIM (Optional) Shall be a scalar INTEGER.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind. If DIM is absent, the result is an array of the lower bounds of ARRAY. If DIM is present, the result is a scalar corresponding to the lower bound of the array along that dimension. If ARRAY is an expression rather than a whole array or array structure component, or if it has a zero extent along the relevant dimension, the lower bound is taken to be 1.

See also: Section 7.221 [UBOUND], page 167

# 7.127 LEADZ — Number of leading zero bits of an integer

Description:

LEADZ returns the number of leading zero bits of an integer.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = LEADZ(I)

Arguments:

I Shall be of type INTEGER.

Return value:

The type of the return value is the default INTEGER. If all the bits of I are zero, the result value is BIT\_SIZE(I).

Example:

PROGRAM test\_leadz

WRITE (\*,\*) LEADZ(1) ! prints 8 if BITSIZE(I) has the value 32
END PROGRAM

See also: Section 7.30 [BIT\_SIZE], page 60, Section 7.216 [TRAILZ], page 165

## 7.128 LEN — Length of a character entity

Description:

Returns the length of a character string. If STRING is an array, the length of an element of STRING is returned. Note that STRING need not be defined when this intrinsic is invoked, since only the length, not the content, of STRING is needed.

Standard: Fortran 77 and later, with KIND argument Fortran 2003 and later

Class: Inquiry function

Syntax: L = LEN(STRING [, KIND])

Arguments:

STRING Shall be a scalar or array of type CHARACTER, with INTENT(IN) KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

See also: Section 7.129 [LEN\_TRIM], page 117, Section 7.8 [ADJUSTL], page 47, Section 7.9 [ADJUSTR], page 47

# 7.129 LEN\_TRIM — Length of a character entity without trailing blank characters

Description:

Returns the length of a character string, ignoring any trailing blanks.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = LEN\_TRIM(STRING [, KIND])

Arguments:

STRING Shall be a scalar of type CHARACTER, with INTENT(IN)

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

See also: Section 7.128 [LEN], page 117, Section 7.8 [ADJUSTL], page 47, Section 7.9

[ADJUSTR], page 47

## 7.130 LGE — Lexical greater than or equal

Description:

Determines whether one string is lexically greater than or equal to another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics LGE, LGT, LLE, and LLT differ from the corresponding intrinsic operators .GE., .GT., .LE., and .LT., in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = LGE(STRING\_A, STRING\_B)

Arguments:

STRING\_A Shall be of default CHARACTER type. STRING\_B Shall be of default CHARACTER type.

Return value:

Returns .TRUE. if STRING\_A >= STRING\_B, and .FALSE. otherwise, based on the ASCII ordering.

See also: Section 7.131 [LGT], page 118, Section 7.133 [LLE], page 119, Section 7.134 [LLT], page 120

# 7.131 LGT — Lexical greater than

Description:

Determines whether one string is lexically greater than another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics LGE, LGT, LLE, and LLT differ from the corresponding intrinsic operators .GE., .GT., .LE., and .LT., in that the

latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = LGT(STRING\_A, STRING\_B)

Arguments:

STRING\_A Shall be of default CHARACTER type. STRING\_B Shall be of default CHARACTER type.

Return value:

Returns .TRUE. if STRING\_A > STRING\_B, and .FALSE. otherwise, based on the ASCII ordering.

See also: Section 7.130 [LGE], page 118, Section 7.133 [LLE], page 119, Section 7.134

[LLT], page 120

#### 7.132 LINK — Create a hard link

Description:

Makes a (hard) link from file *PATH1* to *PATH2*. A null character (CHAR(0)) can be used to mark the end of the names in *PATH1* and *PATH2*; otherwise, trailing blanks in the file names are ignored. If the *STATUS* argument is supplied, it contains 0 on success or a nonzero error code upon return; see link(2).

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL LINK(PATH1, PATH2 [, STATUS])

STATUS = LINK(PATH1, PATH2)

*Arguments*:

PATH1 Shall be of default CHARACTER type.
PATH2 Shall be of default CHARACTER type.

STATUS (Optional) Shall be of default INTEGER type.

See also: Section 7.208 [SYMLNK], page 161, Section 7.223 [UNLINK], page 168

# 7.133 LLE — Lexical less than or equal

Description:

Determines whether one string is lexically less than or equal to another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics LGE, LGT, LLE, and LLT differ from the corresponding intrinsic operators .GE., .GT., .LE., and .LT., in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = LLE(STRING\_A, STRING\_B)

Arguments:

STRING\_A Shall be of default CHARACTER type. STRING\_B Shall be of default CHARACTER type.

Return value:

Returns .TRUE. if STRING\_A <= STRING\_B, and .FALSE. otherwise, based on the ASCII ordering.

See also: Section 7.130 [LGE], page 118, Section 7.131 [LGT], page 118, Section 7.134 [LLT], page 120

#### 7.134 LLT — Lexical less than

#### Description:

Determines whether one string is lexically less than another string, where the two strings are interpreted as containing ASCII character codes. If the String A and String B are not the same length, the shorter is compared as if spaces were appended to it to form a value that has the same length as the longer.

In general, the lexical comparison intrinsics LGE, LGT, LLE, and LLT differ from the corresponding intrinsic operators .GE., .GT., .LE., and .LT., in that the latter use the processor's character ordering (which is not ASCII on some targets), whereas the former always use the ASCII ordering.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = LLT(STRING\_A, STRING\_B)

Arguments:

STRING\_A Shall be of default CHARACTER type. STRING\_B Shall be of default CHARACTER type.

Return value:

Returns .TRUE. if STRING\_A < STRING\_B, and .FALSE. otherwise, based on the ASCII ordering.

See also: Section 7.130 [LGE], page 118, Section 7.131 [LGT], page 118, Section 7.133 [LLE], page 119

# 7.135 LNBLNK — Index of the last non-blank character in a string

Description:

Returns the length of a character string, ignoring any trailing blanks. This is identical to the standard LEN\_TRIM intrinsic, and is only included for backwards compatibility.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = LNBLNK(STRING)

Arguments:

STRING Shall be a scalar of type CHARACTER, with INTENT(IN)

Return value:

The return value is of INTEGER(kind=4) type.

See also: Section 7.111 [INDEX intrinsic], page 109, Section 7.129 [LEN\_TRIM], page 117

### 7.136 LOC — Returns the address of a variable

Description:

LOC(X) returns the address of X as an integer.

Standard: GNU extension

Class: Inquiry function

Syntax: RESULT = LOC(X)

Arguments:

X Variable of any type.

Return value:

The return value is of type INTEGER, with a KIND corresponding to the size (in bytes) of a memory address on the target machine.

Example:

```
program test_loc
  integer :: i
  real :: r
  i = loc(r)
  print *, i
end program test_loc
```

# 7.137 LOG — Logarithm function

Description:

LOG(X) computes the logarithm of X.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = LOG(X)

Arguments:

X The type shall be REAL or COMPLEX.

Return value:

The return value is of type REAL or COMPLEX. The kind type parameter is the same as X. If X is COMPLEX, the imaginary part  $\omega$  is in the range  $-\pi \leq \omega \leq \pi$ .

Example:

```
program test_log
  real(8) :: x = 1.0_8
  complex :: z = (1.0, 2.0)
  x = log(x)
  z = log(z)
end program test_log
```

Specific names:

Name	Argument	Return type	Standard
ALOG(X)	REAL(4) X	REAL(4)	f95, gnu
DLOG(X)	REAL(8) X	REAL(8)	f95, gnu
CLOG(X)	COMPLEX(4) X	COMPLEX(4)	f95, gnu
ZLOG(X)	COMPLEX(8) X	COMPLEX(8)	f95, gnu
CDLOG(X)	COMPLEX(8) X	COMPLEX(8)	f95, gnu

# 7.138 LOG10 — Base 10 logarithm function

Description:

LOG10(X) computes the base 10 logarithm of X.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = LOG10(X)

*Arguments*:

X The type shall be REAL.

Return value:

The return value is of type REAL or COMPLEX. The kind type parameter is the same as X.

Example:

```
program test_log10
  real(8) :: x = 10.0_8
  x = log10(x)
end program test_log10
```

 $Specific\ names:$ 

Name	Argument	Return type	Standard
ALOG10(X)	REAL(4) X	REAL(4)	Fortran 95 and later
DLOG10(X)	REAL(8) X	REAL(8)	Fortran 95 and later

## 7.139 LOG\_GAMMA — Logarithm of the Gamma function

Description:

 $LOG\_GAMMA(X)$  computes the natural logarithm of the absolute value of the Gamma  $(\Gamma)$  function.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: X = LOG\_GAMMA(X)

Arguments:

X Shall be of type REAL and neither zero nor a negative integer.

Return value:

The return value is of type REAL of the same kind as X.

Example:

program test\_log\_gamma
 real :: x = 1.0
 x = lgamma(x) ! returns 0.0
end program test\_log\_gamma

Specific names:

Name	Argument	Return type	Standard
LGAMMA(X)	REAL(4) X	REAL(4)	GNU Extension
ALGAMA(X)	REAL(4) X	REAL(4)	GNU Extension
DLGAMA(X)	REAL(8) X	REAL(8)	GNU Extension

See also: Gamma function: Section 7.85 [GAMMA], page 95

# 7.140 LOGICAL — Convert to logical type

Description:

Converts one kind of LOGICAL variable to another.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = LOGICAL(L [, KIND])

Arguments:

L The type shall be LOGICAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is a LOGICAL value equal to L, with a kind corresponding to KIND, or of the default logical kind if KIND is not given.

See also: Section 7.112 [INT], page 109, Section 7.179 [REAL], page 145, Section 7.42

[CMPLX], page 68

## 7.141 LONG — Convert to integer type

Description:

Convert to a KIND=4 integer type, which is the same size as a C long integer. This is equivalent to the standard INT intrinsic with an optional argument of KIND=4, and is only included for backwards compatibility.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = LONG(A)

Arguments:

A Shall be of type INTEGER, REAL, or COMPLEX.

Return value:

The return value is a INTEGER(4) variable.

See also: Section 7.112 [INT], page 109, Section 7.113 [INT2], page 110, Section 7.114

[INT8], page 110

### 7.142 LSHIFT — Left shift bits

Description:

LSHIFT returns a value corresponding to I with all of the bits shifted left by SHIFT places. If the absolute value of SHIFT is greater than  $BIT\_SIZE(I)$ , the value is undefined. Bits shifted out from the left end are lost; zeros are shifted in from the opposite end.

This function has been superseded by the ISHFT intrinsic, which is standard in Fortran 95 and later.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = LSHIFT(I, SHIFT)

Arguments:

I The type shall be INTEGER. SHIFT The type shall be INTEGER.

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.120 [ISHFT], page 113, Section 7.121 [ISHFTC], page 114, Section 7.184 [RSHIFT], page 147

#### 7.143 LSTAT — Get file status

Description:

LSTAT is identical to Section 7.206 [STAT], page 159, except that if path is a symbolic link, then the link itself is statted, not the file that it refers to.

The elements in BUFF are the same as described by Section 7.206 [STAT], page 159.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL LSTAT(FILE, BUFF [, STATUS])

Arguments:

FILE The type shall be CHARACTER of the default kind, a valid path

within the file system.

BUFF The type shall be INTEGER(4), DIMENSION(13).

STATUS (Optional) status flag of type INTEGER(4). Returns 0 on suc-

cess and a system specific error code otherwise.

Example: See Section 7.206 [STAT], page 159 for an example.

See also: To stat an open file: Section 7.83 [FSTAT], page 94, to stat a file: Section 7.206

[STAT], page 159

### 7.144 LTIME — Convert time to local time info

Description:

Given a system time value *STIME* (as provided by the TIME8() intrinsic), fills TARRAY with values extracted from it appropriate to the local time zone using localtime(3).

Standard: GNU extension

Class: Subroutine

Syntax: CALL LTIME(STIME, TARRAY)

Arguments:

STIME An INTEGER scalar expression corresponding to a system time,

with INTENT(IN).

TARRAY A default INTEGER array with 9 elements, with INTENT (OUT).

Return value:

The elements of TARRAY are assigned as follows:

- 1. Seconds after the minute, range 0–59 or 0–61 to allow for leap seconds
- 2. Minutes after the hour, range 0-59
- 3. Hours past midnight, range 0-23
- 4. Day of month, range 0-31
- 5. Number of months since January, range 0–12
- 6. Years since 1900
- 7. Number of days since Sunday, range 0-6
- 8. Days since January 1

9. Daylight savings indicator: positive if daylight savings is in effect, zero if not, and negative if the information is not available.

See also: Section 7.51 [CTIME], page 74, Section 7.97 [GMTIME], page 101, Section 7.213 [TIME], page 164, Section 7.214 [TIME8], page 164

## 7.145 MALLOC — Allocate dynamic memory

Description:

MALLOC(SIZE) allocates SIZE bytes of dynamic memory and returns the address of the allocated memory. The MALLOC intrinsic is an extension intended to be used with Cray pointers, and is provided in GNU Fortran to allow the user to compile legacy code. For new code using Fortran 95 pointers, the memory allocation intrinsic is ALLOCATE.

Standard: GNU extension

Class: Function

Syntax: PTR = MALLOC(SIZE)

*Arguments*:

SIZE The type shall be INTEGER.

Return value:

The return value is of type INTEGER(K), with K such that variables of type INTEGER(K) have the same size as C pointers (sizeof(void \*)).

Example: The following example demonstrates the use of MALLOC and FREE with Cray pointers.

```
program test_malloc
  implicit none
  integer i
 real*8 x(*), z
 pointer(ptr_x,x)
  ptr_x = malloc(20*8)
  do i = 1, 20
   x(i) = sqrt(1.0d0 / i)
  end do
 z = 0
  do i = 1, 20
   z = z + x(i)
   print *, z
  end do
  call free(ptr_x)
end program test_malloc
```

See also: Section 7.81 [FREE], page 92

# 7.146 MATMUL — matrix multiplication

Description:

Performs a matrix multiplication on numeric or logical arguments.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = MATMUL(MATRIX\_A, MATRIX\_B)

Arguments:

MATRIX\_A An array of INTEGER, REAL, COMPLEX, or LOGICAL type, with

a rank of one or two.

MATRIX\_B An array of INTEGER, REAL, or COMPLEX type if MATRIX\_A is

of a numeric type; otherwise, an array of LOGICAL type. The rank shall be one or two, and the first (or only) dimension of  $MATRIX_{-}B$  shall be equal to the last (or only) dimension of

 $MATRIX\_A$ .

Return value:

The matrix product of  $MATRIX\_A$  and  $MATRIX\_B$ . The type and kind of the result follow the usual type and kind promotion rules, as for the \* or .AND. operators.

See also:

# 7.147 MAX — Maximum value of an argument list

Description:

Returns the argument with the largest (most positive) value.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = MAX(A1, A2 [, A3 [, ...]])

*Arguments*:

A1 The type shall be INTEGER or REAL.

 $A2, A3, \dots$  An expression of the same type and kind as A1. (As a GNU

extension, arguments of different kinds are permitted.)

Return value:

The return value corresponds to the maximum value among the arguments, and has the same type and kind as the first argument.

Specific names:

Name	Argument	Return type	Standard
MAXO(I)	INTEGER(4) I	INTEGER(4)	Fortran 77 and later
AMAXO(I)	INTEGER(4) I	REAL(MAX(X))	Fortran 77 and later
MAX1(X)	REAL X	<pre>INT(MAX(X))</pre>	Fortran 77 and later
AMAX1(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DMAX1(X)	REAL(8) X	REAL(8)	Fortran 77 and later

See also: Section 7.149 [MAXLOC], page 128 Section 7.150 [MAXVAL], page 129,

Section 7.154 [MIN], page 131

## 7.148 MAXEXPONENT — Maximum exponent of a real kind

Description:

MAXEXPONENT(X) returns the maximum exponent in the model of the type of X.

Standard: Fortran 95 and later Inquiry function

Syntax: RESULT = MAXEXPONENT(X)

Arguments:

Class:

X Shall be of type REAL.

Return value:

The return value is of type INTEGER and of the default integer kind.

Example:

```
program exponents
  real(kind=4) :: x
  real(kind=8) :: y
  print *, minexponent(x), maxexponent(x)
  print *, minexponent(y), maxexponent(y)
end program exponents
```

# 7.149 MAXLOC — Location of the maximum value within an array

Description:

Determines the location of the element in the array with the maximum value, or, if the DIM argument is supplied, determines the locations of the maximum element along each row of the array in the DIM direction. If MASK is present, only the elements for which MASK is .TRUE. are considered. If more than one element in the array has the maximum value, the location returned is that of the first such element in array element order. If the array has zero size, or all of the elements of MASK are .FALSE., then the result is an array of zeroes. Similarly, if DIM is supplied and all of the elements of MASK along a given row are zero, the result value for that row is zero.

Fortran 95 and later Standard:

Class: Transformational function

Syntax:

RESULT = MAXLOC(ARRAY, DIM [, MASK]) RESULT = MAXLOC(ARRAY [, MASK])

*Arguments*:

ARRAYShall be an array of type INTEGER, REAL, or CHARACTER.

DIM(Optional) Shall be a scalar of type INTEGER, with a value

between one and the rank of ARRAY, inclusive. It may not

be an optional dummy argument.

MASKShall be an array of type LOGICAL, and conformable with

ARRAY.

#### Return value:

If DIM is absent, the result is a rank-one array with a length equal to the rank of ARRAY. If DIM is present, the result is an array with a rank one less than the rank of ARRAY, and a size corresponding to the size of ARRAY with the DIM dimension removed. If DIM is present and ARRAY has a rank of one, the result is a scalar. In all cases, the result is of default INTEGER type.

See also: Section 7.147 [MAX], page 127, Section 7.150 [MAXVAL], page 129

## 7.150 MAXVAL — Maximum value of an array

#### Description:

Determines the maximum value of the elements in an array value, or, if the DIM argument is supplied, determines the maximum value along each row of the array in the DIM direction. If MASK is present, only the elements for which MASK is .TRUE. are considered. If the array has zero size, or all of the elements of MASK are .FALSE., then the result is -HUGE(ARRAY) if ARRAY is numeric, or a string of nulls if ARRAY is of character type.

Standard: Fortran 95 and later

Class: Transformational function

Syntax:

RESULT = MAXVAL(ARRAY, DIM [, MASK])
RESULT = MAXVAL(ARRAY [, MASK])

Arguments:

ARRAY Shall be an array of type INTEGER, REAL, or CHARACTER.

DIM (Optional) Shall be a scalar of type INTEGER, with a value

between one and the rank of ARRAY, inclusive. It may not

be an optional dummy argument.

MASK Shall be an array of type LOGICAL, and conformable with

ARRAY.

#### Return value:

If DIM is absent, or if ARRAY has a rank of one, the result is a scalar. If DIM is present, the result is an array with a rank one less than the rank of ARRAY, and a size corresponding to the size of ARRAY with the DIM dimension removed. In all cases, the result is of the same type and kind as ARRAY.

See also: Section 7.147 [MAX], page 127, Section 7.149 [MAXLOC], page 128

#### 7.151 MCLOCK — Time function

#### Description:

Returns the number of clock ticks since the start of the process, based on the UNIX function clock(3).

This intrinsic is not fully portable, such as to systems with 32-bit INTEGER types but supporting times wider than 32 bits. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

Standard: GNU extension

Class: Function

Syntax: RESULT = MCLOCK()

Return value:

The return value is a scalar of type INTEGER(4), equal to the number of clock ticks since the start of the process, or -1 if the system does not support clock(3).

See also:

Section 7.51 [CTIME], page 74, Section 7.97 [GMTIME], page 101, Section 7.144 [LTIME], page 125, Section 7.151 [MCLOCK], page 129, Section 7.213 [TIME], page 164

## 7.152 MCLOCK8 — Time function (64-bit)

#### Description:

Returns the number of clock ticks since the start of the process, based on the UNIX function clock(3).

Warning: this intrinsic does not increase the range of the timing values over that returned by clock(3). On a system with a 32-bit clock(3), MCLOCK8() will return a 32-bit value, even though it is converted to a 64-bit INTEGER(8) value. That means overflows of the 32-bit value can still occur. Therefore, the values returned by this intrinsic might be or become negative or numerically less than previous values during a single run of the compiled program.

Standard: GNU extension

Class: Function

Syntax: RESULT = MCLOCK8()

Return value:

The return value is a scalar of type INTEGER(8), equal to the number of clock ticks since the start of the process, or -1 if the system does not support clock(3).

See also:

Section 7.51 [CTIME], page 74, Section 7.97 [GMTIME], page 101, Section 7.144 [LTIME], page 125, Section 7.151 [MCLOCK], page 129, Section 7.214 [TIME8], page 164

# 7.153 MERGE — Merge variables

Description:

Select values from two arrays according to a logical mask. The result is equal to TSOURCE if MASK is .TRUE., or equal to FSOURCE if it is .FALSE..

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = MERGE(TSOURCE, FSOURCE, MASK)

Arguments:

TSOURCE May be of any type.

FSOURCE Shall be of the same type and type parameters as TSOURCE.

MASK Shall be of type LOGICAL.

Return value:

The result is of the same type and type parameters as TSOURCE.

# 7.154 MIN — Minimum value of an argument list

Description:

Returns the argument with the smallest (most negative) value.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = MIN(A1, A2 [, A3, ...])

Arguments:

A1 The type shall be INTEGER or REAL.

 $A2, A3, \dots$  An expression of the same type and kind as A1. (As a GNU

extension, arguments of different kinds are permitted.)

Return value:

The return value corresponds to the maximum value among the arguments, and has the same type and kind as the first argument.

Specific names:

Name	Argument	Return type	Standard
MINO(I)	INTEGER(4) I	INTEGER(4)	Fortran 77 and later
AMINO(I)	INTEGER(4) I	REAL(MIN(X))	Fortran 77 and later
MIN1(X)	REAL X	<pre>INT(MIN(X))</pre>	Fortran 77 and later
AMIN1(X)	REAL(4) X	REAL(4)	Fortran 77 and later
DMIN1(X)	REAL(8) X	REAL(8)	Fortran 77 and later

See also: Section 7.147 [MAX], page 127, Section 7.156 [MINLOC], page 132,

Section 7.157 [MINVAL], page 132

# 7.155 MINEXPONENT — Minimum exponent of a real kind

Description:

MINEXPONENT(X) returns the minimum exponent in the model of the type of X.

Standard: Fortran 95 and later Class: Inquiry function

Syntax: RESULT = MINEXPONENT(X)

*Arguments*:

X Shall be of type REAL.

Return value:

The return value is of type INTEGER and of the default integer kind.

Example: See MAXEXPONENT for an example.

# 7.156 MINLOC — Location of the minimum value within an array

#### Description:

Determines the location of the element in the array with the minimum value, or, if the DIM argument is supplied, determines the locations of the minimum element along each row of the array in the DIM direction. If MASK is present, only the elements for which MASK is .TRUE. are considered. If more than one element in the array has the minimum value, the location returned is that of the first such element in array element order. If the array has zero size, or all of the elements of MASK are .FALSE., then the result is an array of zeroes. Similarly, if DIM is supplied and all of the elements of MASK along a given row are zero, the result value for that row is zero.

Standard: Fortran 95 and later

Class: Transformational function

Syntax:

RESULT = MINLOC(ARRAY, DIM [, MASK])
RESULT = MINLOC(ARRAY [, MASK])

Arguments:

ARRAY Shall be an array of type INTEGER, REAL, or CHARACTER.

DIM (Optional) Shall be a scalar of type INTEGER, with a value

between one and the rank of ARRAY, inclusive. It may not

be an optional dummy argument.

MASK Shall be an array of type LOGICAL, and conformable with

ARRAY.

Return value:

If DIM is absent, the result is a rank-one array with a length equal to the rank of ARRAY. If DIM is present, the result is an array with a rank one less than the rank of ARRAY, and a size corresponding to the size of ARRAY with the DIM dimension removed. If DIM is present and ARRAY has a rank of one, the result is a scalar. In all cases, the result is of default INTEGER type.

See also: Section 7.154 [MIN], page 131, Section 7.157 [MINVAL], page 132

## 7.157 MINVAL — Minimum value of an array

Description:

Determines the minimum value of the elements in an array value, or, if the DIM argument is supplied, determines the minimum value along each row of the array in the DIM direction. If MASK is present, only the elements for which MASK is .TRUE. are considered. If the array has zero size, or all of the elements of MASK are .FALSE., then the result is HUGE(ARRAY) if ARRAY is numeric, or a string of CHAR(255) characters if ARRAY is of character type.

Standard: Fortran 95 and later

Class: Transformational function

Syntax:

RESULT = MINVAL(ARRAY, DIM [, MASK])
RESULT = MINVAL(ARRAY [, MASK])

Arguments:

ARRAY Shall be an array of type INTEGER, REAL, or CHARACTER.

DIM (Optional) Shall be a scalar of type INTEGER, with a value

between one and the rank of ARRAY, inclusive. It may not

be an optional dummy argument.

MASK Shall be an array of type LOGICAL, and conformable with

ARRAY.

Return value:

If DIM is absent, or if ARRAY has a rank of one, the result is a scalar. If DIM is present, the result is an array with a rank one less than the rank of ARRAY, and a size corresponding to the size of ARRAY with the DIM dimension removed. In all cases, the result is of the same type and kind as ARRAY.

See also: Section 7.154 [MIN], page 131, Section 7.156 [MINLOC], page 132

### 7.158 MOD — Remainder function

Description:

MOD(A,P) computes the remainder of the division of A by P. It is calculated as A - (INT(A/P) \* P).

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = MOD(A, P)

*Arguments*:

A Shall be a scalar of type INTEGER or REAL

P Shall be a scalar of the same type as A and not equal to zero

Return value:

The kind of the return value is the result of cross-promoting the kinds of the arguments.

Example:

```
program test_mod
  print *, mod(17,3)
  print *, mod(17.5,5.5)
  print *, mod(17.5d0,5.5)
  print *, mod(17.5,5.5d0)

print *, mod(-17,3)
  print *, mod(-17.5,5.5)
  print *, mod(-17.5d0,5.5)
  print *, mod(-17.5,5.5d0)

print *, mod(17,-3)
  print *, mod(17,-3)
  print *, mod(17.5,-5.5)
```

```
print *, mod(17.5d0,-5.5)
print *, mod(17.5,-5.5d0)
end program test_mod
```

Specific names:

Name	Arguments	Return type	Standard
AMOD(A,P)	REAL(4)	REAL(4)	Fortran 95 and later
DMOD(A,P)	REAL(8)	REAL(8)	Fortran 95 and later

#### 7.159 MODULO — Modulo function

Description:

MODULO(A,P) computes the A modulo P.

Standard: Fortran 95 and later
Class: Elemental function

Syntax: RESULT = MODULO(A, P)

Arguments:

A Shall be a scalar of type INTEGER or REAL

P Shall be a scalar of the same type and kind as A

Return value:

The type and kind of the result are those of the arguments.

If A and P are of type INTEGER:

MODULO(A,P) has the value R such that A=Q\*P+R, where Q is an integer and R is between 0 (inclusive) and P (exclusive).

If A and P are of type REAL:

MODULO(A,P) has the value of A - FLOOR (A / P) \* P.

In all cases, if P is zero the result is processor-dependent.

#### Example:

```
program test_modulo
  print *, modulo(17,3)
  print *, modulo(17.5,5.5)

print *, modulo(-17,3)
  print *, modulo(-17.5,5.5)

print *, modulo(17,-3)
  print *, modulo(17.5,-5.5)
end program
```

# 7.160 MOVE\_ALLOC — Move allocation from one object to another

Description:

MOVE\_ALLOC(SRC, DEST) moves the allocation from SRC to DEST. SRC will become deallocated in the process.

Standard: Fortran 2003 and later

Class: Subroutine

Syntax: CALL MOVE\_ALLOC(SRC, DEST)

Arguments:

SRC ALLOCATABLE, INTENT(INOUT), may be of any type and kind.
DEST ALLOCATABLE, INTENT(OUT), shall be of the same type, kind

and rank as SRC.

Return value:

None

Example:

```
program test_move_alloc
    integer, allocatable :: a(:), b(:)

allocate(a(3))
    a = [ 1, 2, 3 ]
    call move_alloc(a, b)
    print *, allocated(a), allocated(b)
    print *, b
end program test_move_alloc
```

## 7.161 MVBITS — Move bits from one integer to another

Description:

Moves *LEN* bits from positions *FROMPOS* through FROMPOS+LEN-1 of *FROM* to positions *TOPOS* through TOPOS+LEN-1 of *TO*. The portion of argument *TO* not affected by the movement of bits is unchanged. The values of FROMPOS+LEN-1 and TOPOS+LEN-1 must be less than BIT\_SIZE(FROM).

Standard: Fortran 95 and later
Class: Elemental subroutine

Syntax: CALL MVBITS (FROM, FROMPOS, LEN, TO, TOPOS)

Arguments:

FROM The type shall be INTEGER. FROMPOS The type shall be INTEGER. LEN The type shall be INTEGER.

TO The type shall be INTEGER, of the same kind as FROM.

TOPOS The type shall be INTEGER.

See also: Section 7.104 [IBCLR], page 105, Section 7.106 [IBSET], page 106, Section 7.105 [IBITS], page 105, Section 7.102 [IAND], page 104, Section 7.115

[IOR], page 111, Section 7.109 [IEOR], page 108

# 7.162 NEAREST — Nearest representable number

Description:

NEAREST(X, S) returns the processor-representable number nearest to X in the direction indicated by the sign of S.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = NEAREST(X, S)

Arguments:

X Shall be of type REAL.

S (Optional) shall be of type REAL and not equal to zero.

#### Return value:

The return value is of the same type as X. If S is positive, NEAREST returns the processor-representable number greater than X and nearest to it. If S is negative, NEAREST returns the processor-representable number smaller than X and nearest to it.

#### Example:

```
program test_nearest
  real :: x, y
  x = nearest(42.0, 1.0)
  y = nearest(42.0, -1.0)
  write (*,"(3(G20.15))") x, y, x - y
end program test_nearest
```

## 7.163 NEW\_LINE — New line character

Description:

NEW\_LINE(C) returns the new-line character.

Standard: Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = NEW\_LINE(C)

Arguments:

C The argument shall be a scalar or array of the type

CHARACTER.

Return value:

Returns a CHARACTER scalar of length one with the new-line character of the same kind as parameter C.

Example:

```
program newline
  implicit none
  write(*,'(A)') 'This is record 1.'//NEW_LINE('A')//'This is record 2.'
end program newline
```

### 7.164 NINT — Nearest whole number

Description:

NINT(X) rounds its argument to the nearest whole number.

Standard: Fortran 77 and later, with KIND argument Fortran 90 and later

Class: Elemental function

Syntax: RESULT = NINT(X [, KIND])

Arguments:

X The type of the argument shall be REAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

Returns A with the fractional portion of its magnitude eliminated by rounding to the nearest whole number and with its sign preserved, converted to an INTEGER of the default kind.

Example:

```
program test_nint
  real(4) x4
  real(8) x8
  x4 = 1.234E0_4
  x8 = 4.321_8
  print *, nint(x4), idnint(x8)
end program test_nint
```

Specific names:

Name Argument Standard

IDNINT(X) REAL(8) Fortran 95 and later

See also: Section 7.38 [CEILING], page 65, Section 7.75 [FLOOR], page 89

## 7.165 NOT — Logical negation

Description:

NOT returns the bitwise boolean inverse of I.

Standard: Fortran 95 and later
Class: Elemental function
Syntax: RESULT = NOT(I)

Arguments:

I The type shall be INTEGER.

Return value:

The return type is INTEGER, of the same kind as the argument.

See also: Section 7.102 [IAND], page 104, Section 7.109 [IEOR], page 108, Section 7.115 [IOR], page 111, Section 7.105 [IBITS], page 105, Section 7.106 [IBSET],

page 106, Section 7.104 [IBCLR], page 105

# 7.166 NULL — Function that returns an disassociated pointer

Description:

Returns a disassociated pointer.

If *MOLD* is present, a dissassociated pointer of the same type is returned, otherwise the type is determined by context.

In Fortran 95, MOLD is optional. Please note that Fortran 2003 includes cases where it is required.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: PTR => NULL([MOLD])

*Arguments*:

MOLD (Optional) shall be a pointer of any association status and of

any type.

Return value:

A disassociated pointer.

Example:

```
REAL, POINTER, DIMENSION(:) :: VEC => NULL ()
```

See also: Section 7.20 [ASSOCIATED], page 54

## 7.167 OR — Bitwise logical OR

Description:

Bitwise logical OR.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. For integer arguments, programmers should consider the use of the Section 7.115 [IOR], page 111 intrinsic defined by the Fortran standard.

Standard: GNU extension

Class: Function

Syntax: RESULT = OR(X, Y)

*Arguments*:

X The type shall be either a scalar INTEGER type or a scalar

LOGICAL type.

Y The type shall be the same as the type of X.

Return value:

The return type is either a scalar INTEGER or a scalar LOGICAL. If the kind type parameters differ, then the smaller kind type is implicitly converted to larger kind, and the return has the larger kind.

Example:

```
PROGRAM test_or
LOGICAL :: T = .TRUE., F = .FALSE.
INTEGER :: a, b
DATA a / Z'F' /, b / Z'3' /

WRITE (*,*) OR(T, T), OR(T, F), OR(F, T), OR(F, F)
WRITE (*,*) OR(a, b)
END PROGRAM
```

See also: Fortran 95 elemental function: Section 7.115 [IOR], page 111

## 7.168 PACK — Pack an array into an array of rank one

Description:

Stores the elements of ARRAY in an array of rank one.

The beginning of the resulting array is made up of elements whose MASK equals TRUE. Afterwards, positions are filled with elements taken from VECTOR.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = PACK(ARRAY, MASK[, VECTOR]

Arguments:

ARRAY Shall be an array of any type.

MASK Shall be an array of type LOGICAL and of the same size as

ARRAY. Alternatively, it may be a LOGICAL scalar.

VECTOR (Optional) shall be an array of the same type as ARRAY and

of rank one. If present, the number of elements in VECTOR shall be equal to or greater than the number of true elements in MASK. If MASK is scalar, the number of elements in VECTOR shall be equal to or greater than the number of elements

in ARRAY.

Return value:

The result is an array of rank one and the same type as that of ARRAY. If VECTOR is present, the result size is that of VECTOR, the number of TRUE values in MASK otherwise.

Example: Gathering nonzero elements from an array:

```
PROGRAM test_pack_1
    INTEGER :: m(6)
    m = (/ 1, 0, 0, 0, 5, 0 /)
    WRITE(*, FMT="(6(IO, ''))") pack(m, m /= 0) ! "1 5"
END PROGRAM
```

Gathering nonzero elements from an array and appending elements from VEC-TOR:

```
PROGRAM test_pack_2
INTEGER :: m(4)
m = (/ 1, 0, 0, 2 /)
WRITE(*, FMT="(4(I0, ''))") pack(m, m /= 0, (/ 0, 0, 3, 4 /)) ! "1 2 3 4"
END PROGRAM
```

See also: Section 7.224 [UNPACK], page 169

## 7.169 PERROR — Print system error message

Description:

Prints (on the C stderr stream) a newline-terminated error message corresponding to the last system error. This is prefixed by *STRING*, a colon and a space. See perror(3).

Standard: GNU extension

Class: Subroutine

Syntax: CALL PERROR(STRING)

Arguments:

STRING A scalar of type CHARACTER and of the default kind.

See also: Section 7.110 [IERRNO], page 108

## 7.170 PRECISION — Decimal precision of a real kind

Description:

PRECISION(X) returns the decimal precision in the model of the type of X.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = PRECISION(X)

*Arguments*:

X Shall be of type REAL or COMPLEX.

Return value:

The return value is of type INTEGER and of the default integer kind.

Example:

```
program prec_and_range
  real(kind=4) :: x(2)
  complex(kind=8) :: y

print *, precision(x), range(x)
  print *, precision(y), range(y)
end program prec_and_range
```

# 7.171 PRESENT — Determine whether an optional dummy argument is specified

Description:

Determines whether an optional dummy argument is present.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = PRESENT(A)

Arguments:

A May be of any type and may be a pointer, scalar or array

value, or a dummy procedure. It shall be the name of an optional dummy argument accessible within the current sub-

routine or function.

Return value:

Returns either TRUE if the optional argument A is present, or FALSE otherwise.

Example:

```
PROGRAM test_present

WRITE(*,*) f(), f(42) ! "F T"

CONTAINS

LOGICAL FUNCTION f(x)

INTEGER, INTENT(IN), OPTIONAL :: x

f = PRESENT(x)

END FUNCTION

END PROGRAM
```

## 7.172 PRODUCT — Product of array elements

Description:

Multiplies the elements of ARRAY along dimension DIM if the corresponding element in MASK is TRUE.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = PRODUCT(ARRAY[, MASK]) RESULT = PRODUCT(ARRAY, DIM[, MASK])

Arguments:

ARRAY Shall be an array of type INTEGER, REAL or COMPLEX.

DIM (Optional) shall be a scalar of type INTEGER with a value in

the range from 1 to n, where n equals the rank of ARRAY.

MASK (Optional) shall be of type LOGICAL and either be a scalar or

an array of the same shape as ARRAY.

Return value:

The result is of the same type as ARRAY.

If DIM is absent, a scalar with the product of all elements in ARRAY is returned. Otherwise, an array of rank n-1, where n equals the rank of ARRAY, and a shape similar to that of ARRAY with dimension DIM dropped is returned.

#### Example:

See also: Section 7.207 [SUM], page 160

#### 7.173 RADIX — Base of a model number

Description:

RADIX(X) returns the base of the model representing the entity X.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = RADIX(X)

*Arguments*:

X Shall be of type INTEGER or REAL

Return value:

The return value is a scalar of type INTEGER and of the default integer kind.

Example:

```
program test_radix
  print *, "The radix for the default integer kind is", radix(0)
  print *, "The radix for the default real kind is", radix(0.0)
end program test_radix
```

## 7.174 RAN — Real pseudo-random number

Description:

For compatibility with HP FORTRAN 77/iX, the RAN intrinsic is provided as an alias for RAND. See Section 7.175 [RAND], page 142 for complete documentation.

Standard: GNU extension

Class: Function

See also: Section 7.175 [RAND], page 142, Section 7.176 [RANDOM\_NUMBER],

page 143

## 7.175 RAND — Real pseudo-random number

Description:

RAND(FLAG) returns a pseudo-random number from a uniform distribution between 0 and 1. If FLAG is 0, the next number in the current sequence is returned; if FLAG is 1, the generator is restarted by CALL SRAND(0); if FLAG has any other value, it is used as a new seed with SRAND.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. It implements a simple modulo generator as provided by g77. For new code, one should consider the use of Section 7.176 [RANDOM\_NUMBER], page 143 as it implements a superior algorithm.

Standard: GNU extension

Class: Function

Syntax: RESULT = RAND(FLAG)

Arguments:

FLAG Shall be a scalar INTEGER of kind 4.

Return value:

The return value is of REAL type and the default kind.

Example:

```
program test_rand
  integer,parameter :: seed = 86456
  call srand(seed)
```

```
print *, rand(), rand(), rand(), rand()
print *, rand(seed), rand(), rand(), rand()
end program test_rand
```

See also: Section 7.205 [SRAND], page 159, Section 7.176 [RANDOM\_NUMBER], page 143

## 7.176 RANDOM\_NUMBER — Pseudo-random number

Description:

Returns a single pseudorandom number or an array of pseudorandom numbers from the uniform distribution over the range  $0 \le x < 1$ .

The runtime-library implements George Marsaglia's KISS (Keep It Simple Stupid) random number generator (RNG). This RNG combines:

- 1. The congruential generator  $x(n) = 69069 \cdot x(n-1) + 1327217885$  with a period of  $2^{32}$ ,
- 2. A 3-shift shift-register generator with a period of  $2^{32} 1$ ,
- 3. Two 16-bit multiply-with-carry generators with a period of  $597273182964842497 > 2^{59}$ .

The overall period exceeds  $2^{123}$ .

Please note, this RNG is thread safe if used within OpenMP directives, i.e., its state will be consistent while called from multiple threads. However, the KISS generator does not create random numbers in parallel from multiple sources, but in sequence from a single source. If an OpenMP-enabled application heavily relies on random numbers, one should consider employing a dedicated parallel random number generator instead.

Standard: Fortran 95 and later

Class: Subroutine

Syntax: RANDOM\_NUMBER(HARVEST)

Arguments:

HARVEST Shall be a scalar or an array of type REAL.

Example:

```
program test_random_number
  REAL :: r(5,5)
  CALL init_random_seed()     ! see example of RANDOM_SEED
  CALL RANDOM_NUMBER(r)
end program
```

See also: Section 7.177 [RANDOM\_SEED], page 143

# 7.177 RANDOM\_SEED — Initialize a pseudo-random number sequence

Description:

Restarts or queries the state of the pseudorandom number generator used by RANDOM\_NUMBER.

If RANDOM\_SEED is called without arguments, it is initialized to a default state. The example below shows how to initialize the random seed based on the system's time.

Standard: Fortran 95 and later

Class: Subroutine

Syntax: CALL RANDOM\_SEED(SIZE, PUT, GET)

Arguments:

SIZE (Optional) Shall be a scalar and of type default INTEGER, with

INTENT (OUT). It specifies the minimum size of the arrays used

with the PUT and GET arguments.

PUT (Optional) Shall be an array of type default INTEGER and rank

one. It is INTENT(IN) and the size of the array must be larger than or equal to the number returned by the SIZE argument.

GET (Optional) Shall be an array of type default INTEGER and

rank one. It is INTENT (OUT) and the size of the array must be larger than or equal to the number returned by the SIZE

argument.

Example:

```
SUBROUTINE init_random_seed()
  INTEGER :: i, n, clock
  INTEGER, DIMENSION(:), ALLOCATABLE :: seed

CALL RANDOM_SEED(size = n)
  ALLOCATE(seed(n))

CALL SYSTEM_CLOCK(COUNT=clock)

seed = clock + 37 * (/ (i - 1, i = 1, n) /)
  CALL RANDOM_SEED(PUT = seed)

DEALLOCATE(seed)
END SUBROUTINE
```

See also: Section 7.176 [RANDOM\_NUMBER], page 143

# 7.178 RANGE — Decimal exponent range

Description:

RANGE(X) returns the decimal exponent range in the model of the type of X.

Standard: Fortran 95 and later
Class: Inquiry function
Syntax: RESULT = RANGE(X)

Arguments:

X Shall be of type INTEGER, REAL or COMPLEX.

Return value:

The return value is of type INTEGER and of the default integer kind.

Example: See PRECISION for an example.

## 7.179 REAL — Convert to real type

Description:

REAL(X [, KIND]) converts its argument X to a real type. The REALPART(X) function is provided for compatibility with g77, and its use is strongly discouraged.

Standard: Fortran 77 and later
Class: Elemental function

Syntax:

RESULT = REAL(X [, KIND])
RESULT = REALPART(Z)

Arguments:

X Shall be INTEGER, REAL, or COMPLEX.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

These functions return a REAL variable or array under the following rules:

- (A) REAL(X) is converted to a default real type if X is an integer or real variable.
- (B) REAL(X) is converted to a real type with the kind type parameter of X if X is a complex variable.
- (C) REAL(X, KIND) is converted to a real type with kind type parameter KIND if X is a complex, integer, or real variable.

Example:

```
program test_real
  complex :: x = (1.0, 2.0)
  print *, real(x), real(x,8), realpart(x)
end program test_real
```

See also: Section 7.53 [DBLE], page 75, Section 7.55 [DFLOAT], page 76, Section 7.72 [FLOAT], page 87

#### 7.180 RENAME — Rename a file

Description:

Renames a file from file *PATH1* to *PATH2*. A null character (CHAR(0)) can be used to mark the end of the names in *PATH1* and *PATH2*; otherwise, trailing blanks in the file names are ignored. If the *STATUS* argument is supplied, it contains 0 on success or a nonzero error code upon return; see rename(2).

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL RENAME(PATH1, PATH2 [, STATUS])
STATUS = RENAME(PATH1, PATH2)

Arguments:

PATH1 Shall be of default CHARACTER type.
PATH2 Shall be of default CHARACTER type.

STATUS (Optional) Shall be of default INTEGER type.

See also: Section 7.132 [LINK], page 119

## 7.181 REPEAT — Repeated string concatenation

Description:

Concatenates NCOPIES copies of a string.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = REPEAT(STRING, NCOPIES)

Arguments:

STRING Shall be scalar and of type CHARACTER.

NCOPIES Shall be scalar and of type INTEGER.

Return value:

A new scalar of type CHARACTER built up from NCOPIES copies of STRING.

Example:

program test\_repeat
 write(\*,\*) repeat("x", 5) ! "xxxxx"
end program

# 7.182 RESHAPE — Function to reshape an array

Description:

Reshapes SOURCE to correspond to SHAPE. If necessary, the new array may be padded with elements from PAD or permuted as defined by ORDER.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = RESHAPE(SOURCE, SHAPE[, PAD, ORDER])

Arguments:

SOURCE Shall be an array of any type.

SHAPE Shall be of type INTEGER and an array of rank one. Its values

must be positive or zero.

PAD (Optional) shall be an array of the same type as SOURCE. ORDER (Optional) shall be of type INTEGER and an array of the same

shape as SHAPE. Its values shall be a permutation of the numbers from 1 to n, where n is the size of SHAPE. If ORDER

is absent, the natural ordering shall be assumed.

Return value:

The result is an array of shape SHAPE with the same type as SOURCE.

Example:

```
PROGRAM test_reshape
INTEGER, DIMENSION(4) :: x
WRITE(*,*) SHAPE(x) ! prints "4"
WRITE(*,*) SHAPE(RESHAPE(x, (/2, 2/))) ! prints "2 2"
END PROGRAM
```

See also: Section 7.193 [SHAPE], page 152

## 7.183 RRSPACING — Reciprocal of the relative spacing

Description:

RRSPACING(X) returns the reciprocal of the relative spacing of model numbers near X.

Standard: Fortran 95 and later Class: Elemental function

Syntax: RESULT = RRSPACING(X)

Arguments:

X Shall be of type REAL.

Return value:

The return value is of the same type and kind as X. The value returned is equal to ABS(FRACTION(X)) \* FLOAT(RADIX(X)) \*\*DIGITS(X).

See also: Section 7.202 [SPACING], page 157

# 7.184 RSHIFT — Right shift bits

Description:

RSHIFT returns a value corresponding to I with all of the bits shifted right by SHIFT places. If the absolute value of SHIFT is greater than BIT\_SIZE(I), the value is undefined. Bits shifted out from the left end are lost; zeros are shifted in from the opposite end.

This function has been superseded by the ISHFT intrinsic, which is standard in Fortran 95 and later.

Standard: GNU extension

Class: Elemental function

Syntax: RESULT = RSHIFT(I, SHIFT)

*Arguments*:

I The type shall be INTEGER. SHIFT The type shall be INTEGER.

Return value:

The return value is of type INTEGER and of the same kind as I.

See also: Section 7.120 [ISHFT], page 113, Section 7.121 [ISHFTC], page 114, Section 7.142 [LSHIFT], page 124

#### 7.185 SCALE — Scale a real value

Description:

SCALE(X,I) returns X \* RADIX(X)\*\*I.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = SCALE(X, I)

*Arguments*:

X The type of the argument shall be a REAL. I The type of the argument shall be a INTEGER.

Return value:

The return value is of the same type and kind as X. Its value is X \* RADIX(X) \*\*I.

Example:

```
program test_scale
  real :: x = 178.1387e-4
  integer :: i = 5
  print *, scale(x,i), x*radix(x)**i
end program test_scale
```

# 7.186 SCAN — Scan a string for the presence of a set of characters

Description:

Scans a STRING for any of the characters in a SET of characters.

If BACK is either absent or equals FALSE, this function returns the position of the leftmost character of STRING that is in SET. If BACK equals TRUE, the rightmost position is returned. If no character of SET is found in STRING, the result is zero.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = SCAN(STRING, SET[, BACK [, KIND]])

Arguments:

STRING Shall be of type CHARACTER. SET Shall be of type CHARACTER.

BACK (Optional) shall be of type LOGICAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

Example:

```
PROGRAM test_scan

WRITE(*,*) SCAN("FORTRAN", "AO") ! 2, found 'O'

WRITE(*,*) SCAN("FORTRAN", "AO", .TRUE.) ! 6, found 'A'

WRITE(*,*) SCAN("FORTRAN", "C++") ! 0, found none

END PROGRAM
```

See also: Section 7.111 [INDEX intrinsic], page 109, Section 7.225 [VERIFY], page 169

## 7.187 SECNDS — Time function

Description:

SECNDS(X) gets the time in seconds from the real-time system clock. X is a reference time, also in seconds. If this is zero, the time in seconds from midnight is returned. This function is non-standard and its use is discouraged.

Standard: GNU extension

Class: Function

Syntax: RESULT = SECNDS (X)

*Arguments*:

T Shall be of type REAL(4). X Shall be of type REAL(4).

Return value:

None

Example:

```
program test_secnds
  integer :: i
  real(4) :: t1, t2
  print *, secnds (0.0) ! seconds since midnight
  t1 = secnds (0.0) ! reference time
  do i = 1, 10000000 ! do something
  end do
  t2 = secnds (t1) ! elapsed time
  print *, "Something took ", t2, " seconds."
end program test_secnds
```

### 7.188 SECOND — CPU time function

Description:

Returns a REAL(4) value representing the elapsed CPU time in seconds. This provides the same functionality as the standard CPU\_TIME intrinsic, and is only included for backwards compatibility.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL SECOND(TIME)
TIME = SECOND()

Arguments:

TIME Shall be of type REAL(4).

Return value:

In either syntax, TIME is set to the process's current runtime in seconds.

See also: Section 7.49 [CPU\_TIME], page 72

## 7.189 SELECTED\_CHAR\_KIND — Choose character kind

Description:

SELECTED\_CHAR\_KIND (NAME) returns the kind value for the character set named NAME, if a character set with such a name is supported, or -1 otherwise. Currently, supported character sets include "ASCII" and "DEFAULT", which are equivalent.

Standard: Fortran 2003 and later

Class: Transformational function

Syntax: RESULT = SELECTED\_CHAR\_KIND(NAME)

Arguments:

NAME Shall be a scalar and of the default character type.

Example:

```
program ascii_kind
  integer,parameter :: ascii = selected_char_kind("ascii")
  character(kind=ascii, len=26) :: s

s = ascii_"abcdefghijklmnopqrstuvwxyz"
  print *, s
end program ascii_kind
```

# 7.190 SELECTED\_INT\_KIND — Choose integer kind

Description:

SELECTED\_INT\_KIND(I) return the kind value of the smallest integer type that can represent all values ranging from  $-10^I$  (exclusive) to  $10^I$  (exclusive). If there is no integer kind that accommodates this range, SELECTED\_INT\_KIND returns -1.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = SELECTED\_INT\_KIND(I)

Arguments:

I Shall be a scalar and of type INTEGER.

Example:

```
program large_integers
  integer,parameter :: k5 = selected_int_kind(5)
  integer,parameter :: k15 = selected_int_kind(15)
  integer(kind=k5) :: i5
```

```
integer(kind=k15) :: i15

print *, huge(i5), huge(i15)

! The following inequalities are always true print *, huge(i5) >= 10_k5**5-1
print *, huge(i15) >= 10_k15**15-1
end program large_integers
```

## 7.191 SELECTED\_REAL\_KIND — Choose real kind

Description:

SELECTED\_REAL\_KIND(P,R) returns the kind value of a real data type with decimal precision of at least P digits and exponent range greater at least R.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = SELECTED\_REAL\_KIND(P, R)

Arguments:

P (Optional) shall be a scalar and of type INTEGER. R (Optional) shall be a scalar and of type INTEGER.

At least one argument shall be present.

#### Return value:

SELECTED\_REAL\_KIND returns the value of the kind type parameter of a real data type with decimal precision of at least P digits and a decimal exponent range of at least R. If more than one real data type meet the criteria, the kind of the data type with the smallest decimal precision is returned. If no real data type matches the criteria, the result is

- -1 if the processor does not support a real data type with a precision greater than or equal to P
- -2 if the processor does not support a real type with an exponent range greater than or equal to  $\tt R$
- -3 if neither is supported.

#### Example:

```
program real_kinds
  integer,parameter :: p6 = selected_real_kind(6)
  integer,parameter :: p10r100 = selected_real_kind(10,100)
  integer,parameter :: r400 = selected_real_kind(r=400)
  real(kind=p6) :: x
  real(kind=p10r100) :: y
  real(kind=r400) :: z

print *, precision(x), range(x)
  print *, precision(y), range(y)
  print *, precision(z), range(z)
end program real_kinds
```

## 7.192 SET\_EXPONENT — Set the exponent of the model

Description:

SET\_EXPONENT(X, I) returns the real number whose fractional part is that that of X and whose exponent part is I.

Standard: Fortran 95 and later Class: Elemental function

Syntax: RESULT = SET\_EXPONENT(X, I)

Arguments:

X Shall be of type REAL. I Shall be of type INTEGER.

Return value:

The return value is of the same type and kind as X. The real number whose fractional part is that that of X and whose exponent part if I is returned; it is FRACTION(X) \* RADIX(X)\*\*I.

Example:

```
PROGRAM test_setexp

REAL :: x = 178.1387e-4

INTEGER :: i = 17

PRINT *, SET_EXPONENT(x, i), FRACTION(x) * RADIX(x)**i

END PROGRAM
```

## 7.193 SHAPE — Determine the shape of an array

Description:

Determines the shape of an array.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = SHAPE(SOURCE)

Arguments:

SOURCE Shall be an array or scalar of any type. If SOURCE is a

pointer it must be associated and allocatable arrays must be

allocated.

 $Return\ value:$ 

An INTEGER array of rank one with as many elements as SOURCE has dimensions. The elements of the resulting array correspond to the extend of SOURCE along the respective dimensions. If SOURCE is a scalar, the result is the rank one array of size zero.

Example:

```
PROGRAM test_shape
INTEGER, DIMENSION(-1:1, -1:2) :: A
WRITE(*,*) SHAPE(A) ! (/ 3, 4 /)
WRITE(*,*) SIZE(SHAPE(42)) ! (/ /)
END PROGRAM
```

See also: Section 7.182 [RESHAPE], page 146, Section 7.198 [SIZE], page 155

## 7.194 SIGN — Sign copying function

Description:

SIGN(A,B) returns the value of A with the sign of B.

Standard: Fortran 77 and later
Class: Elemental function

Syntax: RESULT = SIGN(A, B)

Arguments:

A Shall be of type INTEGER or REAL

B Shall be of the same type and kind as A

Return value:

The kind of the return value is that of A and B. If  $B \ge 0$  then the result is ABS(A), else it is -ABS(A).

Example:

```
program test_sign
  print *, sign(-12,1)
  print *, sign(-12,0)
  print *, sign(-12,-1)

print *, sign(-12,1.)
  print *, sign(-12.,0.)
  print *, sign(-12.,0.)
  print *, sign(-12.,-1.)
end program test_sign
```

Specific names:

Name	Arguments	Return type	Standard
ISIGN(A,P)	INTEGER(4)	INTEGER(4)	f95, gnu
DSIGN(A,P)	REAL(8)	REAL(8)	f95, gnu

# 7.195 SIGNAL — Signal handling subroutine (or function)

Description:

SIGNAL(NUMBER, HANDLER [, STATUS]) causes external subroutine *HANDLER* to be executed with a single integer argument when signal *NUMBER* occurs. If *HANDLER* is an integer, it can be used to turn off handling of signal *NUMBER* or revert to its default action. See signal(2).

If SIGNAL is called as a subroutine and the *STATUS* argument is supplied, it is set to the value returned by signal(2).

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL SIGNAL (NUMBER, HANDLER [, STATUS])
STATUS = SIGNAL (NUMBER, HANDLER)

Arguments:

NUMBER Shall be a scalar integer, with INTENT(IN)

 $HANDLER \qquad {\tt Signal \ \ } handler \quad ({\tt INTEGER \ \, } {\tt FUNCTION} \quad {\tt or} \quad {\tt SUBROUTINE}) \quad {\tt or} \quad$ 

dummy/global INTEGER scalar. INTEGER. It is INTENT(IN).

STATUS (Optional) STATUS shall be a scalar integer. It has

INTENT(OUT).

Return value:

The SIGNAL function returns the value returned by signal(2).

Example:

program test\_signal
 intrinsic signal
 external handler\_print

call signal (12, handler\_print)
call signal (10, 1)

call sleep (30)
end program test\_signal

## 7.196 SIN — Sine function

Description:

SIN(X) computes the sine of X.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = SIN(X)

*Arguments*:

X The type shall be REAL or COMPLEX.

Return value:

The return value has same type and kind as X.

Example:

program test\_sin
 real :: x = 0.0
 x = sin(x)
end program test\_sin

Specific names:

Name	Argument	Return type	Standard
DSIN(X)	REAL(8) X	REAL(8)	f95, gnu
CSIN(X)	COMPLEX(4) X	COMPLEX(4)	f95, gnu
ZSIN(X)	COMPLEX(8) X	COMPLEX(8)	f95, gnu
CDSIN(X)	COMPLEX(8) X	COMPLEX(8)	f95, gnu

See also: Section 7.18 [ASIN], page 53

# 7.197 SINH — Hyperbolic sine function

Description:

 $\mathtt{SINH}(\mathtt{X})$  computes the hyperbolic sine of X.

Standard: Fortran 95 and later

Elemental function

Syntax: RESULT = SINH(X)

Arguments:

Class:

X The type shall be REAL.

Return value:

The return value is of type REAL.

Example:

program test\_sinh
 real(8) :: x = - 1.0\_8
 x = sinh(x)
end program test\_sinh

Specific names:

Name Argument Return type Standard

DSINH(X) REAL(8) X REAL(8) Fortran 95 and later

See also: Section 7.19 [ASINH], page 54

## 7.198 SIZE — Determine the size of an array

Description:

Determine the extent of ARRAY along a specified dimension DIM, or the total number of elements in ARRAY if DIM is absent.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = SIZE(ARRAY[, DIM [, KIND]])

Arguments:

ARRAY Shall be an array of any type. If ARRAY is a pointer it must

be associated and allocatable arrays must be allocated.

DIM (Optional) shall be a scalar of type INTEGER and its value

shall be in the range from 1 to n, where n equals the rank of

ARRAY.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

Example:

PROGRAM test\_size
WRITE(\*,\*) SIZE((/ 1, 2 /)) ! 2
END PROGRAM

See also: Section 7.193 [SHAPE], page 152, Section 7.182 [RESHAPE], page 146

## 7.199 SIZEOF — Size in bytes of an expression

Description:

SIZEOF(X) calculates the number of bytes of storage the expression X occupies.

Standard: GNU extension

Class: Intrinsic function

Syntax: N = SIZEOF(X)

Arguments:

X The argument shall be of any type, rank or shape.

Return value:

The return value is of type integer and of the system-dependent kind  $C\_SIZE\_T$  (from the  $ISO\_C\_BINDING$  module). Its value is the number of bytes occupied by the argument. If the argument has the POINTER attribute, the number of bytes of the storage area pointed to is returned. If the argument is of a derived type with POINTER or ALLOCATABLE components, the return value doesn't account for the sizes of the data pointed to by these components.

#### Example:

```
integer :: i
real :: r, s(5)
print *, (sizeof(s)/sizeof(r) == 5)
end
```

The example will print .TRUE. unless you are using a platform where default REAL variables are unusually padded.

See also: Section 7.37 [C\_SIZEOF], page 65

# 7.200 SLEEP — Sleep for the specified number of seconds

Description:

Calling this subroutine causes the process to pause for SECONDS seconds.

Standard: GNU extension

Class: Subroutine

Syntax: CALL SLEEP (SECONDS)

Arguments:

SECONDS The type shall be of default INTEGER.

Example:

```
program test_sleep
  call sleep(5)
end
```

## 7.201 SNGL — Convert double precision real to default real

Description:

SNGL(A) converts the double precision real A to a default real value. This is an archaic form of REAL that is specific to one type for A.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = SNGL(A)

*Arguments*:

A The type shall be a double precision REAL.

Return value:

The return value is of type default REAL.

See also: Section 7.53 [DBLE], page 75

# 7.202 SPACING — Smallest distance between two numbers of a given type

Description:

Determines the distance between the argument X and the nearest adjacent number of the same type.

Standard: Fortran 95 and later

Class: Elemental function

Syntax: RESULT = SPACING(X)

*Arguments*:

X Shall be of type REAL.

Return value:

The result is of the same type as the input argument X.

Example:

See also: Section 7.183 [RRSPACING], page 147

# 7.203 SPREAD — Add a dimension to an array

Description:

Replicates a SOURCE array NCOPIES times along a specified dimension DIM.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = SPREAD(SOURCE, DIM, NCOPIES)

Arguments:

SOURCE Shall be a scalar or an array of any type and a rank less than

seven.

DIM Shall be a scalar of type INTEGER with a value in the range

from 1 to n+1, where n equals the rank of SOURCE.

NCOPIES Shall be a scalar of type INTEGER.

Return value:

The result is an array of the same type as *SOURCE* and has rank n+1 where n equals the rank of *SOURCE*.

Example:

See also: Section 7.224 [UNPACK], page 169

## 7.204 SQRT — Square-root function

Description:

SQRT(X) computes the square root of X.

Standard: Fortran 77 and later Class: Elemental function

Syntax: RESULT = SQRT(X)

*Arguments*:

X The type shall be REAL or COMPLEX.

Return value:

The return value is of type REAL or COMPLEX. The kind type parameter is the same as X.

Example:

```
program test_sqrt
  real(8) :: x = 2.0_8
  complex :: z = (1.0, 2.0)
  x = sqrt(x)
  z = sqrt(z)
end program test_sqrt
```

Specific names:

Name	Argument	Return type	Standard
DSQRT(X)	REAL(8) X	REAL(8)	Fortran 95 and later
CSQRT(X)	COMPLEX(4) X	COMPLEX(4)	Fortran 95 and later
ZSQRT(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension
CDSQRT(X)	COMPLEX(8) X	COMPLEX(8)	GNU extension

## 7.205 SRAND — Reinitialize the random number generator

Description:

SRAND reinitializes the pseudo-random number generator called by RAND and IRAND. The new seed used by the generator is specified by the required argument SEED.

Standard: GNU extension

Class: Subroutine

Syntax: CALL SRAND (SEED)

Arguments:

SEED Shall be a scalar INTEGER(kind=4).

Return value:

Does not return anything.

Example: See RAND and IRAND for examples.

Notes: The Fortran 2003 standard specifies the intrinsic RANDOM\_SEED to initialize the

pseudo-random numbers generator and RANDOM\_NUMBER to generate pseudo-random numbers. Please note that in GNU Fortran, these two sets of intrinsics (RAND, IRAND and SRAND on the one hand, RANDOM\_NUMBER and RANDOM\_SEED on the other hand) access two independent pseudo-random number generators.

See also: Section 7.175 [RAND], page 142, Section 7.177 [RANDOM\_SEED], page 143,

Section 7.176 [RANDOM\_NUMBER], page 143

## 7.206 STAT — Get file status

Description:

This function returns information about a file. No permissions are required on the file itself, but execute (search) permission is required on all of the directories in path that lead to the file.

The elements that are obtained and stored in the array BUFF:

<pre>buff(1)</pre>	Device ID
buff(2)	Inode number
buff(3)	File mode
buff(4)	Number of links
buff(5)	Owner's uid
<pre>buff(6)</pre>	Owner's gid
<pre>buff(7)</pre>	ID of device containing directory entry for file (0 if not
	available)
buff(8)	File size (bytes)
buff(9)	Last access time
buff(10)	Last modification time
buff(11)	Last file status change time
buff(12)	Preferred I/O block size (-1 if not available)
buff(13)	Number of blocks allocated (-1 if not available)

Not all these elements are relevant on all systems. If an element is not relevant, it is returned as 0.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax: CALL STAT(FILE, BUFF[,STATUS])

Arguments:

FILE The type shall be CHARACTER, of the default kind and a valid

path within the file system.

BUFF The type shall be INTEGER(4), DIMENSION(13).

STATUS (Optional) status flag of type INTEGER(4). Returns 0 on suc-

cess and a system specific error code otherwise.

Example:

```
PROGRAM test_stat
  INTEGER, DIMENSION(13) :: buff
  INTEGER :: status
  CALL STAT("/etc/passwd", buff, status)
  IF (status == 0) THEN
    WRITE (*, FMT="('Device ID:',
                                                T30, I19)") buff(1)
    WRITE (*, FMT="('Inode number:',
                                                T30, I19)") buff(2)
   WRITE (*, FMT="('File mode (octal):',
                                                T30, 019)") buff(3)
   WRITE (*, FMT="('Number of links:',
                                                T30, I19)") buff(4)
    WRITE (*, FMT="('Owner''s uid:',
                                                T30, I19)") buff(5)
    WRITE (*, FMT="('Owner''s gid:',
                                                T30, I19)") buff(6)
    WRITE (*, FMT="('Device where located:',
                                                T30, I19)") buff(7)
    WRITE (*, FMT="('File size:',
                                                T30, I19)") buff(8)
    WRITE (*, FMT="('Last access time:',
                                                T30, A19)") CTIME(buff(9))
   WRITE (*, FMT="('Last modification time', T30, A19)") CTIME(buff(10))
    WRITE (*, FMT="('Last status change time:', T30, A19)") CTIME(buff(11))
    WRITE (*, FMT="('Preferred block size:',
                                             T30, I19)") buff(12)
   WRITE (*, FMT="('No. of blocks allocated:', T30, I19)") buff(13)
  END IF
END PROGRAM
```

See also: To stat an open file: Section 7.83 [FSTAT], page 94, to stat a link: Section 7.143

[LSTAT], page 124

# 7.207 SUM — Sum of array elements

Description:

Adds the elements of ARRAY along dimension DIM if the corresponding element in MASK is TRUE.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = SUM(ARRAY[, MASK]) RESULT = SUM(ARRAY, DIM[, MASK])

Arguments:

ARRAY Shall be an array of type INTEGER, REAL or COMPLEX.

DIM (Optional) shall be a scalar of type INTEGER with a value in

the range from 1 to n, where n equals the rank of ARRAY.

MASK (Optional) shall be of type LOGICAL and either be a scalar or

an array of the same shape as ARRAY.

Return value:

The result is of the same type as ARRAY.

If DIM is absent, a scalar with the sum of all elements in ARRAY is returned. Otherwise, an array of rank n-1, where n equals the rank of ARRAY, and a shape similar to that of ARRAY with dimension DIM dropped is returned.

Example:

See also: Section 7.172 [PRODUCT], page 141

## 7.208 SYMLNK — Create a symbolic link

Description:

Makes a symbolic link from file *PATH1* to *PATH2*. A null character (CHAR(0)) can be used to mark the end of the names in *PATH1* and *PATH2*; otherwise, trailing blanks in the file names are ignored. If the *STATUS* argument is supplied, it contains 0 on success or a nonzero error code upon return; see symlink(2). If the system does not supply symlink(2), ENOSYS is returned.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL SYMLNK(PATH1, PATH2 [, STATUS])

STATUS = SYMLNK(PATH1, PATH2)

Arguments:

PATH1 Shall be of default CHARACTER type. PATH2 Shall be of default CHARACTER type.

STATUS (Optional) Shall be of default INTEGER type.

See also: Section 7.132 [LINK], page 119, Section 7.223 [UNLINK], page 168

## 7.209 SYSTEM — Execute a shell command

#### Description:

Passes the command COMMAND to a shell (see system(3)). If argument STATUS is present, it contains the value returned by system(3), which is

presumably 0 if the shell command succeeded. Note that which shell is used to invoke the command is system-dependent and environment-dependent.

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL SYSTEM(COMMAND [, STATUS])
STATUS = SYSTEM(COMMAND)

Arguments:

COMMAND Shall be of default CHARACTER type.

STATUS (Optional) Shall be of default INTEGER type.

See also:

## 7.210 SYSTEM\_CLOCK — Time function

Description:

Determines the COUNT of milliseconds of wall clock time since the Epoch (00:00:00 UTC, January 1, 1970) modulo COUNT\_MAX, COUNT\_RATE determines the number of clock ticks per second. COUNT\_RATE and COUNT\_MAX are constant and specific to gfortran.

If there is no clock, COUNT is set to -HUGE(COUNT), and  $COUNT\_RATE$  and  $COUNT\_MAX$  are set to zero

Standard: Fortran 95 and later

Class: Subroutine

Syntax: CALL SYSTEM\_CLOCK([COUNT, COUNT\_RATE, COUNT\_MAX])

Arguments: Arguments:

COUNT (Optional) shall be a scalar of type default INTEGER with

INTENT (OUT).

COUNT\_RATE(Optional) shall be a scalar of type default INTEGER with

INTENT (OUT).

 $COUNT\_MAX$  (Optional) shall be a scalar of type default INTEGER with

INTENT(OUT).

Example:

PROGRAM test\_system\_clock
INTEGER :: count, count\_rate, count\_max
CALL SYSTEM\_CLOCK(count, count\_rate, count\_max)
WRITE(\*,\*) count, count\_rate, count\_max
END PROGRAM

See also: Section 7.52 [DATE\_AND\_TIME], page 74, Section 7.49 [CPU\_TIME], page 72

## 7.211 TAN — Tangent function

Description:

TAN(X) computes the tangent of X.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: RESULT = TAN(X)

Arguments:

X The type shall be REAL.

Return value:

The return value is of type REAL. The kind type parameter is the same as X.

Example:

program test\_tan
 real(8) :: x = 0.165\_8
 x = tan(x)
end program test\_tan

Specific names:

Name Argument Return type Standard

DTAN(X) REAL(8) X REAL(8) Fortran 95 and later

See also: Section 7.21 [ATAN], page 56

# 7.212 TANH — Hyperbolic tangent function

Description:

TANH(X) computes the hyperbolic tangent of X.

Standard: Fortran 77 and later

Class: Elemental function

Syntax: X = TANH(X)

*Arguments*:

X The type shall be REAL.

Return value:

The return value is of type REAL and lies in the range  $-1 \le tanh(x) \le 1$ .

Example:

program test\_tanh
 real(8) :: x = 2.1\_8
 x = tanh(x)
end program test\_tanh

Specific names:

Name Argument Return type Standard

DTANH(X) REAL(8) X REAL(8) Fortran 95 and later

See also: Section 7.23 [ATANH], page 57

#### 7.213 TIME — Time function

#### Description:

Returns the current time encoded as an integer (in the manner of the UNIX function time(3)). This value is suitable for passing to CTIME(), GMTIME(), and LTIME().

This intrinsic is not fully portable, such as to systems with 32-bit INTEGER types but supporting times wider than 32 bits. Therefore, the values returned by this intrinsic might be, or become, negative, or numerically less than previous values, during a single run of the compiled program.

See Section 7.214 [TIME8], page 164, for information on a similar intrinsic that might be portable to more GNU Fortran implementations, though to fewer Fortran compilers.

Standard: GNU extension

Class: Function

Syntax: RESULT = TIME()

Return value:

The return value is a scalar of type INTEGER(4).

See also: Section 7.51 [CTIME], page 74, Section 7.97 [GMTIME], page 101, Section 7.144

[LTIME], page 125, Section 7.151 [MCLOCK], page 129, Section 7.214 [TIME8],

page 164

# 7.214 TIME8 — Time function (64-bit)

#### Description:

Returns the current time encoded as an integer (in the manner of the UNIX function time(3)). This value is suitable for passing to CTIME(), GMTIME(), and LTIME().

Warning: this intrinsic does not increase the range of the timing values over that returned by time(3). On a system with a 32-bit time(3), TIME8() will return a 32-bit value, even though it is converted to a 64-bit INTEGER(8) value. That means overflows of the 32-bit value can still occur. Therefore, the values returned by this intrinsic might be or become negative or numerically less than previous values during a single run of the compiled program.

Standard: GNU extension

Class: Function

Syntax: RESULT = TIME8()

Return value:

The return value is a scalar of type INTEGER(8).

See also: Section 7.51 [CTIME], page 74, Section 7.97 [GMTIME], page 101, Section 7.144

[LTIME], page 125, Section 7.152 [MCLOCK8], page 130, Section 7.213 [TIME],

page 164

## 7.215 TINY — Smallest positive number of a real kind

Description:

TINY(X) returns the smallest positive (non zero) number in the model of the type of X.

Standard: Fortran 95 and later

Class: Inquiry function

Syntax: RESULT = TINY(X)

Arguments:

X Shall be of type REAL.

Return value:

The return value is of the same type and kind as X

Example: See HUGE for an example.

# 7.216 TRAILZ — Number of trailing zero bits of an integer

Description:

TRAILZ returns the number of trailing zero bits of an integer.

Standard: Fortran 2008 and later

Class: Elemental function

Syntax: RESULT = TRAILZ(I)

*Arguments*:

I Shall be of type INTEGER.

Return value:

The type of the return value is the default INTEGER. If all the bits of I are zero, the result value is BIT\_SIZE(I).

Example:

PROGRAM test\_trailz
WRITE (\*,\*) TRAILZ(8) ! prints 3
END PROGRAM

See also: Section 7.30 [BIT\_SIZE], page 60, Section 7.127 [LEADZ], page 116

# 7.217 TRANSFER — Transfer bit patterns

Description:

Interprets the bitwise representation of *SOURCE* in memory as if it is the representation of a variable or array of the same type and type parameters as *MOLD*.

This is approximately equivalent to the C concept of *casting* one type to another.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = TRANSFER(SOURCE, MOLD[, SIZE])

Arguments:

SOURCE Shall be a scalar or an array of any type.

MOLD Shall be a scalar or an array of any type.

SIZE (Optional) shall be a scalar of type INTEGER.

#### Return value:

The result has the same type as MOLD, with the bit level representation of SOURCE. If SIZE is present, the result is a one-dimensional array of length SIZE. If SIZE is absent but MOLD is an array (of any size or shape), the result is a one-dimensional array of the minimum length needed to contain the entirety of the bitwise representation of SOURCE. If SIZE is absent and MOLD is a scalar, the result is a scalar.

If the bitwise representation of the result is longer than that of *SOURCE*, then the leading bits of the result correspond to those of *SOURCE* and any trailing bits are filled arbitrarily.

When the resulting bit representation does not correspond to a valid representation of a variable of the same type as MOLD, the results are undefined, and subsequent operations on the result cannot be guaranteed to produce sensible behavior. For example, it is possible to create LOGICAL variables for which VAR and .NOT. VAR both appear to be true.

#### Example:

```
PROGRAM test_transfer
  integer :: x = 2143289344
  print *, transfer(x, 1.0) ! prints "NaN" on i686
END PROGRAM
```

# 7.218 TRANSPOSE — Transpose an array of rank two

Description:

Transpose an array of rank two. Element (i, j) of the result has the value MATRIX(j, i), for all i, j.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = TRANSPOSE (MATRIX)

Arguments:

MATRIX Shall be an array of any type and have a rank of two.

Return value:

The result has the same type as MATRIX, and has shape (/ m, n /) if MATRIX has shape (/ n, m /).

# 7.219 TRIM — Remove trailing blank characters of a string

#### Description:

Removes trailing blank characters of a string.

Standard: Fortran 95 and later

Class: Transformational function
Syntax: RESULT = TRIM(STRING)

Arguments:

STRING Shall be a scalar of type CHARACTER.

Return value:

A scalar of type CHARACTER which length is that of STRING less the number of trailing blanks.

Example:

```
PROGRAM test_trim
CHARACTER(len=10), PARAMETER :: s = "GFORTRAN "
WRITE(*,*) LEN(s), LEN(TRIM(s)) ! "10 8", with/without trailing blanks
END PROGRAM
```

See also: Section 7.8 [ADJUSTL], page 47, Section 7.9 [ADJUSTR], page 47

#### 7.220 TTYNAM — Get the name of a terminal device.

Description:

Get the name of a terminal device. For more information, see ttyname(3).

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL TTYNAM(UNIT, NAME)
NAME = TTYNAM(UNIT)

Arguments:

UNIT Shall be a scalar INTEGER.

NAME Shall be of type CHARACTER.

Example:

```
PROGRAM test_ttynam
  INTEGER :: unit
  DO unit = 1, 10
    IF (isatty(unit=unit)) write(*,*) ttynam(unit)
  END DO
END PROGRAM
```

See also: Section 7.119 [ISATTY], page 113

# 7.221 UBOUND — Upper dimension bounds of an array

#### Description:

Returns the upper bounds of an array, or a single upper bound along the DIM dimension.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Inquiry function

Syntax: RESULT = UBOUND(ARRAY [, DIM [, KIND]])

Arguments:

ARRAY Shall be an array, of any type.

DIM (Optional) Shall be a scalar INTEGER.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind. If DIM is absent, the result is an array of the upper bounds of ARRAY. If DIM is present, the result is a scalar corresponding to the upper bound of the array along that dimension. If ARRAY is an expression rather than a whole array or array structure component, or if it has a zero extent along the relevant dimension, the upper bound is taken to be the number of elements along the relevant dimension.

See also: Section 7.126 [LBOUND], page 116

## 7.222 UMASK — Set the file creation mask

Description:

Sets the file creation mask to MASK and returns the old value in argument OLD if it is supplied. See umask(2).

Standard: GNU extension

Class: Subroutine

Syntax: CALL UMASK (MASK [, OLD])

Arguments:

MASK Shall be a scalar of type INTEGER.

MASK (Optional) Shall be a scalar of type INTEGER.

# 7.223 UNLINK — Remove a file from the file system

Description:

Unlinks the file *PATH*. A null character (CHAR(0)) can be used to mark the end of the name in *PATH*; otherwise, trailing blanks in the file name are ignored. If the *STATUS* argument is supplied, it contains 0 on success or a nonzero error code upon return; see unlink(2).

This intrinsic is provided in both subroutine and function forms; however, only one form can be used in any given program unit.

Standard: GNU extension

Class: Subroutine, function

Syntax:

CALL UNLINK(PATH [, STATUS])
STATUS = UNLINK(PATH)

Arguments:

PATH Shall be of default CHARACTER type.

STATUS (Optional) Shall be of default INTEGER type.

See also: Section 7.132 [LINK], page 119, Section 7.208 [SYMLNK], page 161

## 7.224 UNPACK — Unpack an array of rank one into an array

Description:

Store the elements of *VECTOR* in an array of higher rank.

Standard: Fortran 95 and later

Class: Transformational function

Syntax: RESULT = UNPACK(VECTOR, MASK, FIELD)

Arguments:

VECTOR Shall be an array of any type and rank one. It shall have at

least as many elements as MASK has TRUE values.

MASK Shall be an array of type LOGICAL.

FIELD Shall be of the same type as VECTOR and have the same

shape as MASK.

Return value:

The resulting array corresponds to FIELD with TRUE elements of MASK replaced by values from VECTOR in array element order.

Example:

```
PROGRAM test_unpack
integer :: vector(2) = (/1,1/)
logical :: mask(4) = (/ .TRUE., .FALSE., .FALSE., .TRUE. /)
integer :: field(2,2) = 0, unity(2,2)

! result: unity matrix
unity = unpack(vector, reshape(mask, (/2,2/)), field)
END PROGRAM
```

See also: Section 7.168 [PACK], page 139, Section 7.203 [SPREAD], page 157

# 7.225 VERIFY — Scan a string for the absence of a set of characters

Description:

Verifies that all the characters in a SET are present in a STRING.

If BACK is either absent or equals FALSE, this function returns the position of the leftmost character of STRING that is not in SET. If BACK equals TRUE, the rightmost position is returned. If all characters of SET are found in STRING, the result is zero.

Standard: Fortran 95 and later, with KIND argument Fortran 2003 and later

Class: Elemental function

Syntax: RESULT = VERIFY(STRING, SET[, BACK [, KIND]])

#### Arguments:

STRING Shall be of type CHARACTER. SET Shall be of type CHARACTER.

BACK (Optional) shall be of type LOGICAL.

KIND (Optional) An INTEGER initialization expression indicating

the kind parameter of the result.

#### Return value:

The return value is of type INTEGER and of kind KIND. If KIND is absent, the return value is of default integer kind.

#### Example:

```
PROGRAM test_verify

WRITE(*,*) VERIFY("FORTRAN", "AO") ! 1, found 'F'
WRITE(*,*) VERIFY("FORTRAN", "FOO") ! 3, found 'R'
WRITE(*,*) VERIFY("FORTRAN", "C++") ! 1, found 'F'
WRITE(*,*) VERIFY("FORTRAN", "C++", .TRUE.) ! 7, found 'N'
WRITE(*,*) VERIFY("FORTRAN", "FORTRAN") ! 0' found none
END PROGRAM
```

See also: Section 7.186 [SCAN], page 148, Section 7.111 [INDEX intrinsic], page 109

## 7.226 XOR — Bitwise logical exclusive OR

#### Description:

Bitwise logical exclusive or.

This intrinsic routine is provided for backwards compatibility with GNU Fortran 77. For integer arguments, programmers should consider the use of the Section 7.109 [IEOR], page 108 intrinsic defined by the Fortran standard.

Standard: GNU extension

Class: Function

Syntax: RESULT = XOR(X, Y)

#### Arguments:

X The type shall be either a scalar INTEGER type or a scalar

LOGICAL type.

Y The type shall be the same as the type of I.

#### Return value:

The return type is either a scalar INTEGER or a scalar LOGICAL. If the kind type parameters differ, then the smaller kind type is implicitly converted to larger kind, and the return has the larger kind.

#### Example:

```
PROGRAM test_xor

LOGICAL :: T = .TRUE., F = .FALSE.

INTEGER :: a, b

DATA a / Z'F' /, b / Z'3' /

WRITE (*,*) XOR(T, T), XOR(T, F), XOR(F, T), XOR(F, F)

WRITE (*,*) XOR(a, b)

END PROGRAM
```

See also: Fortran 95 elemental function: Section 7.109 [IEOR], page 108

## 8 Intrinsic Modules

#### 8.1 ISO\_FORTRAN\_ENV

Standard: Fortran 2003 and later

The ISO\_FORTRAN\_ENV module provides the following scalar default-integer named constants:

#### CHARACTER\_STORAGE\_SIZE:

Size in bits of the character storage unit.

#### ERROR\_UNIT:

Identifies the preconnected unit used for error reporting.

#### FILE\_STORAGE\_SIZE:

Size in bits of the file-storage unit.

#### INPUT\_UNIT:

Identifies the preconnected unit identified by the asterisk (\*) in READ statement.

#### IOSTAT\_END:

The value assigned to the variable passed to the IOSTAT= specifier of an input/output statement if an end-of-file condition occurred.

#### IOSTAT\_EOR:

The value assigned to the variable passed to the IOSTAT= specifier of an input/output statement if an end-of-record condition occurred.

#### NUMERIC\_STORAGE\_SIZE:

The size in bits of the numeric storage unit.

#### OUTPUT\_UNIT:

Identifies the preconnected unit identified by the asterisk (\*) in WRITE statement.

#### 8.2 ISO\_C\_BINDING

Standard: Fortran 2003 and later, GNU extensions

The following intrinsic procedures are provided by the module; their definition can be found in the section Intrinsic Procedures of this manual.

#### C\_ASSOCIATED

C\_F\_POINTER

C\_F\_PROCPOINTER

C\_FUNLOC

#### C\_LOC

The ISO\_C\_BINDING module provides the following named constants of the type integer, which can be used as KIND type parameter. Note that GNU Fortran currently does not support the C\_INT\_FAST... KIND type parameters (marked by an asterisk (\*) in the list

below). The C\_INT\_FAST... parameters have therefore the value -2 and cannot be used as KIND type parameter of the INTEGER type.

In addition to the integer named constants required by the Fortran 2003 standard, GNU Fortran provides as an extension named constants for the 128-bit integer types supported by the C compiler: C\_INT128\_T, C\_INT\_LEAST128\_T, C\_INT\_FAST128\_T.

INTEGER C_SHORT short int INTEGER C_SHORT short int INTEGER C_LONG long int INTEGER C_LONG long long int INTEGER C_SIGNED_CHAR signed char/unsigned char INTEGER C_SIZE_T size_t INTEGER C_SIZE_T size_t INTEGER C_INT8_T int8_t INTEGER C_INT32_T int32_t INTEGER C_INT32_T int44_t INTEGER C_INT4A_T int6_t INTEGER C_INT4A_T int128_t Ext. INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least44_t INTEGER C_INT_LEAST4A_T int_least48_t INTEGER C_INT_LEAST5A_T int_least64_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast46_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST12B_T* int_fast12B_t Ext. INTEGER C_INT_FAST12B_T* int_fast64_t INTEGER C_INT_FAST12B_T* int_fast64_t INTEGER C_INT_FAST12B_T* int_fast12B_t Ext. INTEGER C_INT_FAST12B_T* int_fast12B_t Ext. INTEGER C_INT_FAST12B_T* int_fast12B_t Ext. INTEGER C_INTPTR_T intptr_t REAL C_FLOAT float REAL C_FLOAT float REAL C_FLOAT float COMPLEX C_INOG_DOUBLE long double COMPLEX C_LONG_DOUBLE long double Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex LOGICAL C_BOOL _Bool CHARACTER C_CHAR	Fortran Type	Named constant	C type	Extension
INTEGER C_LONG long int INTEGER C_LONG_LONG long int INTEGER C_LONG_LONG long int INTEGER C_SIGNED_CHAR signed char/unsigned char INTEGER C_SIZE_T size_t INTEGER C_SIXE_T int8_t INTEGER C_INT8_T int8_t INTEGER C_INT32_T int32_t INTEGER C_INT32_T int32_t INTEGER C_INT16_T int16_t INTEGER C_INT32_T int28_t Ext. INTEGER C_INT128_T int128_t Ext. INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST32_T int_least64_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast22_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast22_t INTEGER C_INT_FAST6_T* int_fast22_t INTEGER C_INT_FAST6_T* int_fast28_t INTEGER C_INT_FAST6_T* int_fast6_t INTEGER C_INT_FAST6_T* int_fast6_T* int_fast6_T* INTEGER C_INT_FAST6_T* int_fast6_T* INTEGER C_INT_FAST6_T* int_fast6_T* INTEGER C_INT_F	6 I		0 A	
INTEGER C_SIGNED_CHAR signed char/unsigned char INTEGER C_SIZE_T size_t INTEGER C_SIZE_T int8_t INTEGER C_INT8_T int8_t INTEGER C_INT16_T int16_t INTEGER C_INT32_T int32_t INTEGER C_INT32_T int32_t INTEGER C_INT44_T int18_t INTEGER C_INT48_T int18_t INTEGER C_INT48_T int18_t INTEGER C_INT48_T int18_t INTEGER C_INT_LEAST8_T int18_t INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST32_T int_least16_t INTEGER C_INT_LEAST32_T int_least64_t INTEGER C_INT_LEAST18_T int_least64_t INTEGER C_INT_LEAST18_T int_sat8_t INTEGER C_INT_FAST16_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext. INTEGER C_INT_FAST128_T* int_fast28_t INTEGER	INTEGER		short int	
INTEGER C_SIGNED_CHAR signed char/unsigned char INTEGER C_SIZE_T size_t INTEGER C_SIZE_T int8_t INTEGER C_INT8_T int8_t INTEGER C_INT16_T int16_t INTEGER C_INT32_T int32_t INTEGER C_INT64_T int16_t INTEGER C_INT64_T int16_t INTEGER C_INT128_T int128_t Ext.  INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST32_T int_least16_t INTEGER C_INT_LEAST32_T int_least40_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_LEAST128_T int_least64_t INTEGER C_INT_LEAST128_T int_sast8_t INTEGER C_INT_FAST32_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast60_t INTEGER C_INT_FAST32_T* int_fast60_t INTEGER C_INT_FAST64_T* int_fast60_t INTEGER C_INT_FAST64_T* int_fast60_t INTEGER C_INT_FAST64_T* int_fast60_t INTEGER C_INT_FAST64_T* int_fast60_t INTEGER C_INT_FAST60_T* int_fast60_t INTEGER C	INTEGER	C_LONG	long int	
INTEGER C_SIZE_T size_t INTEGER C_INT8_T int8_t INTEGER C_INT16_T int16_t INTEGER C_INT32_T int32_t INTEGER C_INT64_T int64_t INTEGER C_INT128_T int128_t Ext.  INTEGER C_INT128_T int128_t Ext.  INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST32_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST46_T int_least64_t INTEGER C_INT_LEAST128_T int_least128_t Ext.  INTEGER C_INT_EAST128_T int_fast8_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST32_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTPRAT intmax_t INTEGER C_INTPRT_T intpr_t REAL C_FLOAT float REAL C_FLOAT float REAL C_DOUBLE double REAL C_LONG_DOUBLE long double COMPLEX C_FLOAT_COMPLEX float_Complex COMPLEX C_DOUBLE_COMPLEX double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex LOGICAL	INTEGER	C_LONG_LONG	9	
INTEGER C_INT8_T int8_t INTEGER C_INT16_T int16_t INTEGER C_INT32_T int32_t INTEGER C_INT64_T int64_t INTEGER C_INT128_T int128_t Ext. INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST32_T int_least64_t INTEGER C_INT_LEAST18_T int_least64_t INTEGER C_INT_LEAST18_T int_least128_t Ext. INTEGER C_INT_LEAST128_T int_sast16_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast64_t INTEGER C_INT_FAST32_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext. INTEGER C_INTAX_T intmax_t INTEGER C_INTPTR_T intptr_t REAL C_FLOAT float REAL C_FLOAT float REAL C_DOUBLE double REAL C_LONG_DOUBLE long double COMPLEX C_FLOAT_COMPLEX float_Complex COMPLEX C_DOUBLE_COMPLEX double_Complex COMPLEX C_DOUBLE_COMPLEX long double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex LOGICAL C_BOOL _Bool	INTEGER	C_SIGNED_CHAR	signed char/unsigned char	
INTEGER C_INT16_T int16_t INTEGER C_INT32_T int32_t INTEGER C_INT64_T int64_t INTEGER C_INT128_T int128_t Ext.  INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_LEAST64_T int_least128_t Ext.  INTEGER C_INT_LEAST64_T int_least128_t Ext.  INTEGER C_INT_LEAST64_T int_fast8_t INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast16_t INTEGER C_INT_FAST16_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST18_T* int_fast128_t Ext.  INTEGER C_INTAX_T intmax_t INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t REAL C_FLOAT float REAL C_FLOAT float REAL C_DOUBLE double  COMPLEX C_FLOAT_COMPLEX float_Complex COMPLEX C_DOUBLE_COMPLEX double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex LOGICAL C_BOOL _Bool	INTEGER	C_SIZE_T	size_t	
INTEGER C_INT32_T int32_t INTEGER C_INT64_T int64_t INTEGER C_INT128_T int128_t Ext.  INTEGER C_INT_LEAST8_T int_least8_t INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_LEAST128_T int_least128_t Ext.  INTEGER C_INT_FAST18_T* int_fast8_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex	INTEGER	C_INT8_T	int8_t	
INTEGER	INTEGER	C_INT16_T	int16_t	
INTEGER C_INT_LEASTB_T int_least8_t INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST4_T int_least64_t INTEGER C_INT_LEAST128_T int_least128_t Ext. INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST16_T* int_fast16_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext. INTEGER C_INTMAX_T intmax_t INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t REAL C_FLOAT float REAL C_DOUBLE double REAL C_LONG_DOUBLE long double COMPLEX C_FLOAT_COMPLEX float_Complex COMPLEX C_DOUBLE_COMPLEX double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex LOGICAL C_BOOL _Bool	INTEGER	C_INT32_T	int32_t	
INTEGER C_INT_LEAST8_T int_least8_t  INTEGER C_INT_LEAST16_T int_least16_t  INTEGER C_INT_LEAST32_T int_least32_t  INTEGER C_INT_LEAST64_T int_least64_t  INTEGER C_INT_LEAST128_T int_least128_t Ext.  INTEGER C_INT_FAST8_T* int_fast8_t  INTEGER C_INT_FAST16_T* int_fast16_t  INTEGER C_INT_FAST32_T* int_fast32_t  INTEGER C_INT_FAST44_T* int_fast64_t  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t  INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  COMPLEX C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex	INTEGER	C_INT64_T	int64_t	
INTEGER C_INT_LEAST16_T int_least16_t INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_LEAST128_T int_least128_t Ext. INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST16_T* int_fast16_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext. INTEGER C_INT_FAST128_T* int_fast128_t Ext. INTEGER C_INTPTR_T intptr_t REAL C_INTPTR_T intptr_t REAL C_DOUBLE double REAL C_LONG_DOUBLE long double COMPLEX C_FLOAT_COMPLEX float_Complex COMPLEX C_DOUBLE_COMPLEX double _Complex COMPLEX C_DOUBLE_COMPLEX long double _Complex COMPLEX C_BOOL _Bool	INTEGER	C_INT128_T	int128_t	Ext.
INTEGER C_INT_LEAST32_T int_least32_t INTEGER C_INT_LEAST64_T int_least64_t INTEGER C_INT_LEAST128_T int_least128_t Ext.  INTEGER C_INT_FAST8_T* int_fast8_t INTEGER C_INT_FAST16_T* int_fast16_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  COMPLEX C_BOOL _Bool	INTEGER	C_INT_LEAST8_T	int_least8_t	
INTEGER C_INT_LEAST64_T int_least64_t  INTEGER C_INT_LEAST128_T int_least128_t Ext.  INTEGER C_INT_FAST8_T* int_fast8_t  INTEGER C_INT_FAST16_T* int_fast16_t  INTEGER C_INT_FAST32_T* int_fast32_t  INTEGER C_INT_FAST64_T* int_fast64_t  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t  INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INT_LEAST16_T	int_least16_t	
INTEGER C_INT_LEAST128_T int_least128_t Ext.  INTEGER C_INT_FAST8_T* int_fast8_t  INTEGER C_INT_FAST16_T* int_fast16_t  INTEGER C_INT_FAST32_T* int_fast32_t  INTEGER C_INT_FAST64_T* int_fast64_t  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t  INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INT_LEAST32_T	int_least32_t	
INTEGER C_INT_FAST8_T* int_fast8_t  INTEGER C_INT_FAST16_T* int_fast16_t  INTEGER C_INT_FAST32_T* int_fast32_t  INTEGER C_INT_FAST64_T* int_fast64_t  INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t  INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INT_LEAST64_T	int_least64_t	
INTEGER C_INT_FAST16_T* int_fast16_t INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_BOOLBool	INTEGER	C_INT_LEAST128_T	int_least128_t	Ext.
INTEGER C_INT_FAST32_T* int_fast32_t INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  COMPLEX C_BOOL _Bool	INTEGER	C_INT_FAST8_T*	int_fast8_t	
INTEGER C_INT_FAST64_T* int_fast64_t INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float _Complex  COMPLEX C_DOUBLE_COMPLEX double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  COMPLEX C_BOOL _Bool	INTEGER	C_INT_FAST16_T*	int_fast16_t	
INTEGER C_INT_FAST128_T* int_fast128_t Ext.  INTEGER C_INTMAX_T intmax_t  INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INT_FAST32_T*	int_fast32_t	
INTEGER C_INTMAX_T intmax_t INTEGER C_INTPTR_T intptr_t REAL C_FLOAT float REAL C_DOUBLE double REAL C_LONG_DOUBLE long double COMPLEX C_FLOAT_COMPLEX float_Complex COMPLEX C_DOUBLE_COMPLEX double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex COMPLEX C_BOOL _Bool	INTEGER	C_INT_FAST64_T*	int_fast64_t	
INTEGER C_INTPTR_T intptr_t  REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float_Complex  COMPLEX C_DOUBLE_COMPLEX double_Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INT_FAST128_T*	int_fast128_t	Ext.
REAL C_FLOAT float  REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float _Complex  COMPLEX C_DOUBLE_COMPLEX double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INTMAX_T	intmax_t	
REAL C_DOUBLE double  REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float _Complex  COMPLEX C_DOUBLE_COMPLEX double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  LOGICAL C_BOOL _Bool	INTEGER	C_INTPTR_T	intptr_t	
REAL C_LONG_DOUBLE long double  COMPLEX C_FLOAT_COMPLEX float _Complex  COMPLEX C_DOUBLE_COMPLEX double _Complex  COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex  LOGICAL C_BOOL _Bool	REAL	C_FLOAT	float	
COMPLEX C_FLOAT_COMPLEX float _Complex COMPLEX C_DOUBLE_COMPLEX double _Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex LOGICAL C_BOOL _Bool	REAL	C_DOUBLE	double	
COMPLEX C_DOUBLE_COMPLEX double_Complex COMPLEX C_LONG_DOUBLE_COMPLEX long double_Complex LOGICAL C_BOOL _Bool	REAL	C_LONG_DOUBLE	long double	
COMPLEX C_LONG_DOUBLE_COMPLEX long double _Complex LOGICAL C_BOOL _Bool	COMPLEX	C_FLOAT_COMPLEX	-	
LOGICAL C_BOOL _Bool	COMPLEX	C_DOUBLE_COMPLEX	double _Complex	
	COMPLEX	C_LONG_DOUBLE_COMPLEX	long double _Complex	
CHARACTER C_CHAR char	LOGICAL	C_BOOL	_Bool	
	CHARACTER	C_CHAR	char	

Additionally, the following (CHARACTER(KIND=C\_CHAR)) are defined.

Name	C definition	Value
C_NULL_CHAR	null character	,\0,
C_ALERT	alert	'\a'
C_BACKSPACE	backspace	'\b'
C_FORM_FEED	form feed	'\f'
C_NEW_LINE	new line	'\n'
C_CARRIAGE_	carriage return	'\r'
RETURN		

C\_HORIZONTAL\_ horizontal tab '\t'

TAB

C\_VERTICAL\_TAB vertical tab '\v'

## 8.3 OpenMP Modules OMP\_LIB and OMP\_LIB\_KINDS

Standard: OpenMP Application Program Interface v3.0

The OpenMP Fortran runtime library routines are provided both in a form of two Fortran 90 modules, named OMP\_LIB and OMP\_LIB\_KINDS, and in a form of a Fortran include file named 'omp\_lib.h'. The procedures provided by OMP\_LIB can be found in the Section "Introduction" in GNU OpenMP runtime library manual, the named constants defined in the OMP\_LIB\_KINDS module are listed below.

For details refer to the actual OpenMP Application Program Interface v3.0. OMP\_LIB\_KINDS provides the following scalar default-integer named constants:

omp\_integer\_kind
omp\_logical\_kind
omp\_lock\_kind
omp\_nest\_lock\_kind
omp\_sched\_kind

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## Contributing

Free software is only possible if people contribute to efforts to create it. We're always in need of more people helping out with ideas and comments, writing documentation and contributing code.

If you want to contribute to GNU Fortran, have a look at the long lists of projects you can take on. Some of these projects are small, some of them are large; some are completely orthogonal to the rest of what is happening on GNU Fortran, but others are "mainstream" projects in need of enthusiastic hackers. All of these projects are important! We'll eventually get around to the things here, but they are also things doable by someone who is willing and able.

#### Contributors to GNU Fortran

Most of the parser was hand-crafted by *Andy Vaught*, who is also the initiator of the whole project. Thanks Andy! Most of the interface with GCC was written by *Paul Brook*.

The following individuals have contributed code and/or ideas and significant help to the GNU Fortran project (in alphabetical order):

- Janne Blomqvist
- Steven Bosscher
- Paul Brook
- Tobias Burnus
- François-Xavier Coudert
- Bud Davis
- Jerry DeLisle
- Erik Edelmann
- Bernhard Fischer
- Daniel Franke
- Richard Guenther
- Richard Henderson
- Katherine Holcomb
- Jakub Jelinek
- Niels Kristian Bech Jensen
- Steven Johnson
- Steven G. Kargl
- Thomas Koenig
- Asher Langton
- H. J. Lu
- Toon Moene
- Brooks Moses
- Andrew Pinski
- Tim Prince

- Christopher D. Rickett
- Richard Sandiford
- Tobias Schlüter
- Roger Sayle
- Paul Thomas
- Andy Vaught
- Feng Wang
- Janus Weil

The following people have contributed bug reports, smaller or larger patches, and much needed feedback and encouragement for the GNU Fortran project:

- Bill Clodius
- Dominique d'Humières
- Kate Hedstrom
- Erik Schnetter

Many other individuals have helped debug, test and improve the GNU Fortran compiler over the past few years, and we welcome you to do the same! If you already have done so, and you would like to see your name listed in the list above, please contact us.

## **Projects**

Help build the test suite

Solicit more code for donation to the test suite: the more extensive the testsuite, the smaller the risk of breaking things in the future! We can keep code private on request.

Bug hunting/squishing

Find bugs and write more test cases! Test cases are especially very welcome, because it allows us to concentrate on fixing bugs instead of isolating them. Going through the bugzilla database at <a href="http://gcc.gnu.org/bugzilla/">http://gcc.gnu.org/bugzilla/</a> to reduce testcases posted there and add more information (for example, for which version does the testcase work, for which versions does it fail?) is also very helpful.

## **Proposed Extensions**

Here's a list of proposed extensions for the GNU Fortran compiler, in no particular order. Most of these are necessary to be fully compatible with existing Fortran compilers, but they are not part of the official J3 Fortran 95 standard.

## Compiler extensions:

- User-specified alignment rules for structures.
- Automatically extend single precision constants to double.
- Compile code that conserves memory by dynamically allocating common and module storage either on stack or heap.

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- Compile flag to generate code for array conformance checking (suggest -CC).
- User control of symbol names (underscores, etc).
- Compile setting for maximum size of stack frame size before spilling parts to static or heap.
- Flag to force local variables into static space.
- Flag to force local variables onto stack.

#### **Environment Options**

- Pluggable library modules for random numbers, linear algebra. LA should use BLAS calling conventions.
- Environment variables controlling actions on arithmetic exceptions like overflow, underflow, precision loss—Generate NaN, abort, default. action.
- Set precision for fp units that support it (i387).
- Variable for setting fp rounding mode.
- Variable to fill uninitialized variables with a user-defined bit pattern.
- Environment variable controlling filename that is opened for that unit number.
- Environment variable to clear/trash memory being freed.
- Environment variable to control tracing of allocations and frees.
- Environment variable to display allocated memory at normal program end.
- Environment variable for filename for \* IO-unit.
- Environment variable for temporary file directory.
- Environment variable forcing standard output to be line buffered (unix).

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Version 3, 29 June 2007

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## **Option Index**

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