

# Using GNU Fortran

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For GCC version 4.5.0

(GCC)

The gfortran team

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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 supports the Fortran 77, 90 and 95 standards completely, parts of the Fortran 2003 and Fortran 2008 standards, and several vendor extensions. The development goal is to provide the following features:

- 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, `__GFORTTRAN__` 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 and Fortran 2008.

## 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 31](#) section of the documentation.

The next version of the Fortran standard (Fortran 2008) 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 32](#) section.

Additionally, the GNU Fortran compilers supports the OpenMP specification (version 3.0, <http://openmp.org/wp/openmp-specifications/>).

### 1.6.1 Varying Length Character Strings

The Fortran 95 standard specifies in Part 2 (ISO/IEC 1539-2:2000) varying length character strings. While GNU Fortran currently does not support such strings directly, there exist two Fortran implementations for them, which work with GNU Fortran. They can be found at [http://www.fortran.com/iso\\_varying\\_string.f95](http://www.fortran.com/iso_varying_string.f95) and at [ftp://ftp.nag.co.uk/sc22wg5/ISO\\_VARYING\\_STRING/](ftp://ftp.nag.co.uk/sc22wg5/ISO_VARYING_STRING/).



## **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
-implicitlib dir -iprefix file -isysroot dir
-iquote -isystem dir -nocpp -nostdinc -undef
-Aquestion=answer -Aquestion[=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 -Wimplicit-procedure -Wline-truncation
-Wintrinsic-std -Wsurprising -Wno-tabs -Wunderflow -Wunused-parameter
-Wintrinsic-shadow -Wno-align-commons
```

#### *Debugging Options*

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

```
-fdump-parse-tree -ffpe-trap=list
-fdump-core -fbacktrace
```

#### *Directory Options*

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

```
-Idir -Jdir -Mdir
-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
-fwhole-file -fsecond-underscore
-fbounds-check -fcheck-array-temporaries -fmax-array-constructor =n
-fcheck=<all|array-temps|bounds|do|mem|pointer|recursion> -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|snan>
-finit-logical=<true|false> -finit-character=n
-fno-align-commons -fno-protect-parens
```

## 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 `'$'` as a valid non-first character in a symbol name. Symbols that start with `'$'` are rejected since it is unclear which rules to apply to implicit typing as different vendors implement different rules. Using `'$'` in `IMPLICIT` statements is also rejected.

**`-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`, `\v`, `\\`, and `\0` to the ASCII characters alert, backspace, form feed, newline, carriage return, horizontal tab, vertical tab, backslash, and NUL, respectively. Additionally, `\xnn`, `\unnnn` and `\Unnnnnnnn` (where each `n` is a hexadecimal digit) are translated into the Unicode characters corresponding to the specified code points. All other combinations of a character preceded by `\` are unexpanded.

**`-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'FFFFFFFF'/` 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.

**-Wimplicit-procedure**

Warn if a procedure is called that has neither an explicit interface nor has been declared as `EXTERNAL`.

**-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 behavior 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.
- A `CHARACTER` variable is declared with negative length.

**-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.

**-I***dir* 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.

**-J***dir*

**-M***dir* 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.

‘-M’ is deprecated to avoid conflicts with existing GCC options.

**-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 enabled, floating point numbers of value zero with the sign bit set are written as negative number in formatted output and treated as negative in the **SIGN** intrinsic. **fno-sign-zero** does not print the negative sign of zero values and regards zero as positive number in the **SIGN** intrinsic 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.

**-ff2c**      Generate code designed to be compatible with code generated by **g77** and **f2c**.

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.

#### `-fwhole-file`

By default, GNU Fortran parses, resolves and translates each procedure in a file separately. Using this option modifies this such that the whole file is parsed and placed in a single front-end tree. During resolution, in addition to all the usual checks and fixups, references to external procedures that are in the same file effect resolution of that procedure, if not already done, and a check of the interfaces. The dependences are resolved by changing the order in which the file is translated into the backend tree. Thus, a procedure that is referenced is translated before the reference and the duplication of backend tree declarations eliminated.

#### `-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.

#### `-fcheck=<keyword>`

Enable the generation of run-time checks; the argument shall be a comma-delimited list of the following keywords.

‘`all`’            Enable all run-time test of ‘`-fcheck`’.

‘`array-temps`’

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.

- 'bounds' 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 '-fcheck=bounds' 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.
- 'do' Enable generation of run-time checks for invalid modification of loop iteration variables.
- 'mem' Enable generation of run-time checks for memory allocation. Note: This option does not affect explicit allocations using the ALLOCATE statement, which will be always checked.
- 'pointer' Enable generation of run-time checks for pointers and allocatables.
- 'recursion' Enable generation of run-time checks for recursively called sub-routines and functions which are not marked as recursive. See also '-frecursive'. Note: This check does not work for OpenMP programs and is disabled if used together with '-frecursive' and '-fopenmp'.

**-fbounds-check**

Deprecated alias for '-fcheck=bounds'.

**-fcheck-array-temporaries**

Deprecated alias for '-fcheck=array-temps'.

**-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|snan>
-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|snan>`’ (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. For a signalling NaN use ‘`-finit-real=snan`’; note, however, that compile-time optimizations may convert them into quiet NaN and that trapping needs to be enabled (e.g. via ‘`-ffpe-trap`’).

```
-falign-commons
```

By default, `gfortran` enforces proper alignment of all variables in a `COMMON` 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 largest to smallest.

```
-fno-protect-parens
```

By default the parentheses in expression are honored for all optimization levels such that the compiler does not do any re-association. Using ‘`-fno-protect-parens`’ allows the compiler to reorder `REAL` and `COMPLEX` expressions to produce faster code. Note that for the re-association optimization ‘`-fno-signed-zeros`’ and ‘`-fno-trapping-math`’ need to be in effect.

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 25, 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 `GFORTTRAN_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 `GFORTTRAN_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 `GFORTTRAN_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 `GFORTTRAN_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 `GFORTTRAN_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 `GFORTTRAN_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 `GFORTTRAN_UNBUFFERED_PRECONNECTED`—Don’t buffer I/O on preconnected units

The environment variable named `GFORTTRAN_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 `GFORTTRAN_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 41, 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\_DUMP CORE—Dump core on run-time errors

If the `GFORTRAN_ERROR_DUMP CORE` 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**

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## 4 Fortran 2003 and 2008 Status

### 4.1 Fortran 2003 status

GNU Fortran supports several Fortran 2003 features; an incomplete list can be found below. See also the [wiki page](#) about Fortran 2003.

- Intrinsic `command_argument_count`, `get_command`, `get_command_argument`, `get_environment_variable`, and `move_alloc`.
- Array constructors using square brackets. That is, [...] rather than (/.../). Type-specification for array constructors like (`/ some-type :: ... /`).
- FLUSH statement.
- 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 ERRMSG= tag is now supported in ALLOCATE and DEALLOCATE statements. The SOURCE= tag is supported in an ALLOCATE statement. An *intrinsic-type-spec* can be used as the *type-spec* in an ALLOCATE statement; while the use of a *derived-type-name* is currently unsupported.
- 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 CMLX.
- Type-bound procedures with PROCEDURE or GENERIC, and operators bound to a derived-type.
- Extension of derived-types (the EXTENDS(...) syntax).
- ABSTRACT derived-types and declaring procedure bindings DEFERRED.

## 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 as **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.

The [wiki](#) has some information about the current Fortran 2008 implementation status.

## 5 Compiler Characteristics

This chapter describes certain characteristics of the GNU Fortran compiler, namely the KIND type parameter values supported.

### 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

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

(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.



## 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 `size` is a byte count corresponding to the storage size of a valid kind for that type. (For `COMPLEX` variables, `size` is the total size of the real and imaginary parts.) The statement then declares `x`, `y` and `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:

```

?

&mynm1
  x
  x%y
  ch
&end

```

Entering '=?' outputs the namelist to stdout, as if WRITE(\*,NML = mynm1) 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 /mynm1/ x
  PRINT mynm1
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 ('F00=' 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'`, where 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'0000001' + 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 :: l
l = 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 bitwise 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) = 16HABCDEFGHJKLMNPO
call foo (4h abc)
```

Invalid Hollerith constants examples:

```
integer*4 a
a = 8H12345678 ! Valid, but the Hollerith constant will be truncated.
a = 0H          ! 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.

```
INTEGER(KIND=4) :: a
a = TRANSFER ("abcd", a)      ! equivalent to: a = 4Habcd
```

### 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 8.145 \[MALLOC\]](#), page 138).

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 26, 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:

```
open(file='big.dat',form='unformatted',access='sequential', &
      convert='big_endian')
```

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 v3.0](#).

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 cannot 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))
      end

```

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

Also, `c_by_val.f` and its partner `c_by_val.c` of the GNU Fortran testsuite 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
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
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
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:

```

      CHARACTER(LEN=80) LINE
      REAL A, B, C
c     ... Code that sets A, B and C
      WRITE (UNIT=LINE, FMT=9000) A, B, C
      9000 FORMAT (1X, 'OUTPUT IS ', 3(F10.5))

```

### 6.2.3 Variable FORMAT expressions

A variable FORMAT expression is format statement which includes angle brackets enclosing a Fortran expression: FORMAT(I<N>). GNU Fortran does not support this legacy extension. The effect of variable format expressions can be reproduced by using the more powerful (and standard) combination of internal output and string formats. For example, replace a code fragment like this:

```

      WRITE(6,20) INT1
      20  FORMAT(I<N+1>)

```

with the following:



```
c    Variable declaration
      CHARACTER(LEN=20) F
c
c    Other code here...
c
      WRITE(FMT,'("I", IO, ")")' ) N+1
      WRITE(6,FM) INT1
```

or with:

```
c    Variable declaration
      CHARACTER(LEN=20) FMT
c
c    Other code here...
c
      WRITE(FMT,*) N+1
      WRITE(6,"(I" // ADJUSTL(FMT) // ")") INT1
```



## 7 Mixed-Language Programming

This chapter is about mixed-language interoperability, but also applies if one links Fortran code compiled by different compilers. In most cases, use of the C Binding features of the Fortran 2003 standard is sufficient, and their use is highly recommended.

### 7.1 Interoperability with C

Since Fortran 2003 (ISO/IEC 1539-1:2004(E)) there is a standardized way to generate procedure and derived-type declarations and global variables which are interoperable with C (ISO/IEC 9899:1999). The `bind(C)` attribute has been added to inform the compiler that a symbol shall be interoperable with C; also, some constraints are added. Note, however, that not all C features have a Fortran equivalent or vice versa. For instance, neither C's unsigned integers nor C's functions with variable number of arguments have an equivalent in Fortran.

Note that array dimensions are reversely ordered in C and that arrays in C always start with index 0 while in Fortran they start by default with 1. Thus, an array declaration `A(n,m)` in Fortran matches `A[m][n]` in C and accessing the element `A(i,j)` matches `A[j-1][i-1]`. The element following `A(i,j)` (C: `A[j-1][i-1]`; assuming  $i < n$ ) in memory is `A(i+1,j)` (C: `A[j-1][i]`).

#### 7.1.1 Intrinsic Types

In order to ensure that exactly the same variable type and kind is used in C and Fortran, the named constants shall be used which are defined in the `ISO_C_BINDING` intrinsic module. That module contains named constants for kind parameters and character named constants for the escape sequences in C. For a list of the constants, see [Section 9.2 \[ISO\\_C\\_BINDING\]](#), page 185.

#### 7.1.2 Derived Types and struct

For compatibility of derived types with `struct`, one needs to use the `BIND(C)` attribute in the type declaration. For instance, the following type declaration

```
USE ISO_C_BINDING
TYPE, BIND(C) :: myType
  INTEGER(C_INT) :: i1, i2
  INTEGER(C_SIGNED_CHAR) :: i3
  REAL(C_DOUBLE) :: d1
  COMPLEX(C_FLOAT_COMPLEX) :: c1
  CHARACTER(KIND=C_CHAR) :: str(5)
END TYPE
```

matches the following `struct` declaration in C

```
struct {
  int i1, i2;
  /* Note: "char" might be signed or unsigned. */
  signed char i3;
  double d1;
  float _Complex c1;
  char str[5];
} myType;
```

Derived types with the C binding attribute shall not have the `sequence` attribute, type parameters, the `extends` attribute, nor type-bound procedures. Every component must be

of interoperable type and kind and may not have the `pointer` or `allocatable` attribute. The names of the variables are irrelevant for interoperability.

As there exist no direct Fortran equivalents, neither unions nor structs with bit field or variable-length array members are interoperable.

### 7.1.3 Interoperable Global Variables

Variables can be made accessible from C using the C binding attribute, optionally together with specifying a binding name. Those variables have to be declared in the declaration part of a `MODULE`, be of interoperable type, and have neither the `pointer` nor the `allocatable` attribute.

```
MODULE m
  USE myType_module
  USE ISO_C_BINDING
  integer(C_INT), bind(C, name="_MyProject_flags") :: global_flag
  type(myType), bind(C) :: tp
END MODULE
```

Here, `_MyProject_flags` is the case-sensitive name of the variable as seen from C programs while `global_flag` is the case-insensitive name as seen from Fortran. If no binding name is specified, as for `tp`, the C binding name is the (lowercase) Fortran binding name. If a binding name is specified, only a single variable may be after the double colon. Note of warning: You cannot use a global variable to access `errno` of the C library as the C standard allows it to be a macro. Use the `IERRNO` intrinsic (GNU extension) instead.

### 7.1.4 Interoperable Subroutines and Functions

Subroutines and functions have to have the `BIND(C)` attribute to be compatible with C. The dummy argument declaration is relatively straightforward. However, one needs to be careful because C uses call-by-value by default while Fortran behaves usually similar to call-by-reference. Furthermore, strings and pointers are handled differently. Note that only explicit size and assumed-size arrays are supported but not assumed-shape or allocatable arrays.

To pass a variable by value, use the `VALUE` attribute. Thus the following C prototype

```
int func(int i, int *j)
```

matches the Fortran declaration

```
integer(c_int) function func(i,j)
  use iso_c_binding, only: c_int
  integer(c_int), VALUE :: i
  integer(c_int) :: j
```

Note that pointer arguments also frequently need the `VALUE` attribute.

Strings are handled quite differently in C and Fortran. In C a string is a NUL-terminated array of characters while in Fortran each string has a length associated with it and is thus not terminated (by e.g. NUL). For example, if one wants to use the following C function,

```
#include <stdio.h>
void print_C(char *string) /* equivalent: char string[] */
{
  printf("%s\n", string);
}
```

to print "Hello World" from Fortran, one can call it using

```

use iso_c_binding, only: C_CHAR, C_NULL_CHAR
interface
  subroutine print_c(string) bind(C, name="print_C")
    use iso_c_binding, only: c_char
    character(kind=c_char) :: string(*)
  end subroutine print_c
end interface
call print_c(C_CHAR_"Hello World"//C_NULL_CHAR)

```

As the example shows, one needs to ensure that the string is NUL terminated. Additionally, the dummy argument *string* of `print_C` is a length-one assumed-size array; using `character(len=*)` is not allowed. The example above uses `c_char_"Hello World"` to ensure the string literal has the right type; typically the default character kind and `c_char` are the same and thus "Hello World" is equivalent. However, the standard does not guarantee this.

The use of pointers is now illustrated using the C library function `strncpy`, whose prototype is

```
char *strncpy(char *restrict s1, const char *restrict s2, size_t n);
```

The function `strncpy` copies at most *n* characters from string *s2* to *s1* and returns *s1*. In the following example, we ignore the return value:

```

use iso_c_binding
implicit none
character(len=30) :: str,str2
interface
  ! Ignore the return value of strncpy -> subroutine
  ! "restrict" is always assumed if we do not pass a pointer
  subroutine strncpy(dest, src, n) bind(C)
    import
    character(kind=c_char), intent(out) :: dest(*)
    character(kind=c_char), intent(in)  :: src(*)
    integer(c_size_t), value, intent(in) :: n
  end subroutine strncpy
end interface
str = repeat('X',30) ! Initialize whole string with 'X'
call strncpy(str, c_char_"Hello World"//C_NULL_CHAR, &
             len(c_char_"Hello World",kind=c_size_t))
print '(a)', str ! prints: "Hello WorldXXXXXXXXXXXXXXXXXXXX"
end

```

C pointers are represented in Fortran via the special derived type `type(c_ptr)`, with private components. Thus one needs to use intrinsic conversion procedures to convert from or to C pointers. For example,

```

use iso_c_binding
type(c_ptr) :: cptr1, cptr2
integer, target :: array(7), scalar
integer, pointer :: pa(:), ps
cptr1 = c_loc(array(1)) ! The programmer needs to ensure that the
                       ! array is contiguous if required by the C
                       ! procedure
cptr2 = c_loc(scalar)
call c_f_pointer(cptr2, ps)
call c_f_pointer(cptr2, pa, shape=[7])

```

When converting C to Fortran arrays, the one-dimensional `SHAPE` argument has to be passed. Note: A pointer argument `void *` matches `TYPE(C_PTR)`, `VALUE` while `TYPE(C_PTR)` matches `void **`.

Procedure pointers are handled analogously to pointers; the C type is `TYPE(C_FUNPTR)` and the intrinsic conversion procedures are `C_F_PROC_POINTER` and `C_FUNLOC`.

The intrinsic procedures are described in [Chapter 8 \[Intrinsic Procedures\]](#), page 55.

### 7.1.5 Further Interoperability of Fortran with C

Assumed-shape and allocatable arrays are passed using an array descriptor (dope vector). The internal structure of the array descriptor used by GNU Fortran is not yet documented and will change. There will also be a Technical Report (TR 29113) which standardizes an interoperable array descriptor. Until then, you can use the Chasm Language Interoperability Tools, <http://chasm-interop.sourceforge.net/>, which provide an interface to GNU Fortran's array descriptor.

The technical report 29113 will presumably also include support for C-interoperable `OPTIONAL` and for assumed-rank and assumed-type dummy arguments. However, the TR has neither been approved nor implemented in GNU Fortran; therefore, these features are not yet available.

## 7.2 GNU Fortran Compiler Directives

The Fortran standard describes how a conforming program shall behave; however, the exact implementation is not standardized. In order to allow the user to choose specific implementation details, compiler directives can be used to set attributes of variables and procedures which are not part of the standard. Whether a given attribute is supported and its exact effects depend on both the operating system and on the processor; see [Section “C Extensions” in \*Using the GNU Compiler Collection \(GCC\)\*](#) for details.

For procedures and procedure pointers, the following attributes can be used to change the calling convention:

- `CDECL` – standard C calling convention
- `STDCALL` – convention where the called procedure pops the stack
- `FASTCALL` – part of the arguments are passed via registers instead using the stack

Besides changing the calling convention, the attributes also influence the decoration of the symbol name, e.g., by a leading underscore or by a trailing at-sign followed by the number of bytes on the stack. When assigning a procedure to a procedure pointer, both should use the same calling convention.

On some systems, procedures and global variables (module variables and `COMMON` blocks) need special handling to be accessible when they are in a shared library. The following attributes are available:

- `DLEXPOT` – provide a global pointer to a pointer in the DLL
- `DLLIMPORT` – reference the function or variable using a global pointer

The attributes are specified using the syntax

```
!GCC$ ATTRIBUTES attribute-list :: variable-list
```

where in free-form source code only whitespace is allowed before `!GCC$` and in fixed-form source code `!GCC$`, `cGCC$` or `*GCC$` shall start in the first column.

For procedures, the compiler directives shall be placed into the body of the procedure; for variables and procedure pointers, they shall be in the same declaration part as the variable or procedure pointer.

## 7.3 Non-Fortran Main Program

Even if you are doing mixed-language programming, it is very likely that you do not need to know or use the information in this section. Since it is about the internal structure of GNU Fortran, it may also change in GCC minor releases.

When you compile a `PROGRAM` with GNU Fortran, a function with the name `main` (in the symbol table of the object file) is generated, which initializes the `libgfortran` library and then calls the actual program which uses the name `MAIN_`, for historic reasons. If you link GNU Fortran compiled procedures to, e.g., a C or C++ program or to a Fortran program compiled by a different compiler, the `libgfortran` library is not initialized and thus a few intrinsic procedures do not work properly, e.g. those for obtaining the command-line arguments.

Therefore, if your `PROGRAM` is not compiled with GNU Fortran and the GNU Fortran compiled procedures require intrinsics relying on the library initialization, you need to initialize the library yourself. Using the default options, `gfortran` calls `_gfortran_set_args` and `_gfortran_set_options`. The initialization of the former is needed if the called procedures access the command line (and for backtracing); the latter sets some flags based on the standard chosen or to enable backtracing. In typical programs, it is not necessary to call any initialization function.

If your `PROGRAM` is compiled with GNU Fortran, you shall not call any of the following functions. The `libgfortran` initialization functions are shown in C syntax but using C bindings they are also accessible from Fortran.

### 7.3.1 `_gfortran_set_args` — Save command-line arguments

*Description:*

`_gfortran_set_args` saves the command-line arguments; this initialization is required if any of the command-line intrinsics is called. Additionally, it shall be called if backtracing is enabled (see `_gfortran_set_options`).

*Syntax:* `void _gfortran_set_args (int argc, char *argv[])`

*Arguments:*

<code>argc</code>	number of command line argument strings
<code>argv</code>	the command-line argument strings; <code>argv[0]</code> is the pathname of the executable itself.

*Example:*

```
int main (int argc, char *argv[])
{
    /* Initialize libgfortran. */
    _gfortran_set_args (argc, argv);
    return 0;
}
```

### 7.3.2 `_gfortran_set_options` — Set library option flags

*Description:*

`_gfortran_set_options` sets several flags related to the Fortran standard to be used, whether backtracing or core dumps should be enabled and whether range checks should be performed. The syntax allows for upward compatibility

since the number of passed flags is specified; for non-passed flags, the default value is used. See also see [Section 2.9 \[Code Gen Options\]](#), page 18. Please note that not all flags are actually used.

*Syntax:* `void _gfortran_set_options (int num, int options[])`

*Arguments:*

`num`                    number of options passed  
`argv`                    The list of flag values

*option flag list:*

`option[0]`            Allowed standard; can give run-time errors if e.g. an input-output edit descriptor is invalid in a given standard. Possible values are (bitwise or-ed) `GFC_STD_F77` (1), `GFC_STD_F95_OBS` (2), `GFC_STD_F95_DEL` (4), `GFC_STD_F95` (8), `GFC_STD_F2003` (16), `GFC_STD_GNU` (32), `GFC_STD_LEGACY` (64), and `GFC_STD_F2008` (128). Default: `GFC_STD_F95_OBS | GFC_STD_F95_DEL | GFC_STD_F2003 | GFC_STD_F2008 | GFC_STD_F95 | GFC_STD_F77 | GFC_STD_GNU | GFC_STD_LEGACY`.

`option[1]`            Standard-warning flag; prints a warning to standard error. Default: `GFC_STD_F95_DEL | GFC_STD_LEGACY`.

`option[2]`            If non zero, enable pedantic checking. Default: off.

`option[3]`            If non zero, enable core dumps on run-time errors. Default: off.

`option[4]`            If non zero, enable backtracing on run-time errors. Default: off. Note: Installs a signal handler and requires command-line initialization using `_gfortran_set_args`.

`option[5]`            If non zero, supports signed zeros. Default: enabled.

`option[6]`            Enables run-time checking. Possible values are (bitwise or-ed): `GFC_RTCHECK_BOUNDS` (1), `GFC_RTCHECK_ARRAY_TEMPS` (2), `GFC_RTCHECK_RECURSION` (4), `GFC_RTCHECK_DO` (16), `GFC_RTCHECK_POINTER` (32). Default: disabled.

`option[7]`            If non zero, range checking is enabled. Default: enabled. See `-frange-check` (see [Section 2.9 \[Code Gen Options\]](#), page 18).

*Example:*

```
/* Use gfortran 4.5 default options. */
static int options[] = {68, 255, 0, 0, 0, 1, 0, 1};
_gfortran_set_options (8, &options);
```

### 7.3.3 `_gfortran_set_convert` — Set endian conversion

*Description:*

`_gfortran_set_convert` set the representation of data for unformatted files.

*Syntax:* `void _gfortran_set_convert (int conv)`



*Arguments:*

<code>conv</code>	Endian conversion,	possible values:
	<code>GFC_CONVERT_NATIVE</code>	(0, default),
	<code>GFC_CONVERT_SWAP</code> (1),	<code>GFC_CONVERT_BIG</code>
	(2), <code>GFC_CONVERT_LITTLE</code> (3).	

*Example:*

```
int main (int argc, char *argv[])
{
    /* Initialize libgfortran. */
    _gfortran_set_args (argc, argv);
    _gfortran_set_convert (1);
    return 0;
}
```

### 7.3.4 `_gfortran_set_record_marker` — Set length of record markers

*Description:*

`_gfortran_set_record_marker` sets the length of record markers for unformatted files.

*Syntax:* `void _gfortran_set_record_marker (int val)`

*Arguments:*

<code>val</code>	Length of the record marker; valid values are 4 and 8. Default is 4.
------------------	--

*Example:*

```
int main (int argc, char *argv[])
{
    /* Initialize libgfortran. */
    _gfortran_set_args (argc, argv);
    _gfortran_set_record_marker (8);
    return 0;
}
```

### 7.3.5 `_gfortran_set_fpe` — Set when a Floating Point Exception should be raised

*Description:*

`_gfortran_set_fpe` sets the IEEE exceptions for which 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.

*Syntax:* `void _gfortran_set_fpe (int val)`

*Arguments:*

<code>option[0]</code>	IEEE exceptions. Possible values are (bitwise or-ed) zero (0, default) no trapping, <code>GFC_FPE_INVALID</code> (1), <code>GFC_FPE_DENORMAL</code> (2), <code>GFC_FPE_ZERO</code> (4), <code>GFC_FPE_OVERFLOW</code> (8), <code>GFC_FPE_UNDERFLOW</code> (16), and <code>GFC_FPE_PRECISION</code> (32).
------------------------	--

*Example:*

```
int main (int argc, char *argv[])
{
```

```

    /* Initialize libgfortran. */
    _gfortran_set_args (argc, argv);
    /* FPE for invalid operations such as SQRT(-1.0). */
    _gfortran_set_fpe (1);
    return 0;
}

```

### 7.3.6 `_gfortran_set_max_subrecord_length` — Set subrecord length

*Description:*

`_gfortran_set_max_subrecord_length` set the maximum length for a subrecord. This option only makes sense for testing and debugging of unformatted I/O.

*Syntax:* `void _gfortran_set_max_subrecord_length (int val)`

*Arguments:*

`val` the maximum length for a subrecord; the maximum permitted value is 2147483639, which is also the default.

*Example:*

```

int main (int argc, char *argv[])
{
    /* Initialize libgfortran. */
    _gfortran_set_args (argc, argv);
    _gfortran_set_max_subrecord_length (8);
    return 0;
}

```

## 8 Intrinsic Procedures

### 8.1 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.

### 8.2 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 8.68 \[EXIT\], page 97](#), [Section 8.124 \[KILL\], page 128](#)

### 8.3 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)
  z = 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

### 8.4 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:*

<i>NAME</i>	Scalar CHARACTER of default kind with the file name. Tailing blank are ignored unless the character <code>achar(0)</code> is present, then all characters up to and excluding <code>achar(0)</code> are used as file name.
<i>MODE</i>	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:*

## 8.5 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>I</i>	The type shall be INTEGER.
<i>KIND</i>	(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 8.107 \[ICHAR\]](#), page 119 for a discussion of converting between numerical values and formatted string representations.

*See also:* [Section 8.39 \[CHAR\]](#), page 78, [Section 8.101 \[IACHAR\]](#), page 116, [Section 8.107 \[ICHAR\]](#), page 119

## 8.6 ACOS — Arccosine function

*Description:*

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

*Standard:* Fortran 77 and later, for a complex argument Fortran 2008 or later

*Class:* Elemental function

*Syntax:* RESULT = ACOS(*X*)

*Arguments:*

*X*                    The type shall either be REAL with a magnitude that is less than or equal to one - or the type shall be COMPLEX.

*Return value:*

The return value is of the same type and kind as *X*. The real part of the result is in radians and lies in the range  $0 \leq \Re \operatorname{acos}(x) \leq \pi$ .

*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( <i>X</i> )	REAL(8) <i>X</i>	REAL(8)	Fortran 77 and later

*See also:* Inverse function: [Section 8.46 \[COS\]](#), page 83

## 8.7 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  $X$ . If  $X$  is complex, the imaginary part of the result is in radians and lies between  $0 \leq \Im \operatorname{acosh}(x) \leq \pi$ .

*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 8.47 \[COSH\]](#), page 83

## 8.8 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 8.9 \[ADJUSTR\]](#), page 59, [Section 8.219 \[TRIM\]](#), page 179

## 8.9 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 8.8 \[ADJUSTL\]](#), page 59, [Section 8.219 \[TRIM\]](#), page 179

## 8.10 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

## 8.11 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

## 8.12 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.

### 8.13 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 l
  l = all(/.true., .true., .true./)
  print *, l
  call section
contains
  subroutine section
    integer a(2,3), b(2,3)
    a = 1
    b = 1
  end subroutine section
end program test_all

```

```

        b(2,2) = 2
        print *, all(a .eq. b, 1)
        print *, all(a .eq. b, 2)
    end subroutine section
end program test_all

```

## 8.14 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

```

## 8.15 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 8.102 \[IAND\], page 116](#) 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 8.102 \[IAND\]](#), page 116

## 8.16 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

## 8.17 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 l
  l = any(/.true., .true., .true./)
  print *, l
  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

```

## 8.18 ASIN — Arcsine function

*Description:*

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

*Standard:* Fortran 77 and later, for a complex argument Fortran 2008 or later

*Class:* Elemental function

*Syntax:* RESULT = ASIN(X)

*Arguments:*

*X* The type shall be either REAL and a magnitude that is less than or equal to one - or be COMPLEX.

*Return value:*

The return value is of the same type and kind as  $X$ . The real part of the result is in radians and lies in the range  $-\pi/2 \leq \Re \operatorname{asin}(x) \leq \pi/2$ .

*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 8.196 \[SIN\]](#), page 167

## 8.19 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  $X$ . If  $X$  is complex, the imaginary part of the result is in radians and lies between  $-\pi/2 \leq \Im \operatorname{asinh}(x) \leq \pi/2$ .

*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 8.197 \[SINH\]](#), page 167

## 8.20 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:*

```

program test_associated
  implicit none
  real, target :: tgt(2) = (/1., 2./)
  real, pointer :: ptr(:)
  ptr => tgt
  if (associated(ptr) .eqv. .false.) call abort
  if (associated(ptr,tgt) .eqv. .false.) call abort
end program test_associated

```

See also: [Section 8.166 \[NULL\]](#), page 150

## 8.21 ATAN — Arctangent function

*Description:*

ATAN(X) computes the arctangent of X.

*Standard:* Fortran 77 and later, for a complex argument and for two arguments Fortran 2008 or later

*Class:* Elemental function

*Syntax:* RESULT = ATAN(X) RESULT = ATAN(Y, X)

*Arguments:*

X The type shall be REAL or COMPLEX; if Y is present, X shall be REAL.

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

*Return value:*

The return value is of the same type and kind as X. If Y is present, the result is identical to ATAN2(Y,X). Otherwise, it the arcus tangent of X, where the real part of the result is in radians and lies in the range  $-\pi/2 \leq \Re \operatorname{atan}(x) \leq \pi/2$ .

*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 8.211 \[TAN\]](#), page 175

## 8.22 ATAN2 — Arctangent function

*Description:*

ATAN2(Y, X) computes the principal value of the argument function of the complex number  $X + iY$ . This function can be used to transform from cartesian into polar coordinates and allows to determine the angle in the correct quadrant.

*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  $-\pi \leq \text{atan}(x) \leq \pi$ . 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, Y)	REAL(8) X, REAL(8) Y	REAL(8)	Fortran 77 and later

## 8.23 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  $X$ . If  $X$  is complex, the imaginary part of the result is in radians and lies between  $-\pi/2 \leq \Im \text{atanh}(x) \leq \pi/2$ .

*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 8.212 \[TANH\]](#), page 176

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

*Description:*

BESSEL\_J0(X) computes the Bessel function of the first kind of order 0 of  $X$ . This function is available under the name BESJ0 as a GNU extension.

*Standard:* Fortran 2008 and later

*Class:* Elemental function

*Syntax:* RESULT = BESSEL\_J0(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  $-0.4027... \leq Bessel(0, x) \leq 1$ . It has the same kind as X.

*Example:*

```
program test_besj0
  real(8) :: x = 0.0_8
  x = bessell_j0(x)
end program test_besj0
```

*Specific names:*

Name	Argument	Return type	Standard
DBESJ0(X)	REAL(8) X	REAL(8)	GNU extension

## 8.25 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  $-0.5818... \leq Bessel(0, x) \leq 0.5818$ . It has the same kind as X.

*Example:*

```
program test_besj1
  real(8) :: x = 1.0_8
  x = bessell_j1(x)
end program test_besj1
```

*Specific names:*

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

## 8.26 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(N, X)	INTEGER N	REAL(8)	GNU extension
	REAL(8) X		

## 8.27 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\_Y0(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
DBESY0(X)	REAL(8) X	REAL(8)	GNU extension

## 8.28 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 = bessell_y1(x)
end program test_besy1
```

*Specific names:*

Name	Argument	Return type	Standard
DBESY1( <i>X</i> )	REAL(8) <i>X</i>	REAL(8)	GNU extension

## 8.29 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 = bessell_yn(5,x)
end program test_besyn
```

*Specific names:*

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

### 8.30 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

```

### 8.31 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

```

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

*Description:*

C\_ASSOCIATED(*c\_ptr\_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\_ptr\_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 8.36 \[C\\_LOC\], page 76](#), [Section 8.33 \[C\\_FUNLOC\], page 74](#)

### 8.33 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:*

*x*                    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.

*Example:*

```
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 8.32 [C\_ASSOCIATED], page 74, Section 8.36 [C\_LOC], page 76, Section 8.35 [C\_F\_POINTER], page 76, Section 8.34 [C\_F\_PROCPOINTER], page 75

### 8.34 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*.

*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(cfuptr, myFunc)
    end program main

```

*See also:* [Section 8.36 \[C\\_LOC\], page 76](#), [Section 8.35 \[C\\_F\\_POINTER\], page 76](#)

### 8.35 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:*

<i>CPTR</i>	scalar of the type <code>C_PTR</code> . It is <code>INTENT(IN)</code> .
<i>FPTR</i>	pointer interoperable with <i>cptr</i> . It is <code>INTENT(OUT)</code> .
<i>SHAPE</i>	(Optional) Rank-one array of type <code>INTEGER</code> with <code>INTENT(IN)</code> . It shall be present if and only if <i>fptr</i> is an array. The size must be equal to the rank of <i>fptr</i> .

*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 8.36 \[C\\_LOC\], page 76](#), [Section 8.34 \[C\\_F\\_PROCPOINTER\], page 75](#)

### 8.36 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:*

<i>X</i>	Associated scalar pointer or interoperable scalar or allocated allocatable variable with <code>TARGET</code> attribute.
----------	---



*Return value:*

The return value is of type `C_PTR` and contains the C address of the argument.

*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 8.32 \[C\\_ASSOCIATED\], page 74](#), [Section 8.33 \[C\\_FUNLOC\], page 74](#), [Section 8.35 \[C\\_F\\_POINTER\], page 76](#), [Section 8.34 \[C\\_F\\_PROCPOINTER\], page 75](#)

## 8.37 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 8.199 \[SIZEOF\], page 168](#)

### 8.38 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 8.75 \[FLOOR\]](#), page 101, [Section 8.164 \[NINT\]](#), page 149

### 8.39 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 8.107 \[ICHAR\]](#), page 119 for a discussion of converting between numerical values and formatted string representations.

*See also:* [Section 8.5 \[ACHAR\]](#), page 57, [Section 8.101 \[IACHAR\]](#), page 116, [Section 8.107 \[ICHAR\]](#), page 119

## 8.40 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:*

<i>NAME</i>	The type shall be CHARACTER of default kind and shall specify a valid path within the file system.
<i>STATUS</i>	(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 8.90 \[GETCWD\]](#), page 111

## 8.41 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:*

<i>NAME</i>	Scalar CHARACTER of default kind with the file name. Trailing blanks are ignored unless the character <code>achar(0)</code> is present, then all characters up to and excluding <code>achar(0)</code> are used as the file name.
<i>MODE</i>	Scalar CHARACTER of default kind giving the file permission. <i>MODE</i> uses the same syntax as the <i>MODE</i> argument of <code>/bin/chmod</code> .
<i>STATUS</i>	(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

```

## 8.42 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:*

<i>X</i>	The type may be INTEGER, REAL, or COMPLEX.
<i>Y</i>	(Optional; only allowed if <i>X</i> is not COMPLEX.) May be INTEGER or REAL.
<i>KIND</i>	(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*.

*Example:*

```

program test_cplx
  integer :: i = 42
  real :: x = 3.14
  complex :: z
  z = cplx(i, x)
  print *, z, cplx(x)
end program test_cplx

```

*See also:* [Section 8.44 \[COMPLEX\]](#), page 81

### 8.43 `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 an `INTEGER` of default kind.

*Example:*

```

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

```

*See also:* [Section 8.88 \[GET\\_COMMAND\]](#), page 109, [Section 8.89 \[GET\\_COMMAND\\_ARGUMENT\]](#), page 110

### 8.44 `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.

*Example:*

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

*See also:*   Section 8.42 [CMPLX], page 80

## 8.45 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( <i>Z</i> )	COMPLEX(8) <i>Z</i>	COMPLEX(8)	GNU extension

## 8.46 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 the same type and kind as *X*. The real part of the result is in radians. If *X* is of the type REAL, the return value lies in the range  $-1 \leq \cos(x) \leq 1$ .

*Example:*

```
program test_cos
  real :: x = 0.0
  x = cos(x)
end program test_cos
```

*Specific names:*

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

*See also:* Inverse function: [Section 8.6 \[ACOS\]](#), page 58

## 8.47 COSH — Hyperbolic cosine function

*Description:*

COSH(*X*) computes the hyperbolic cosine of *X*.

*Standard:* Fortran 77 and later, for a complex argument Fortran 2008 or later

*Class:* Elemental function

*Syntax:* X = COSH(*X*)

*Arguments:*

*X*                    The type shall be REAL or COMPLEX.

*Return value:*

The return value has same type and kind as *X*. If *X* is complex, the imaginary part of the result is in radians. If *X* is REAL, the return value has a lower bound of one,  $\cosh(x) \geq 1$ .

*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 8.7 \[ACOSH\]](#), page 58

## 8.48 COUNT — Count function

*Description:*

Counts the number of `.TRUE.` elements in a logical `MASK`, or, if the `DIM` argument is supplied, counts the number of elements along each row of the array in the `DIM` direction. If the array has zero size, or all of the elements of `MASK` are `.FALSE.`, then the result is 0.

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

*Class:* Transformational function

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

*Arguments:*

<code>MASK</code>	The type shall be <code>LOGICAL</code> .
<code>DIM</code>	(Optional) The type shall be <code>INTEGER</code> .
<code>KIND</code>	(Optional) An <code>INTEGER</code> 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 present, the result is an array with a rank one less than the rank of `ARRAY`, and a size corresponding to the shape of `ARRAY` with the `DIM` dimension removed.

*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 '(3i3)', mask(1,:)
  print '(3i3)', mask(2,:)
  print *
  print '(3i3)', count(mask)
  print *
  print '(3i3)', count(mask, 1)
  print *
  print '(3i3)', count(mask, 2)
end program test_count

```



## 8.49 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 8.210 \[SYSTEM\\_CLOCK\]](#), page 175, [Section 8.52 \[DATE\\_AND\\_TIME\]](#), page 87

## 8.50 CSHIFT — Circular shift elements of an array

### Description:

**CSHIFT**(*ARRAY*, *SHIFT* [, *DIM*]) performs a circular 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  $1 \leq DIM \leq n$ ) 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.

*Example:*

```

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

```

## 8.51 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 8.97 [GMTIME], page 114, Section 8.144 [LTIME], page 138, Section 8.213 [TIME], page 176, Section 8.214 [TIME8], page 177

## 8.52 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 8.49 \[CPU\\_TIME\]](#), page 85, [Section 8.210 \[SYSTEM\\_CLOCK\]](#), page 175

## 8.53 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:*

```

program test_dble
    real    :: x = 2.18
    integer :: i = 5
    complex :: z = (2.3,1.14)
    print *, dble(x), dble(i), dble(z)
end program test_dble

```

*See also:* [Section 8.55 \[DFLOAT\]](#), page 89, [Section 8.72 \[FLOAT\]](#), page 99, [Section 8.179 \[REAL\]](#), page 157

## 8.54 DCMLPX — Double complex conversion function

*Description:*

DCMLPX(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 = DCMLPX(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_dcplx
  integer :: i = 42
  real :: x = 3.14
  complex :: z
  z = cmplx(i, x)
  print *, dcplx(i)
  print *, dcplx(x)
  print *, dcplx(z)
  print *, dcplx(x,i)
end program test_dcplx

```

## 8.55 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_dfloating
  integer :: i = 5
  print *, dfloating(i)
end program test_dfloating

```

*See also:* [Section 8.53 \[DBLE\]](#), page 88, [Section 8.72 \[FLOAT\]](#), page 99, [Section 8.179 \[REAL\]](#), page 157

## 8.56 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

```

## 8.57 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) X,Y	INTEGER(4)	Fortran 77 and later
DDIM(X,Y)	REAL(8) X,Y	REAL(8)	Fortran 77 and later

## 8.58 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..

*Example:*

```

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

```

## 8.59 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

```

## 8.60 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 8.10 \[AIMAG\], page 60](#)

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

*Description:*

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

VALUE and TIME are INTENT(OUT) and provide the following:

VALUE(1):	User time in seconds.
VALUE(2):	System time in seconds.
TIME:	Run time since start in seconds.



*Standard:* GNU extension

*Class:* Subroutine, function

*Syntax:*

```
CALL DTIME(VALUE, TIME).
TIME = DTIME(VALUE), (not recommended).
```

*Arguments:*

*VALUES*        The type shall be REAL(4), DIMENSION(2).  
*TIME*            The type shall be REAL(4).

*Return value:*

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

*Example:*

```
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 8.49 \[CPU\\_TIME\]](#), page 85

## 8.62 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  $1 \leq DIM \leq n$  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 *BOUNDARY* 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*.

<i>Array Type</i>	<i>Boundary Value</i>
Numeric	0 of the type and kind of <i>ARRAY</i> .
Logical	<code>.FALSE.</code>
Character( <i>len</i> )	<i>len</i> 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.

*Example:*

```

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

```

## 8.63 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

```

## 8.64 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  $-1 \leq \text{erf}(x) \leq 1$ .

*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

## 8.65 ERFC — Error function

*Description:*

ERFC(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  $0 \leq \text{erfc}(x) \leq 2$ .

*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

## 8.66 ERFC\_SCALED — Error function

*Description:*

ERFC\_SCALED(*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
```

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

*Description:*

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

*VALUES* and *TIME* are INTENT(OUT) and provide the following:

<i>VALUES</i> (1):	User time in seconds.
<i>VALUES</i> (2):	System time in seconds.
<i>TIME</i> :	Run time since start in seconds.

*Standard:* GNU extension

*Class:* Subroutine, function

*Syntax:*

CALL ETIME(*VALUES*, *TIME*).  
*TIME* = ETIME(*VALUES*), (not recommended).

*Arguments:*

*VALUES*            The type shall be REAL(4), DIMENSION(2).  
*TIME*                The type shall be REAL(4).

*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
  end do
  call ETIME(tarray, result)
  print *, result
  print *, tarray(1)
  print *, tarray(2)
end program test_etime

```

*See also:* [Section 8.49 \[CPU\\_TIME\]](#), page 85

## 8.68 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

*Syntax:* 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 8.2 \[ABORT\]](#), page 55, [Section 8.124 \[KILL\]](#), page 128

## 8.69 EXP — Exponential function

*Description:*

EXP(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

## 8.70 EXPONENT — Exponent function

*Description:*

EXPONENT(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
```

## 8.71 FDATE — Get the current time as a string

*Description:*

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

*Example:*

```
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
```

## 8.72 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 8.53 [`DBLE`], page 88, Section 8.55 [`DFLOAT`], page 89, Section 8.179 [`REAL`], page 157

## 8.73 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 31.

*Standard:* GNU extension

*Class:* Subroutine, function

*Syntax:* CALL FGET(C [, STATUS])

### *Arguments:*

<i>C</i>	The type shall be CHARACTER and of default kind.
<i>STATUS</i>	(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 8.74 \[FGETC\]](#), page 100, [Section 8.78 \[FPUT\]](#), page 103, [Section 8.79 \[FPUTC\]](#), page 103

## 8.74 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 31.

*Standard:* GNU extension

*Class:* Subroutine, function

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

*Arguments:*

<i>UNIT</i>	The type shall be INTEGER.
<i>C</i>	The type shall be CHARACTER and of default kind.
<i>STATUS</i>	(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_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 8.73 \[FGET\]](#), page 100, [Section 8.78 \[FPUT\]](#), page 103, [Section 8.79 \[FPUTC\]](#), page 103

## 8.75 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:*

<i>A</i>	The type shall be REAL.
<i>KIND</i>	(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 8.38 \[CEILING\]](#), page 78, [Section 8.164 \[NINT\]](#), page 149

## 8.76 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.

## 8.77 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

```

## 8.78 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 31.

*Standard:* GNU extension

*Class:* Subroutine, function

*Syntax:* CALL FPUT(C [, STATUS])

### *Arguments:*

<i>C</i>	The type shall be CHARACTER and of default kind.
<i>STATUS</i>	(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_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 8.79 \[FPUTC\]](#), page 103, [Section 8.73 \[FGET\]](#), page 100, [Section 8.74 \[FGETC\]](#), page 100

## 8.79 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 31.

*Standard:* GNU extension

*Class:* Subroutine, function

*Syntax:* CALL FPUTC(UNIT, C [, STATUS])

*Arguments:*

<i>UNIT</i>	The type shall be <code>INTEGER</code> .
<i>C</i>	The type shall be <code>CHARACTER</code> and of default kind.
<i>STATUS</i>	(Optional) status flag of type <code>INTEGER</code> . Returns 0 on success, -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 8.78 \[FPUT\]](#), page 103, [Section 8.73 \[FGET\]](#), page 100, [Section 8.74 \[FGETC\]](#), page 100

## 8.80 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:*

<i>X</i>	The type of the argument shall be a <code>REAL</code> .
----------	---

*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
```

## 8.81 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 8.145 \[MALLOC\]](#), page 138

## 8.82 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 31.

*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
  fd = 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 8.84 \[FTELL\], page 107](#)

## 8.83 FSTAT — Get file status

*Description:*

FSTAT is identical to [Section 8.206 \[STAT\], page 172](#), except that information about an already opened file is obtained.

The elements in VALUES are the same as described by [Section 8.206 \[STAT\], page 172](#).

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, VALUES [, STATUS])

*Arguments:*

*UNIT* An open I/O unit number of type INTEGER.  
*VALUES* The type shall be INTEGER(4), DIMENSION(13).  
*STATUS* (Optional) status flag of type INTEGER(4). Returns 0 on success and a system specific error code otherwise.

*Example:* See [Section 8.206 \[STAT\], page 172](#) for an example.

*See also:* To stat a link: [Section 8.143 \[LSTAT\], page 137](#), to stat a file: [Section 8.206 \[STAT\], page 172](#)

## 8.84 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 8.82 \[FSEEK\]](#), page 105

## 8.85 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 8.139 \[LOG\\_GAMMA\]](#), page 135

## 8.86 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 8.110 \[IERRNO\]](#), page 121, [Section 8.169 \[PERROR\]](#), page 152

## 8.87 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 8.89 \[GET\\_COMMAND\\_ARGUMENT\]](#), page 110 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 integer 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 *POS*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 *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 8.103 \[IARGC\]](#), page 117  
 Fortran 2003 functions and subroutines: [Section 8.88 \[GET\\_COMMAND\]](#), page 109, [Section 8.89 \[GET\\_COMMAND\\_ARGUMENT\]](#), page 110, [Section 8.43 \[COMMAND\\_ARGUMENT\\_COUNT\]](#), page 81

## 8.88 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, LENGTH, STATUS])

*Arguments:*

*COMMAND* (Optional) shall be of type CHARACTER and of default kind.  
*LENGTH* (Optional) Shall be of type INTEGER and of default kind.  
*STATUS* (Optional) Shall be of type INTEGER and of default kind.

*Return value:*

If *COMMAND* is present, stores the entire command line that was used to invoke the program in *COMMAND*. If *LENGTH* is present, it is assigned the length of the command line. If *STATUS* is present, it is assigned 0 upon success of the command, -1 if *COMMAND* is too short to store the command line, or a positive value in case of an error.

*Example:*

```
PROGRAM test_get_command
  CHARACTER(len=255) :: cmd
  CALL get_command(cmd)
  WRITE (*,*) TRIM(cmd)
END PROGRAM
```

*See also:* [Section 8.89 \[GET\\_COMMAND\\_ARGUMENT\]](#), page 110, [Section 8.43 \[COMMAND\\_ARGUMENT\\_COUNT\]](#), page 81

## 8.89 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` and of default kind,  $NUMBER \geq 0$

*VALUE* Shall be a scalar of type `CHARACTER` and of default kind.

*LENGTH* (Option) Shall be a scalar of type `INTEGER` and of default kind.

*STATUS* (Option) Shall be a scalar of type `INTEGER` and of default kind.

*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 8.88 \[GET\\_COMMAND\]](#), page 109, [Section 8.43 \[COMMAND\\_ARGUMENT\\_COUNT\]](#), page 81

## 8.90 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 8.40 \[CHDIR\], page 79](#)

## 8.91 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 8.92 \[GET\\_ENVIRONMENT\\_VARIABLE\], page 112](#) 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 8.92 \[GET\\_ENVIRONMENT\\_VARIABLE\], page 112](#)

## 8.92 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 and of default kind.  
*VALUE* Shall be a scalar of type CHARACTER and of default kind.  
*LENGTH* Shall be a scalar of type INTEGER and of default kind.  
*STATUS* Shall be a scalar of type INTEGER and of default kind.  
*TRIM\_NAME* Shall be a scalar of type LOGICAL 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. 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
```

## 8.93 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 8.95 \[GETPID\]](#), page 113, [Section 8.96 \[GETUID\]](#), page 113

## 8.94 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 8.96 \[GETUID\], page 113](#)

## 8.95 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 8.93 \[GETGID\], page 112](#), [Section 8.96 \[GETUID\], page 113](#)

## 8.96 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 8.95 \[GETPID\], page 113](#), [Section 8.94 \[GETLOG\], page 113](#)

## 8.97 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:*

<i>TIME</i>	An INTEGER scalar expression corresponding to a system time, with INTENT(IN).
<i>VALUES</i>	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 8.51 \[CTIME\], page 86](#), [Section 8.144 \[LTIME\], page 138](#), [Section 8.213 \[TIME\], page 176](#), [Section 8.214 \[TIME8\], page 177](#)

## 8.98 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.

## 8.99 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
```

## 8.100 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

```

## 8.101 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 8.107 \[ICHAR\]](#), page 119 for a discussion of converting between numerical values and formatted string representations.

*See also:* [Section 8.5 \[ACHAR\]](#), page 57, [Section 8.39 \[CHAR\]](#), page 78, [Section 8.107 \[ICHAR\]](#), page 119

## 8.102 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 8.115 [IOR], page 123, Section 8.109 [IEOR], page 120, Section 8.105 [IBITS], page 118, Section 8.106 [IBSET], page 118, Section 8.104 [IBCLR], page 118, Section 8.165 [NOT], page 150

### 8.103 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 8.43 [COMMAND\_ARGUMENT\_COUNT], page 81 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 8.87 [GETARG], page 108

*See also:* GNU Fortran 77 compatibility subroutine: Section 8.87 [GETARG], page 108  
 Fortran 2003 functions and subroutines: Section 8.88 [GET\_COMMAND], page 109, Section 8.89 [GET\_COMMAND\_ARGUMENT], page 110, Section 8.43 [COMMAND\_ARGUMENT\_COUNT], page 81

### 8.104 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>I</i>	The type shall be INTEGER.
<i>POS</i>	The type shall be INTEGER.

*Return value:*

The return value is of type INTEGER and of the same kind as *I*.

*See also:* [Section 8.105 \[IBITS\]](#), page 118, [Section 8.106 \[IBSET\]](#), page 118, [Section 8.102 \[IAND\]](#), page 116, [Section 8.115 \[IOR\]](#), page 123, [Section 8.109 \[IEOR\]](#), page 120, [Section 8.161 \[MVBITS\]](#), page 148

### 8.105 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>I</i>	The type shall be INTEGER.
<i>POS</i>	The type shall be INTEGER.
<i>LEN</i>	The type shall be INTEGER.

*Return value:*

The return value is of type INTEGER and of the same kind as *I*.

*See also:* [Section 8.30 \[BIT\\_SIZE\]](#), page 73, [Section 8.104 \[IBCLR\]](#), page 118, [Section 8.106 \[IBSET\]](#), page 118, [Section 8.102 \[IAND\]](#), page 116, [Section 8.115 \[IOR\]](#), page 123, [Section 8.109 \[IEOR\]](#), page 120

### 8.106 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 8.104 [IBCLR], page 118, Section 8.105 [IBITS], page 118, Section 8.102 [IAND], page 116, Section 8.115 [IOR], page 123, Section 8.109 [IEOR], page 120, Section 8.161 [MVBITS], page 148

## 8.107 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:*     Fortran 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 8.5 \[ACHAR\], page 57](#), [Section 8.39 \[CHAR\], page 78](#), [Section 8.101 \[IACHAR\], page 116](#)

## 8.108 IDATE — Get current local time subroutine (day/month/year)

*Description:*

IDATE(VALUE) Fills *VALUES* 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 *VALUES*, respectively. The year has four significant digits.

*Standard:* GNU extension

*Class:* Subroutine

*Syntax:* CALL IDATE(VALUE)

*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

```

## 8.109 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 8.115 \[IOR\]](#), page 123, [Section 8.102 \[IAND\]](#), page 116, [Section 8.105 \[IBITS\]](#), page 118, [Section 8.106 \[IBSET\]](#), page 118, [Section 8.104 \[IBCLR\]](#), page 118, [Section 8.165 \[NOT\]](#), page 150

**8.110 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 8.169 \[PERROR\]](#), page 152

**8.111 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:*

<i>STRING</i>	Shall be a scalar <code>CHARACTER</code> , with <code>INTENT(IN)</code>
<i>SUBSTRING</i>	Shall be a scalar <code>CHARACTER</code> , with <code>INTENT(IN)</code>
<i>BACK</i>	(Optional) Shall be a scalar <code>LOGICAL</code> , with <code>INTENT(IN)</code>
<i>KIND</i>	(Optional) An <code>INTEGER</code> 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 8.186 \[SCAN\]](#), page 161, [Section 8.225 \[VERIFY\]](#), page 182

## 8.112 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  $|A| \geq 1$ , 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

## 8.113 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 8.112 \[INT\]](#), page 122, [Section 8.114 \[INT8\]](#), page 123, [Section 8.141 \[LONG\]](#), page 136

## 8.114 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 8.112 \[INT\]](#), page 122, [Section 8.113 \[INT2\]](#), page 122, [Section 8.141 \[LONG\]](#), page 136

## 8.115 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 8.109 \[IEOR\]](#), page 120, [Section 8.102 \[IAND\]](#), page 116, [Section 8.105 \[IBITS\]](#), page 118, [Section 8.106 \[IBSET\]](#), page 118, [Section 8.104 \[IBCLR\]](#), page 118, [Section 8.165 \[NOT\]](#), page 150

## 8.116 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 8.176 \[RANDOM\\_NUMBER\]](#), page 155 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(), irand()
  print *, irand(seed), irand(), irand(), irand()
end program test_irand

```

## 8.117 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
```

### 8.118 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
```

### 8.119 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 8.220 \[TTYNAM\]](#), page 180

## 8.120 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>I</i>	The type shall be INTEGER.
<i>SHIFT</i>	The type shall be INTEGER.

*Return value:*

The return value is of type INTEGER and of the same kind as *I*.

*See also:* [Section 8.121 \[ISHFTC\]](#), page 126

## 8.121 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>I</i>	The type shall be INTEGER.
<i>SHIFT</i>	The type shall be INTEGER.
<i>SIZE</i>	(Optional) The type shall be INTEGER; the value must be greater than zero and less than or equal to BIT_SIZE( <i>I</i> ).

*Return value:*

The return value is of type `INTEGER` and of the same kind as *I*.

*See also:* [Section 8.120 \[ISHFT\]](#), page 126

## 8.122 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

```

## 8.123 ITIME — Get current local time subroutine (hour/minutes/seconds)

*Description:*

`IDATE(VALUE)` 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(VALUE)`

*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

```

## 8.124 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:*

<i>C</i>	Shall be a scalar <code>INTEGER</code> , with <code>INTENT(IN)</code>
<i>VALUE</i>	Shall be a scalar <code>INTEGER</code> , with <code>INTENT(IN)</code>
<i>STATUS</i>	(Optional) status flag of type <code>INTEGER(4)</code> or <code>INTEGER(8)</code> . Returns 0 on success, or a system-specific error code otherwise.

*See also:* [Section 8.2 \[ABORT\], page 55](#), [Section 8.68 \[EXIT\], page 97](#)

## 8.125 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:*

<i>X</i>	Shall be of type <code>LOGICAL</code> , <code>INTEGER</code> , <code>REAL</code> , <code>COMPLEX</code> or <code>CHARACTER</code> .
----------	---

*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

```

### 8.126 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 8.221 \[UBOUND\]](#), page 180

### 8.127 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 8.30 \[BIT\\_SIZE\]](#), page 73, [Section 8.216 \[TRAILZ\]](#), page 178

## 8.128 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 8.129 \[LEN\\_TRIM\], page 130](#), [Section 8.8 \[ADJUSTL\], page 59](#), [Section 8.9 \[ADJUSTR\], page 59](#)

## 8.129 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 8.128 \[LEN\], page 130](#), [Section 8.8 \[ADJUSTL\], page 59](#), [Section 8.9 \[ADJUSTR\], page 59](#)

## 8.130 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 8.131 \[LGT\], page 131](#), [Section 8.133 \[LLE\], page 132](#), [Section 8.134 \[LLT\], page 133](#)

### 8.131 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 8.130 \[LGE\], page 130](#), [Section 8.133 \[LLE\], page 132](#), [Section 8.134 \[LLT\], page 133](#)

### 8.132 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 8.208 \[SYMLNK\]](#), page 174, [Section 8.223 \[UNLINK\]](#), page 181

### 8.133 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 8.130 \[LGE\]](#), page 130, [Section 8.131 \[LGT\]](#), page 131, [Section 8.134 \[LLT\]](#), page 133



### 8.134 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 8.130 \[LGE\]](#), page 130, [Section 8.131 \[LGT\]](#), page 131, [Section 8.133 \[LLE\]](#), page 132

### 8.135 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 8.111 \[INDEX intrinsic\]](#), page 121, [Section 8.129 \[LEN\\_TRIM\]](#), page 130

### 8.136 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
```

### 8.137 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( <i>X</i> )	REAL(4) <i>X</i>	REAL(4)	f95, gnu
DLOG( <i>X</i> )	REAL(8) <i>X</i>	REAL(8)	f95, gnu
CLOG( <i>X</i> )	COMPLEX(4) <i>X</i>	COMPLEX(4)	f95, gnu

ZLOG(X)	COMPLEX(8) X	COMPLEX(8)	f95, gnu
CDLOG(X)	COMPLEX(8) X	COMPLEX(8)	f95, gnu

### 8.138 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

### 8.139 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 8.85 \[GAMMA\]](#), page 107

## 8.140 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 8.112 \[INT\]](#), page 122, [Section 8.179 \[REAL\]](#), page 157, [Section 8.42 \[CMPLX\]](#), page 80

## 8.141 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 8.112 \[INT\]](#), page 122, [Section 8.113 \[INT2\]](#), page 122, [Section 8.114 \[INT8\]](#), page 123

### 8.142 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>I</i>	The type shall be <code>INTEGER</code> .
<i>SHIFT</i>	The type shall be <code>INTEGER</code> .

*Return value:*

The return value is of type `INTEGER` and of the same kind as *I*.

*See also:* [Section 8.120 \[ISHFT\], page 126](#), [Section 8.121 \[ISHFTC\], page 126](#), [Section 8.184 \[RSHIFT\], page 160](#)

### 8.143 LSTAT — Get file status

*Description:*

LSTAT is identical to [Section 8.206 \[STAT\], page 172](#), except that if path is a symbolic link, then the link itself is statted, not the file that it refers to.

The elements in `VALUES` are the same as described by [Section 8.206 \[STAT\], page 172](#).

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(NAME, VALUES [, STATUS])`

*Arguments:*

<i>NAME</i>	The type shall be <code>CHARACTER</code> of the default kind, a valid path within the file system.
<i>VALUES</i>	The type shall be <code>INTEGER(4)</code> , <code>DIMENSION(13)</code> .
<i>STATUS</i>	(Optional) status flag of type <code>INTEGER(4)</code> . Returns 0 on success and a system specific error code otherwise.

*Example:* See [Section 8.206 \[STAT\], page 172](#) for an example.

*See also:* To stat an open file: [Section 8.83 \[FSTAT\], page 106](#), to stat a file: [Section 8.206 \[STAT\], page 172](#)

## 8.144 LTIME — Convert time to local time info

*Description:*

Given a system time value *TIME* (as provided by the `TIME8()` intrinsic), fills *VALUES* with values extracted from it appropriate to the local time zone using `localtime(3)`.

*Standard:* GNU extension

*Class:* Subroutine

*Syntax:* `CALL LTIME(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 8.51 \[CTIME\], page 86](#), [Section 8.97 \[GMTIME\], page 114](#), [Section 8.213 \[TIME\], page 176](#), [Section 8.214 \[TIME8\], page 177](#)

## 8.145 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 8.81 \[FREE\]](#), page 105

## 8.146 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:*

## 8.147 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, ...*          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
MAX0(I)	INTEGER(4) I	INTEGER(4)	Fortran 77 and later
AMAX0(I)	INTEGER(4) I	REAL(MAX(X))	Fortran 77 and later
MAX1(X)	REAL X	INT(MAX(X))	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 8.149 \[MAXLOC\], page 141](#) [Section 8.150 \[MAXVAL\], page 141](#), [Section 8.154 \[MIN\], page 143](#)

## 8.148 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

*Class:* Inquiry function

*Syntax:* RESULT = MAXEXPONENT(X)

*Arguments:*

*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

```



## 8.149 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.

*Standard:* Fortran 95 and later

*Class:* Transformational function

### *Syntax:*

```
RESULT = MAXLOC(ARRAY, DIM [, MASK])
RESULT = MAXLOC(ARRAY [, MASK])
```

### *Arguments:*

<i>ARRAY</i>	Shall be an array of type <i>INTEGER</i> or <i>REAL</i> .
<i>DIM</i>	(Optional) Shall be a scalar of type <i>INTEGER</i> , with a value between one and the rank of <i>ARRAY</i> , inclusive. It may not be an optional dummy argument.
<i>MASK</i>	Shall be an array of type <i>LOGICAL</i> , and conformable with <i>ARRAY</i> .

### *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 8.147 \[MAX\]](#), page 140, [Section 8.150 \[MAXVAL\]](#), page 141

## 8.150 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` or `REAL`.  
*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 8.147 \[MAX\]](#), page 140, [Section 8.149 \[MAXLOC\]](#), page 141

## 8.151 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 8.51 \[CTIME\]](#), page 86, [Section 8.97 \[GMTIME\]](#), page 114, [Section 8.144 \[LTIME\]](#), page 138, [Section 8.151 \[MCLOCK\]](#), page 142, [Section 8.213 \[TIME\]](#), page 176

## 8.152 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 8.51 \[CTIME\]](#), page 86, [Section 8.97 \[GMTIME\]](#), page 114, [Section 8.144 \[LTIME\]](#), page 138, [Section 8.151 \[MCLOCK\]](#), page 142, [Section 8.214 \[TIME8\]](#), page 177

### 8.153 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:*

<i>TSOURCE</i>	May be of any type.
<i>FSOURCE</i>	Shall be of the same type and type parameters as <i>TSOURCE</i> .
<i>MASK</i>	Shall be of type <code>LOGICAL</code> .

*Return value:*

The result is of the same type and type parameters as *TSOURCE*.

### 8.154 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:*

<i>A1</i>	The type shall be <code>INTEGER</code> or <code>REAL</code> .
<i>A2, A3, ...</i>	An expression of the same type and kind as <i>A1</i> . (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	INT(MIN(X))	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 8.147 [MAX], page 140, Section 8.156 [MINLOC], page 144, Section 8.157 [MINVAL], page 145

## 8.155 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.

## 8.156 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` or `REAL`.  
*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 8.154 \[MIN\]](#), page 143, [Section 8.157 \[MINVAL\]](#), page 145

## 8.157 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` or `REAL`.  
*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 8.154 \[MIN\]](#), page 143, [Section 8.156 \[MINLOC\]](#), page 144

## 8.158 MOD — Remainder function

*Description:*

MOD(A,P) computes the remainder of the division of A by P. It is calculated as  $A - (\text{INT}(A/P) * P)$ .

*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(17.5,-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

## 8.159 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  $A - \text{FLOOR}(A / P) * P$ .

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

```

## 8.160 **MOVE\_ALLOC** — Move allocation from one object to another

*Description:*

**MOVE\_ALLOC**( $FROM$ ,  $TO$ ) moves the allocation from  $FROM$  to  $TO$ .  $FROM$  will become deallocated in the process.

*Standard:* Fortran 2003 and later

*Class:* Subroutine

*Syntax:* **CALL** **MOVE\_ALLOC**( $FROM$ ,  $TO$ )

*Arguments:*

$FROM$	<b>ALLOCATABLE</b> , <b>INTENT</b> ( <b>INOUT</b> ), may be of any type and kind.
$TO$	<b>ALLOCATABLE</b> , <b>INTENT</b> ( <b>OUT</b> ), shall be of the same type, kind and rank as $FROM$ .

*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

```

## 8.161 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:*

<i>FROM</i>	The type shall be <code>INTEGER</code> .
<i>FROMPOS</i>	The type shall be <code>INTEGER</code> .
<i>LEN</i>	The type shall be <code>INTEGER</code> .
<i>TO</i>	The type shall be <code>INTEGER</code> , of the same kind as <i>FROM</i> .
<i>TOPOS</i>	The type shall be <code>INTEGER</code> .

*See also:* [Section 8.104 \[IBCLR\]](#), page 118, [Section 8.106 \[IBSET\]](#), page 118, [Section 8.105 \[IBITS\]](#), page 118, [Section 8.102 \[IAND\]](#), page 116, [Section 8.115 \[IOR\]](#), page 123, [Section 8.109 \[IEOR\]](#), page 120

## 8.162 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:*

<i>X</i>	Shall be of type <code>REAL</code> .
<i>S</i>	(Optional) shall be of type <code>REAL</code> 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

```



### 8.163 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

```

### 8.164 NINT — Nearest whole number

*Description:*

NINT(*A*) 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(*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:*

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( <i>X</i> )	REAL(8)	Fortran 95 and later

*See also:* Section 8.38 [CEILING], page 78, Section 8.75 [FLOOR], page 101

## 8.165 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 8.102 [IAND], page 116, Section 8.109 [IEOR], page 120, Section 8.115 [IOR], page 123, Section 8.105 [IBITS], page 118, Section 8.106 [IBSET], page 118, Section 8.104 [IBCLR], page 118

## 8.166 NULL — Function that returns an disassociated pointer

*Description:*

Returns a disassociated pointer.

If *MOLD* is present, a disassociated 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 8.20 [ASSOCIATED], page 66

## 8.167 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 8.115 \[IOR\], page 123](#) intrinsic defined by the Fortran standard.

*Standard:* GNU extension

*Class:* Function

*Syntax:* RESULT = OR(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 *J*.

### 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 8.115 \[IOR\], page 123](#)

## 8.168 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(I0, ' '))") pack(m, m /= 0) ! "1 5"
END PROGRAM
```

Gathering nonzero elements from an array and appending elements from *VECTOR*:

```
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 8.224 \[UNPACK\], page 182](#)

## 8.169 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 8.110 \[IERRNO\], page 121](#)

## 8.170 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

```

### 8.171 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 subroutine 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

```

### 8.172 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:*

```
PROGRAM test_product
  INTEGER :: x(5) = (/ 1, 2, 3, 4 ,5 /)
  print *, PRODUCT(x)           ! all elements, product = 120
  print *, PRODUCT(x, MASK=MOD(x, 2)==1) ! odd elements, product = 15
END PROGRAM
```

*See also:* [Section 8.207 \[SUM\], page 173](#)

## 8.173 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
```

### 8.174 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 8.175 \[RAND\]](#), page 155 for complete documentation.

*Standard:* GNU extension

*Class:* Function

*See also:* [Section 8.175 \[RAND\]](#), page 155, [Section 8.176 \[RANDOM\\_NUMBER\]](#), page 155

### 8.175 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 8.176 \[RANDOM\\_NUMBER\]](#), page 155 as it implements a superior algorithm.

*Standard:* GNU extension

*Class:* Function

*Syntax:* RESULT = RAND(I)

*Arguments:*

I                    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 8.205 \[SRAND\]](#), page 171, [Section 8.176 \[RANDOM\\_NUMBER\]](#), page 155

### 8.176 RANDOM\_NUMBER — Pseudo-random number

*Description:*

Returns a single pseudorandom number or an array of pseudorandom numbers from the uniform distribution over the range  $0 \leq x < 1$ .

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 8.177 \[RANDOM\\_SEED\]](#), page 156

## 8.177 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 8.176 \[RANDOM.NUMBER\]](#), page 155

## 8.178 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.

## 8.179 REAL — Convert to real type

*Description:*

`REAL(A [, KIND])` converts its argument `A` to a real type. The `REALPART` function is provided for compatibility with `g77`, and its use is strongly discouraged.

*Standard:* Fortran 77 and later

*Class:* Elemental function

*Syntax:*

```
RESULT = REAL(A [, KIND])
RESULT = REALPART(Z)
```

*Arguments:*

*A* 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(*A*) is converted to a default real type if *A* is an integer or real variable.
- (B) REAL(*A*) is converted to a real type with the kind type parameter of *A* if *A* is a complex variable.
- (C) REAL(*A*, *KIND*) is converted to a real type with kind type parameter *KIND* if *A* 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 8.53 \[DBLE\]](#), page 88, [Section 8.55 \[DFLOAT\]](#), page 89, [Section 8.72 \[FLOAT\]](#), page 99

## 8.180 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 8.132 \[LINK\]](#), page 132

### 8.181 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
```

### 8.182 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 8.193 \[SHAPE\]](#), page 165

### 8.183 RRSPPACING — 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 = RRSPPACING(*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 8.202 \[SPACING\]](#), page 170

### 8.184 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 8.120 \[ISHFT\]](#), page 126, [Section 8.121 \[ISHFTC\]](#), page 126, [Section 8.142 \[LSHIFT\]](#), page 137

### 8.185 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  $X * \text{RADIX}(X)**I$ .

*Example:*

```
program test_scale
  real :: x = 178.1387e-4
  integer :: i = 5
  print *, scale(x,i), x*radix(x)**i
end program test_scale
```

## 8.186 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 8.111 [INDEX intrinsic], page 121, Section 8.225 [VERIFY], page 182

## 8.187 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:*

<i>T</i>	Shall be of type REAL(4).
<i>X</i>	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

```

## 8.188 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:*

<i>TIME</i>	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 8.49 \[CPU\\_TIME\], page 85](#)

### 8.189 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_"abcdefghijklmnopqrstuvwxy"
  print *, s
end program ascii_kind

```

### 8.190 SELECTED\_INT\_KIND — Choose integer kind

*Description:*

SELECTED\_INT\_KIND(R) return the kind value of the smallest integer type that can represent all values ranging from  $-10^R$  (exclusive) to  $10^R$  (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(R)

*Arguments:*

R                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

```

## 8.191 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 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

```

## 8.192 SET\_EXPONENT — Set the exponent of the model

*Description:*

SET\_EXPONENT(X, I) returns the real number whose fractional part is 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 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
```

**8.193 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 extent 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(A))     ! (/ /)
END PROGRAM
```

*See also:* [Section 8.182 \[RESHAPE\]](#), page 159, [Section 8.198 \[SIZE\]](#), page 168

**8.194 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  $B \geq 0$  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.,-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

## 8.195 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*         Signal handler (INTEGER FUNCTION or SUBROUTINE) or 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

```

## 8.196 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 8.18 \[ASIN\], page 65](#)

## 8.197 SINH — Hyperbolic sine function

*Description:*

SINH(X) computes the hyperbolic sine of X.

*Standard:* Fortran 95 and later, for a complex argument Fortran 2008 or later

*Class:* Elemental function

*Syntax:* RESULT = SINH(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_sinh
  real(8) :: x = - 1.0_8
  x = sinh(x)
end program test_sinh
```

*Specific names:*

Name	Argument	Return type	Standard
DSINH( <i>X</i> )	REAL(8) <i>X</i>	REAL(8)	Fortran 95 and later

*See also:* [Section 8.19 \[ASINH\]](#), page 66

## 8.198 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:*

<i>ARRAY</i>	Shall be an array of any type. If <i>ARRAY</i> is a pointer it must be associated and allocatable arrays must be allocated.
<i>DIM</i>	(Optional) shall be a scalar of type <code>INTEGER</code> and its value shall be in the range from 1 to <i>n</i> , where <i>n</i> equals the rank of <i>ARRAY</i> .
<i>KIND</i>	(Optional) An <code>INTEGER</code> 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 8.193 \[SHAPE\]](#), page 165, [Section 8.182 \[RESHAPE\]](#), page 159

## 8.199 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 8.37 [*C\_SIZEOF*], page 77

## 8.200 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
```

## 8.201 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 8.53 \[DBLE\]](#), page 88

## 8.202 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:*

```
PROGRAM test_spacing
  INTEGER, PARAMETER :: SGL = SELECTED_REAL_KIND(p=6, r=37)
  INTEGER, PARAMETER :: DBL = SELECTED_REAL_KIND(p=13, r=200)

  WRITE(*,*) spacing(1.0_SGL)      ! "1.1920929E-07"          on i686
  WRITE(*,*) spacing(1.0_DBL)      ! "2.220446049250313E-016" on i686
END PROGRAM
```

*See also:* [Section 8.183 \[RRSPACING\]](#), page 160

## 8.203 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:*

```
PROGRAM test_spread
  INTEGER :: a = 1, b(2) = (/ 1, 2 /)
  WRITE(*,*) SPREAD(A, 1, 2)      ! "1 1"
  WRITE(*,*) SPREAD(B, 1, 2)      ! "1 1 2 2"
END PROGRAM
```

*See also:* [Section 8.224 \[UNPACK\]](#), page 182

## 8.204 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( <i>X</i> )	REAL(8) <i>X</i>	REAL(8)	Fortran 95 and later
CSQRT( <i>X</i> )	COMPLEX(4) <i>X</i>	COMPLEX(4)	Fortran 95 and later
ZSQRT( <i>X</i> )	COMPLEX(8) <i>X</i>	COMPLEX(8)	GNU extension
CDSQRT( <i>X</i> )	COMPLEX(8) <i>X</i>	COMPLEX(8)	GNU extension

## 8.205 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 8.175 \[RAND\], page 155](#), [Section 8.177 \[RANDOM\\_SEED\], page 156](#), [Section 8.176 \[RANDOM\\_NUMBER\], page 155](#)

## 8.206 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 `VALUES`:

<code>VALUES(1)</code>	Device ID
<code>VALUES(2)</code>	Inode number
<code>VALUES(3)</code>	File mode
<code>VALUES(4)</code>	Number of links
<code>VALUES(5)</code>	Owner's uid
<code>VALUES(6)</code>	Owner's gid
<code>VALUES(7)</code>	ID of device containing directory entry for file (0 if not available)
<code>VALUES(8)</code>	File size (bytes)
<code>VALUES(9)</code>	Last access time
<code>VALUES(10)</code>	Last modification time
<code>VALUES(11)</code>	Last file status change time
<code>VALUES(12)</code>	Preferred I/O block size (-1 if not available)
<code>VALUES(13)</code>	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(NAME, VALUES [, STATUS])`

*Arguments:*

*NAME*            The type shall be `CHARACTER`, of the default kind and a valid path within the file system.



**VALUES**        The type shall be INTEGER(4), DIMENSION(13).  
**STATUS**        (Optional) status flag of type INTEGER(4). Returns 0 on success 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, O19)") 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 8.83 \[FSTAT\]](#), page 106, to stat a link: [Section 8.143 \[LSTAT\]](#), page 137

## 8.207 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:*

```
PROGRAM test_sum
  INTEGER :: x(5) = (/ 1, 2, 3, 4 ,5 /)
  print *, SUM(x)                ! all elements, sum = 15
  print *, SUM(x, MASK=MOD(x, 2)==1) ! odd elements, sum = 9
END PROGRAM
```

*See also:* [Section 8.172 \[PRODUCT\], page 153](#)

## 8.208 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:*

<i>PATH1</i>	Shall be of default CHARACTER type.
<i>PATH2</i>	Shall be of default CHARACTER type.
<i>STATUS</i>	(Optional) Shall be of default INTEGER type.

*See also:* [Section 8.132 \[LINK\], page 132](#), [Section 8.223 \[UNLINK\], page 181](#)

## 8.209 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:*

## 8.210 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 8.52 [DATE\_AND\_TIME], page 87, Section 8.49 [CPU\_TIME], page 85

## 8.211 TAN — Tangent function

*Description:*

TAN(X) computes the tangent of X.

*Standard:* Fortran 77 and later, for a complex argument Fortran 2008 or later

*Class:* Elemental function

*Syntax:* RESULT = TAN(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_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 8.21 \[ATAN\], page 68](#)

## 8.212 TANH — Hyperbolic tangent function

*Description:*

TANH( $X$ ) computes the hyperbolic tangent of  $X$ .

*Standard:* Fortran 77 and later, for a complex argument Fortran 2008 or later

*Class:*        Elemental function

*Syntax:*       $X = \text{TANH}(X)$

*Arguments:*

$X$                     The type shall be REAL or COMPLEX.

*Return value:*

The return value has same type and kind as  $X$ . If  $X$  is complex, the imaginary part of the result is in radians. If  $X$  is REAL, the return value lies in the range  $-1 \leq \tanh(x) \leq 1$ .

*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 8.23 \[ATANH\], page 69](#)

## 8.213 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 8.214 \[TIME8\]](#), page 177, 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 8.51 \[CTIME\]](#), page 86, [Section 8.97 \[GMTIME\]](#), page 114, [Section 8.144 \[LTIME\]](#), page 138, [Section 8.151 \[MCLOCK\]](#), page 142, [Section 8.214 \[TIME8\]](#), page 177

## 8.214 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 8.51 \[CTIME\]](#), page 86, [Section 8.97 \[GMTIME\]](#), page 114, [Section 8.144 \[LTIME\]](#), page 138, [Section 8.152 \[MCLOCK8\]](#), page 142, [Section 8.213 \[TIME\]](#), page 176

## 8.215 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.

## 8.216 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 8.30 \[BIT\\_SIZE\], page 73](#), [Section 8.127 \[LEADZ\], page 129](#)

## 8.217 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
```

**8.218 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 /).

**8.219 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 8.8 \[ADJUSTL\], page 59](#), [Section 8.9 \[ADJUSTR\], page 59](#)

## 8.220 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:*

<code>UNIT</code>	Shall be a scalar <code>INTEGER</code> .
<code>NAME</code>	Shall be of type <code>CHARACTER</code> .

*Example:*

```
PROGRAM test_ttyname
  INTEGER :: unit
  DO unit = 1, 10
    IF (isatty(unit=unit)) write(*,*) ttyname(unit)
  END DO
END PROGRAM
```

*See also:* [Section 8.119 \[ISATTY\], page 125](#)

## 8.221 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:*

<code>ARRAY</code>	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 8.126 \[LBOUND\]](#), page 129

**8.222 UMASK — Set the file creation mask***Description:*

Sets the file creation mask to *MASK*. If called as a function, it returns the old value. If called as a subroutine and argument *OLD* if it is supplied, it is set to the old value. See `umask(2)`.

*Standard:* GNU extension

*Class:* Subroutine, function

*Syntax:* `CALL UMASK(MASK [, OLD]) OLD = UMASK(MASK)`

*Arguments:*

*MASK* Shall be a scalar of type `INTEGER`.  
*OLD* (Optional) Shall be a scalar of type `INTEGER`.

**8.223 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 8.132 \[LINK\]](#), page 132, [Section 8.208 \[SYMLNK\]](#), page 174

## 8.224 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 8.168 \[PACK\], page 151](#), [Section 8.203 \[SPREAD\], page 170](#)

## 8.225 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 8.186 \[SCAN\]](#), page 161, [Section 8.111 \[INDEX intrinsic\]](#), page 121

## 8.226 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 8.109 \[IEOR\]](#), page 120 intrinsic and for logical arguments the `.NEQV.` operator, which are both defined by the Fortran standard.

*Standard:* GNU extension

*Class:* Function

*Syntax:* `RESULT = XOR(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_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 8.109 \[IEOR\]](#), page 120



## 9 Intrinsic Modules

### 9.1 ISO\_FORTRAN\_ENV

*Standard:* Fortran 2003 and later; INT8, INT16, INT32, INT64, REAL32, REAL64, REAL128 are Fortran 2008 or 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.

**INT8, INT16, INT32, INT64**

Kind type parameters to specify an INTEGER type with a storage size of 16, 32, and 64 bits. It is negative if a target platform does not support the particular kind.

**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.

**REAL32, REAL64, REAL128**

Kind type parameters to specify a REAL type with a storage size of 32, 64, and 128 bits. It is negative if a target platform does not support the particular kind.

### 9.2 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 type default integer, which can be used as KIND type parameters.

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.

Fortran Type	Named constant	C type	Extension
INTEGER	C_INT	int	
INTEGER	C_SHORT	short int	
INTEGER	C_LONG	long int	
INTEGER	C_LONG_LONG	long long int	
INTEGER	C_SIGNED_CHAR	signed char/unsigned char	
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_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_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	
CHARACTER	C_CHAR	char	

Additionally, the following parameters of type CHARACTER(KIND=C\_CHAR) are defined.

Name	C definition	Value
C_NULL_CHAR	null character	'\0'

<code>C_ALERT</code>	alert	<code>'\a'</code>
<code>C_BACKSPACE</code>	backspace	<code>'\b'</code>
<code>C_FORM_FEED</code>	form feed	<code>'\f'</code>
<code>C_NEW_LINE</code>	new line	<code>'\n'</code>
<code>C_CARRIAGE_</code>	carriage return	<code>'\r'</code>
<code>RETURN</code>		
<code>C_HORIZONTAL_</code>	horizontal tab	<code>'\t'</code>
<code>TAB</code>		
<code>C_VERTICAL_TAB</code>	vertical tab	<code>'\v'</code>

### 9.3 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
```





## 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
- Daniel Kraft

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
- Joost VandeVondele

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 <http://gcc.gnu.org/bugzilla/> 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.
- Flag to generate `Makefile` info.

- Automatically extend single precision constants to double.
- Compile code that conserves memory by dynamically allocating common and module storage either on stack or heap.
- 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

gfortran's command line options are indexed here without any initial '-' or '--'. Where an option has both positive and negative forms (such as `-foption` and `-fno-option`), relevant entries in the manual are indexed under the most appropriate form; it may sometimes be useful to look up both forms.

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