Technical Specification

ISO/IEC TS 18661-5

Second edition
2025-03

Programming languages, their environments, and system software interfaces — Floating-point extensions for C —

Part 5: Supplementary attributes

Langages de programmation, leurs environnements et interfaces du logiciel système — Extensions à virgule flottante pour C —

Partie 5: Attributs supplémentaires

Reference number
ISO/IEC TS 18661-5:2025(en)

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

Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 22, *Programming languages, their environments and system software interfaces*.

This second edition cancels and replaces the first edition (ISO/IEC TS 18661-5:2016), which has been technically revised.

The main changes are as follows:

— The specification has been updated to extend ISO/IEC 9899:2024.

— Conformance macros have been added to allow conformance to each of the four feature sets (evaluation formats, optimization controls, reproducibility, and alternate exception handling) independently.

A list of all parts in the ISO/IEC 18661 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

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Introduction

The IEEE 754-1985 standard for binary floating-point arithmetic was motivated by an expanding diversity in floating-point data representation and arithmetic, which made writing reliable programs, debugging and moving programs between systems exceedingly difficult. Now the great majority of systems provide data formats and arithmetic operations according to IEEE 754. Corresponding versions of IEEE 754 and ISO/IEC 60559 have equivalent content.

Support for IEEE 754-1985 was added in ISO/IEC 9899:1999 (also referred to as C99), and ISO/IEC 9899:2018 is still based on IEEE 754-1985. However, IEEE 754 underwent a major revision in 2008 and a minor revision in 2019, which added several new features.

The purpose of the ISO/IEC 18661 series (first published 2014 through 2016) has been to specify C language support for the new features introduced into IEEE 754 since 1985. Most of the ISO/IEC 18661 series has been incorporated into ISO/IEC 9899:2024 (also referred to as C23 because major work on this revision was completed in 2023), which supports all required and most recommended features in IEEE 754-2019.

IEEE 754 defines alternatives for certain attributes of floating-point semantics, and aims to provide, through programming languages, a means by which a program can specify which of the alternative semantics apply to a given block of code. The program specification of attributes is constant (fixed at translation time), not dynamic (changeable at execution time).

The `FENV_ROUND` and `FENV_DEC_ROUND` pragmas in C23 provide the rounding direction attributes required by IEEE 754.

IEEE 754 also recommends other attributes that are not supported in C23, including:

— preferredWidth: evaluation formats for floating-point operations;

— value-changing optimizations: allow/disallow program transformations that can affect floating-point result values;

— reproducibility: support for getting floating-point result values and exceptions that are exactly reproducible on other systems;

— alternate exception handling: methods of handling floating-point exceptions.

To supplement the IEEE 754 support in C23, this document provides these recommended attributes by means of standard pragmas. The pragma parameters represent the alternative semantics. The pragmas are similar in form to the floating-point pragmas (`FENV_ACCESS`, `FP_CONTRACT`, `CX_LIMITED_RANGE`) that have been in C since 1999.

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Programming languages, their environments, and system software interfaces — Floating-point extensions for C —

Part 5: Supplementary attributes

1 Scope

This document specifies extensions to programming language C to include pragmas corresponding to attributes specified and recommended in ISO/IEC 60559 but not supported in ISO/IEC 9899:2024 (also referred to as C23).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9899:2024, *Information technology — Programming languages — C*

ISO/IEC 60559:2020, *Information technology — Microprocessor Systems — Floating-Point arithmetic*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 9899:2024 and ISO/IEC 60559:2020 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Conformance

An implementation that meets the requirements for a conforming implementation of C23 may conform to any or all of the four feature sets in this document. The implementation conforms to the feature sets if

a) it defines `__STDC_IEC_60559_BFP__` or `__STDC_IEC_60559_DFP__` or both, indicating support for ISO/IEC 60559 binary or decimal floating-point arithmetic, as specified in C23, Annex F;

and one or more of the following are true:

b) it defines `__STDC_IEC_60559_ATTRIB_EVALUATION_FORMAT__` to `202401L` and provides the features for evaluation formats as specified in this document (Clause 7);

c) it defines `__STDC_IEC_60559_ATTRIB_OPTIMIZATION__` to `202401L` and provides the features for optimization as specified in this document (Clause 8);

d) it defines `__STDC_IEC_60559_ATTRIB_REPRODUCIBLE__` to `202401L` and provides the features for reproducibility as specified in this document (Clause 9);

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