

Fourth edition
2018-11

**Information technology —
Programming languages — Fortran —
Part 1:
Base language**

*Technologies de l'information — Langages de programmation —
Fortran —*

Partie 1: Langage de base



Reference number
ISO/IEC 1539-1:2018(E)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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- 2 The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).
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- 6 This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 22, *Programming languages, their environments and system software interfaces*.
- 7 This fourth edition cancels and replaces the third edition (ISO 1539-1:2010), which has been technically revised. It also incorporates the Technical Corrigenda ISO/IEC 1539-1:2010/Cor. 1:2012, ISO/IEC 1539-1:2010/Cor. 2:2013, ISO/IEC 1539-1:2010/Cor. 3:2014, and ISO/IEC 1539-1:2010/Cor. 4:2016. The main changes compared to the previous edition are as follows:
 - The Technical Specifications ISO/IEC TS 29113:2012 and ISO/IEC TS 18508:2015 have been incorporated.
 - Support for IEEE floating-point arithmetic has been updated to ISO/IEC/IEEE 60559:2011.
- 8 A list of all parts in the ISO 1539 series can be found on the ISO website.
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- 1 This document comprises the specification of the base Fortran language, informally known as Fortran 2018. With the limitations noted in 4.3.3, the syntax and semantics of Fortran 2008 are contained entirely within Fortran 2018. Therefore, any standard-conforming Fortran 2008 program not affected by such limitations is a standard-conforming Fortran 2018 program. New features of Fortran 2018 can be compatibly incorporated into such Fortran 2008 programs, with any exceptions indicated in the text of this document.
- 2 Fortran 2018 contains several extensions to Fortran 2008; these are listed below.
 - Data declaration:

Constant properties of an object declared in its *entity-decl* can be used in its *initialization*. The **EQUIVALENCE** and **COMMON** statements and the **block data program unit** have been redundant since Fortran 90 and are now specified to be **obsolescent**. Diagnosis of the appearance of a **PROTECTED TARGET** variable accessed by **use association** as a *data-target* in a structure constructor is required.
 - Data usage and computation:

The **declared type** of the value supplied for a **polymorphic allocatable component** in a **structure constructor** is no longer required to be the same as the **declared type** of the **component**. **FORALL** is now specified to be **obsolescent**. The type and kind of an implied DO variable in an **array constructor** or **DATA statement** can be specified within the constructor or statement. The **SELECT RANK construct** provides structured access to the elements of an **assumed-rank array**. Completing execution of a **BLOCK construct** can cause the **association status of a pointer** with the **PROTECTED attribute** to become undefined. The standard intrinsic operations **<**, **<=**, **>**, and **>=** (also known as **.LT.**, **.LE.**, **.GT.**, and **.GE.**) on IEEE numbers provide **compareSignaling{relation}** operations; the **=** and **/=** operations (also known as **.EQ.** and **.NE.**) provide **compareQuiet{relation}** operations. Finalization of an allocatable subobject during intrinsic assignment has been clarified. The *char-length* in an executable statement is no longer required to be a specification expression.
 - Input/output:

The **SIZE= specifier** can be used with advancing input. It is no longer prohibited to open a file on more than one unit. The value assigned by the **RECL= specifier** in an **INQUIRE statement** has been standardized. The values assigned by the **POS=** and **SIZE=** specifiers in an **INQUIRE statement** for a unit that has pending asynchronous operations have been standardized. The **G0.d edit descriptor** can be used for list items of type **Integer**, **Logical**, and **Character**. The **D**, **E**, **EN**, and **ES** edit descriptors can have a field width of zero, analogous to the **F** edit descriptor. The exponent width *e* in a **data edit descriptor** can be zero, analogous to a field width of zero. Floating-point formatted input accepts hexadecimal-significand numbers that conform to ISO/IEC/IEEE 60559:2011. The **EX edit descriptor** provides hexadecimal-significand formatted output conforming to ISO/IEC/IEEE 60559:2011. An error condition occurs if unacceptable characters are presented for logical or numeric editing during execution of a formatted input statement.
 - Execution control:

The **arithmetic IF statement** has been deleted. Labeled **DO loops** have been redundant since Fortran 90 and are now specified to be **obsolescent**. The **nonblock DO construct** has been deleted. The locality of a variable used in a **DO CONCURRENT construct** can be explicitly specified. The stop code in a **STOP** or **ERROR STOP** statement can be nonconstant. Output of the stop code and exception summary from the **STOP** and **ERROR STOP** statements can be controlled.
 - Intrinsic procedures and modules:

In a reference to the intrinsic function **CMPLEX** with an actual argument of type complex, no keyword is needed for a **KIND** argument. In references to the intrinsic functions **ALL**, **ANY**, **FINDLOC**, **IALL**, **IANY**, **IPARITY**, **MAXLOC**, **MAXVAL**, **MINLOC**, **MINVAL**, **NORM2**, **PARITY**, **PRODUCT**, **SUM**, and **THIS_IMAGE**, the **actual argument** for **DIM** can be a present optional **dummy argument**. The new intrinsic function **COSHAPE** returns the coshape of a **coarray**. The new intrinsic function **OUT_OF_RANGE** tests whether a numeric value can be safely converted to a different type or kind. The new intrinsic subroutine **RANDOM_INIT** establishes the initial state of the pseudorandom number generator used by **RANDOM_NUMBER**. The new intrinsic function **REDUCE** performs user-specified array reductions. A processor is required to report use of a **nonstandard intrinsic** procedure, use of a **nonstandard intrinsic** module, and use of a nonstandard procedure from a **standard intrinsic** module. Integer and logical arguments to intrinsic proced-

requirement, except for `RANDOM_SEED`. Specific names for intrinsic functions are now deemed *obsolescent*. All standard procedures in the intrinsic module `ISO_C_BINDING`, other than `C_F_POINTER`, are now *pure*. The arguments to the intrinsic function `SIGN` can be of different kind. Nonpolymorphic pointer arguments to the intrinsic functions `EXTENDS_TYPE_OF` and `SAME_TYPE_AS` need not have defined pointer association status. The effects of invoking the intrinsic procedures `COMMAND_ARGUMENT_COUNT`, `GET_COMMAND`, and `GET_COMMAND_ARGUMENT`, on *images* other than *image* one, are no longer processor dependent. Access to error messages from the intrinsic subroutines `GET_COMMAND`, `GET_COMMAND_ARGUMENT`, and `GET_ENVIRONMENT_VARIABLE` is provided by an optional `ERRMSG` argument. The result of `NORM2` for a zero-sized array argument has been clarified.

- Program units and procedures:

The `IMPORT` statement can appear in a contained subprogram or `BLOCK` construct, and can restrict access via host association; diagnosis of violation of the `IMPORT` restrictions is required. The `GENERIC` statement can be used to declare generic interfaces. The number of procedure arguments is used in *generic resolution*. In a module, the *default accessibility* of entities accessed from another module can be controlled separately from the default accessibility of entities declared in the using module. An `IMPLICIT NONE` statement can require explicit declaration of the `EXTERNAL` attribute throughout a *scoping unit* and its contained *scoping units*. A *defined operation* need not specify `INTENT (IN)` for a *dummy argument* with the `VALUE` attribute. A *defined assignment* need not specify `INTENT (IN)` for the second *dummy argument* if it has the `VALUE` attribute. Procedures that are not declared with an asterisk *type-param-value*, including `ELEMENTAL` procedures, can be invoked recursively by default; the `RECURSIVE` keyword is advisory only. The `NON_RECURSIVE` keyword specifies that a procedure is not recursive. The `ERROR STOP` statement can appear in a *pure subprogram*. A *dummy argument* of a *pure function* is permitted in a variable definition context, if it has the `VALUE` attribute. A *coarray dummy argument* can be referenced or defined by another *image*.
- Features previously described by ISO/IEC TS 29113:2012:

A *dummy data object* can assume its rank from its effective argument. A *dummy data object* can assume the type from its effective argument, without having the ability to perform type selection. An *interoperable procedure* can have *dummy arguments* that are *assumed-type* and/or *assumed-rank*. An *interoperable procedure* can have *dummy data objects* that are *allocatable*, *assumed-shape*, *optional*, or *pointers*. The *character length* of a *dummy data object* of an *interoperable procedure* can be assumed. The argument to `C_LOC` can be a noninteroperable array. The `FPTR` argument to `C_F_POINTER` can be a noninteroperable array pointer. The argument to `C_FUNLOC` can be a noninteroperable procedure. The `FPTR` argument to `C_F_PROCPTR` can be a noninteroperable procedure pointer. There is a new named constant `C_PTRDIFF_T` to provide interoperability with the C type `ptrdiff_t`. Additionally to ISO/IEC TS 29113:2012, a scalar *actual argument* can be associated with an *assumed-type assumed-size dummy argument*, an *assumed-rank dummy data object* that is not associated with an *assumed-size array* can be used as the argument to the function `C_SIZEOF` from the intrinsic module `ISO_C_BINDING`, and the `type` argument to `CFI_establish` can have a positive value corresponding to an interoperable C type.
- Changes to the intrinsic modules `IEEE_ARITHMETIC`, `IEEE_EXCEPTIONS`, and `IEEE_FEATURES` for conformance with ISO/IEC/IEEE 60559:2011:

There is a new, optional, rounding mode `IEEE_AWAY`. The new type `IEEE_MODES_TYPE` encapsulates all floating-point modes. Features associated with subnormal numbers can be accessed with functions and types named `...SUBNORMAL...` (the old `...DENORMAL...` names remain). The new function `IEEE_FMA` performs fused multiply-add operations. The function `IEEE_INT` performs rounded conversions to integer type. The new functions `IEEE_MAX_NUM`, `IEEE_MAX_NUM_MAG`, `IEEE_MIN_NUM`, and `IEEE_MIN_NUM_MAG` calculate maximum and minimum numeric values. The new functions `IEEE_NEXT_DOWN` and `IEEE_NEXT_UP` return the adjacent machine numbers. The new functions `IEEE_QUIET_EQ`, `IEEE_QUIET_GE`, `IEEE_QUIET_GT`, `IEEE_QUIET_LE`, `IEEE_QUIET_LT`, and `IEEE_QUIET_NE` perform quiet comparisons. The new functions `IEEE_SIGNALING_EQ`, `IEEE_SIGNALING_GE`, `IEEE_SIGNALING_GT`, `IEEE_SIGNALING_LE`, `IEEE_SIGNALING_LT`, and `IEEE_SIGNALING_NE` perform signaling comparisons. The decimal rounding mode can be inquired and set independently of the binary rounding mode, using the `RADIX` argument to `IEEE_GET_ROUNDING_MODE` and `IEEE_SET_ROUNDING_MODE`. The new function `IEEE_`

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have the same radix. The function `IEEE_RINT` now has a `ROUND` argument to perform specific rounding. The new function `IEEE_SIGNBIT` tests the sign bit of an IEEE number.

- Features previously described by ISO/IEC TS 18508:2015:

The `CRITICAL` statement has optional `ERRMSG=` and `STAT=` specifiers. The intrinsic subroutines `ATOMIC_DEFINE` and `ATOMIC_REF` have an optional `STAT` argument. The new intrinsic subroutines `ATOMIC_ADD`, `ATOMIC_AND`, `ATOMIC_CAS`, `ATOMIC_FETCH_ADD`, `ATOMIC_FETCH_AND`, `ATOMIC_FETCH_OR`, `ATOMIC_FETCH_XOR`, `ATOMIC_OR`, and `ATOMIC_XOR` perform atomic operations. The new intrinsic functions `FAILED_IMAGES` and `STOPPED_IMAGES` return indices of images known to have `failed` or `stopped` respectively. The new intrinsic function `IMAGE_STATUS` returns the image execution status of an image. The intrinsic subroutine `MOVE_ALLOC` has optional `ERRMSG` and `STAT` arguments. The intrinsic functions `IMAGE_INDEX` and `NUM_IMAGES` have additional forms with a `TEAM` or `TEAM_NUMBER` argument. The intrinsic function `THIS_IMAGE` has an optional `TEAM` argument. The `EVENT POST` and `EVENT WAIT` statements, the intrinsic subroutine `EVENT_QUERY`, and the type `EVENT_TYPE` provide an event facility for one-sided segment ordering. The `CHANGE TEAM` construct, derived type `TEAM_TYPE`, `FORM TEAM` and `SYNC TEAM` statements, intrinsic functions `GET_TEAM` and `TEAM_NUMBER`, and the `TEAM=` and `TEAM_NUMBER=` specifiers on image selectors, provide a team facility for a subset of the program's images to act in concert as if it were the set of all images. This team facility allows an allocatable `coarray` to be allocated or deallocated on a subset of images. The new intrinsic subroutines `CO_BROADCAST`, `CO_MAX`, `CO_MIN`, `CO_REDUCE`, and `CO_SUM` perform collective reduction operations on the images of the `current team`. The concept of `failed images`, the `FAIL IMAGE` statement, the `STAT=` specifier on image selectors, and the named constant `STAT_FAILED_IMAGE` from the intrinsic module `ISO_FORTRAN_ENV` provide support for fault-tolerant parallel execution.

- Changes to features previously described by ISO/IEC TS 18508:2015:

The `CHANGE TEAM` and `SYNC TEAM` statements, and the `TEAM=` specifier on image selectors, permit the team to be specified by an expression. The intrinsic functions `FAILED_IMAGES` and `STOPPED_IMAGES` have no restriction on the kind of their result. The name of the function argument to the intrinsic function `CO_REDUCE` is `OPERATION` instead of `OPERATOR`; this argument is not required to be commutative. The named constant `STAT_UNLOCKED_FAILED_IMAGE` from the intrinsic module `ISO_FORTRAN_ENV` indicates that a `lock variable` was locked by an image that `failed`. The `team number` for the `initial team` can be used in image selectors, and in the intrinsic functions `NUM_IMAGES` and `IMAGE_INDEX`. A `team variable` that appears in a `CHANGE TEAM` statement can no longer be defined or become undefined during execution of the `CHANGE TEAM` construct. All images of the `current team` are no longer required to execute the same `CHANGE TEAM` statement. A variable of type `TEAM_TYPE` from the intrinsic module `ISO_FORTRAN_ENV` is not permitted to be a `coarray`. A variable of type `TEAM_TYPE` from the intrinsic module `ISO_FORTRAN_ENV` can have a pointer component, and a `team variable` becomes undefined if assigned a value from another `image`. The intrinsic function `UCOBOUND` produces a value for the final upper `cobound` that is always relative to the `current team`. An `EXIT` statement can be used to complete execution of a `CHANGE TEAM` or `CRITICAL` construct.

- 3 This document is organized in 19 clauses, dealing with 8 conceptual areas. These 8 areas, and the clauses in which they are treated, are:

High/low level concepts	Clauses 4, 5, 6
Data concepts	Clauses 7, 8, 9
Computations	Clauses 10, 16, 17
Execution control	Clause 11
Input/output	Clauses 12, 13
Program units	Clauses 14, 15
Interoperability with C	Clause 18
Scoping and association rules	Clause 19

- 4 It also contains the following nonnormative material:

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Deleted and obsolescent features	Annex B
Extended notes	Annex C
Index	Index

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Information technology — Programming languages — Fortran —

Part 1: Base language

1 Scope

- 1 This document specifies the form and establishes the interpretation of programs expressed in the base Fortran language. The purpose of this document is to promote portability, reliability, maintainability, and efficient execution of Fortran programs for use on a variety of computing systems.
- 2 This document specifies
 - the forms that a program written in the Fortran language can take,
 - the rules for interpreting the meaning of a program and its data,
 - the form of the input data to be processed by such a program, and
 - the form of the output data resulting from the use of such a program.
- 3 Except where stated otherwise, requirements and prohibitions specified by this document apply to programs rather than processors.
- 4 This document does not specify
 - the mechanism by which programs are transformed for use on computing systems,
 - the operations required for setup and control of the use of programs on computing systems,
 - the method of transcription of programs or their input or output data to or from a storage medium,
 - the program and processor behavior when this document fails to establish an interpretation except for the processor detection and reporting requirements in items (2) to (10) of 4.2,
 - the maximum number of [images](#), or the size or complexity of a program and its data that will exceed the capacity of any particular computing system or the capability of a particular processor,
 - the mechanism for determining the number of [images](#) of a program,
 - the physical properties of an [image](#) or the relationship between [images](#) and the computational elements of a computing system,
 - the physical properties of the representation of quantities and the method of rounding, approximating, or computing numeric values on a particular processor, except by reference to ISO/IEC/IEEE 60559:2011 under conditions specified in Clause 17,
 - the physical properties of input/output records, files, and units, or
 - the physical properties and implementation of storage.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 646:1991 (International Reference Version), *Information technology—ISO 7-bit coded character set for information interchange*

ISO/IEC 9899:2011, *Programming languages—C*

ISO/IEC 10646, *Information technology—Universal Multiple-Octet Coded Character Set (UCS)*

ISO/IEC/IEEE 60559:2011, *Information technology — Microprocessor Systems — Floating-Point arithmetic*