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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

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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.

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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.