

C support for IEEE 754-2019

WG 14 N2488

2020-02-19

C FP Group

Ref: N2273, N2274, N2275, N2454

In N2275, CFP proposed support for the IEEE 754 revision then in progress. WG 14 directed CFP to wait until the revision published. This paper is an update to N2275, based on the now-published floating-point standard IEEE 754-2019.

C99, C11, and C17 include optional support for IEC 60559:1989 (IEEE 754-1985). TS 18661 (2014-2016), specifies extensions to C to support IEC 60559:2011 (IEEE 754-2008). Parts of TS 18661, including support for all required features of IEC 60559:2011 (IEEE 754-2008), are being incorporated into in the C2X draft (N2454).

Last year, IEEE 754 completed another revision cycle and published IEEE 754-2019, which supersedes IEEE 754-2008. See <https://standards.ieee.org/standard/754-2019.html>. An equivalent revision of IEC 60559 is expected to follow soon. IEEE 754-2019 is a minor revision, for defect fixes and clarification. It is constrained to require no new features. Thus, the few features too important to defer to the subsequent revision have been added as optional. See http://grouper.ieee.org/groups/msc/ANSI_IEEE-Std-754-2019/background/conformance-and-options.txt.

CFP and WG 14 have approved some of the new IEEE 754 features as needed natural completions for C floating point. These features are already in C (C17 or draft C2X) or TS 18661.

The remaining new 754 features amount to a small addition to C2X, as the list below shows, but their inclusion advances C support of the floating-point standard ahead another 10 years.

Below, in italics, are the items in the IEEE 754 committee's list of substantive changes (by subclause) in the IEEE 754 revision (http://grouper.ieee.org/groups/msc/ANSI_IEEE-Std-754-2019/background/), each followed by CFP comments and status regarding C.

4.3.1 roundTiesToEven definition extended to cover the unusual case when both nearest neighbors are odd

This is more of a defect fix, as the old specification was not meaningful for the special case. This is already covered in a note in the C2X draft (F.5#6).

5.3.1 {min,max}{Num,NumMag} operations, formerly required, are now deleted

The 754 committee took this unusual step because it believed the specification was seriously flawed and problematic for the intended use.

This, along with 754's replacement min-max operations (see below), will be covered by a C2X proposal from CFP, updating N2273.

5.3.2 new quantum operation for decimal formats is recommended

Functions for this operation are already in the C2X draft (7.12.15.3).

5.7.1 new predicate operation is 754 version 2019 is required

This is supported by feature macros (see F.1).

5.10 totalOrder and totalOrderMag definition relaxed the ordering of NaNs

The C specification of the corresponding functions does not state the details for ordering NaNs, but adopts them from IEC 60559 by reference, so will pick up the change automatically (F.10.12.1, F.10.12.2).

9.2 new tanPi, aSinPi, and aCosPi operations are recommended

Corresponding functions are already in the C2X draft (7.12.4.14, F.10.1.14, 7.12.4.8, F.10.1.8, 7.12.4.9, F.10.1.9).

9.2.1 new special cases for power functions

These are already in the C2X draft (F.10.4.5).

9.2.2 preferred exponents are specified for 9.2 operations

This is covered in the table of preferred quantum exponents in 5.2.4.2.3 in the C2X draft.

9.4 preferred exponents and inexact exception are not specified for reduction operations

This is covered in TS 18661-4, in the specification for reduction functions. CFP is not proposing the reduction functions for C2X.

9.5 new augmented {Addition, Subtraction, Multiplication} are recommended

CFP suggest adding functions for these operations in a forthcoming update to TS 18661, but does not suggest adding them to C2X. (See N2274).

9.6 new {min, max}imum {Number, Magnitude, MagnitudeNumber} operations are recommended; NaN and signed zero handling are changed from 754-2008 5.3.1.

This will be covered by a C2X proposal from CFP, updating N2273.

9.7 new {getPayload, setPayload, setPayloadsignaling} operations are recommended

Functions for these operations are already in the C2X draft (F.10.13).

The changes to the min-max functions are the only technical changes included in CFP's proposal to update C2X support for the floating-point standard to IEEE 754-2019.

Also, C2X is currently based on IEC 60559:2011 (IEEE 754-2008) and contains references to that version of the floating-point standard. C support for the newer version of the floating-point standard will entail updating these references in C. In the same spirit, the

brief history of the standards, in F.1#1, will need to be updated. CFP will propose these changes to draft C2X in a separate document.

A revision to TS 18661 to include parts not fully integrated into C2X will need to refer to the newer version of the floating-point standard (as well as to the newer version of C).