

TS 18661-1,2 FOR C2X

N2095

WG 14 - Pittsburg
October 17-21, 2016

C FP group

TS 18661-1 FOR C2X

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TS 18661 background

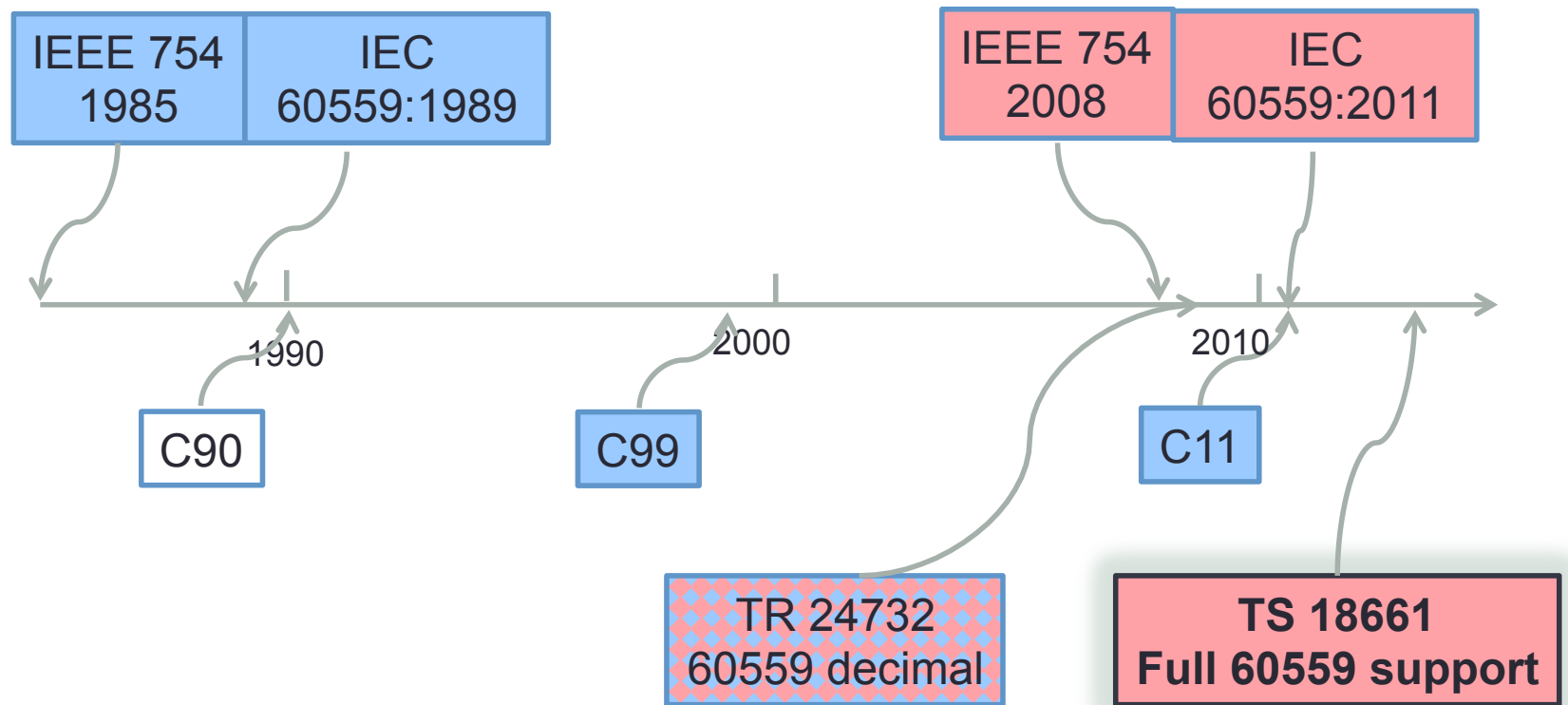
TS 18661-1

Overview

Contents

Summary

Floating-point and C standards



Background

Specify a C binding for IEEE 754-2008

- Work began 2009
- Under direction of ISO/IEC JTC1/SC22/WG14 – C
- Expertise in floating-point and language standards, compilers, libraries
- 754 adopted as international standard ISO/IEC/IEEE 60559:2011

Principles

- Support all of the current FP standard, as-is
- Specify as changes to C11
- Use existing C mechanisms, minimize language invention
- Develop specification in parts, to pipeline process
- Supersede TR 24732 (decimal)
- Allow support by free-standing C implementations
- Deliver an ISO/IEC Technical Specification

Status

- In five parts
 - Required features in IEC 60559
 - 1 Binary floating-point arithmetic
 - 2 Decimal floating-point arithmetic
 - Recommended features in IEC 60559
 - 3 Interchange and extended types
 - 4 Supplementary functions
 - 5 Supplementary attributes
- All parts published 2014-2016

Publications

- [ISO/IEC TS 18661-1:2014, Information technology — Programming languages, their environments and system software interfaces — Floating-point extensions for C — Part 1: Binary floating-point arithmetic](#)
- [ISO/IEC TS 18661-2:2015, Information technology — Programming languages, their environments and system software interfaces — Floating-point extensions for C — Part 2: Decimal floating-point arithmetic](#)
- [ISO/IEC TS 18661-3:2015, Information technology — Programming languages, their environments and system software interfaces — Floating-point extensions for C — Part 3: Interchange and extended types](#)
- [ISO/IEC TS 18661-4:2015, Information Technology — Programming languages, their environments, and system software interfaces — Floating-point extensions for C — Part 4: Supplementary functions](#)
- [ISO/IEC TS 18661-5:2016, Information Technology — Programming languages, their environments, and system software interfaces — Floating-point extensions for C — Part 5: Supplementary attributes](#)

TS 18661-1 overview

- C currently supports the 1989 version of the IEC 60559 floating-point standard
- ISO/IEC TS 18661-1:2014 updates this support to the required features for binary floating-point arithmetic in the current IEC 60559 standard (2011)
- TS 18661-1 includes specific changes to C11

Contents

1-4: Boilerplate, introduction, terminology, etc.

5.1: Allows conformance for freestanding implementations.

5.2: Conformance macro **__STDC_IEC_60559_BFP__** obsolesces **__STDC_IEC_559__** as declaration of support for annex F.

__STDC_IEC_60559_COMPLEX__ obsolesces **__STDC_IEC_559_COMPLEX__**.

5.3: Lists all identifiers defined or declared by user-defined **__STDC_WANT_IEC_60559_BFP_EXT__** .

6: Updates introduction to annex F.

Contents (2)

7.1: Updates terminology to match IEC 60559.

7.2: Adds concept of canonical encoding (in 5.2.4.2.2).
Cleans up use of term *encoding*.

8: Updates C binding for IEC 60559, in annex F.

9: Updates footnote to clarify IEC 60559 recommendation on implicit floating-to-integer conversions and the “inexact” exception.

10.1: Updates annex F conversions to decimal character sequences to support new stricter requirements. Adds new `<float.h>` macro **CR_DECIMAL_DIG**.

10.2: Adds new **strto** functions in `<stdlib.h>`, to enable support by freestanding implementations.

Contents (3)

11: Adds support for new IEC 60559 requirement for constant rounding modes:

- Changes to distinguish *constant* vs *dynamic* control modes (mostly just inserting “dynamic” where appropriate).
- New rounding control pragma

`#pragma STDC FENV_ROUND` *direction*

- Identifies library functions affected by the pragma (when macro expansion has not been disabled). User functions not affected.
- Example shows how to implement constant rounding modes with dynamic ones.

Contents (4)

12: Cleans up NaN specifications so an implementation could support signaling NaNs within the C standard:

- Implementation may define **FE_SNANS_ALWAYS_SIGNAL** to declare support for signaling NaNs.
- Clarifies that F.10 latitude for “underflow” and “inexact” applies to functions not covered by IEC 60559.

13: Adds “width” macros, e.g., **LONG_WIDTH**, for all integer types, for use with **roundfp** functions and for general use.

Contents (5)

14: Adds new required `<math.h>` functions and macros:

- **fromfp**, etc. convert all floating types to integers, of all widths, signed and unsigned, w/ and w/o “inexact” exceptions.
- **llogb** -- since **logbl** doesn't meet IEC 60559 spec if **int** is 16 bits and **long double** is binary128
- **fmaxmag**, **fminmag**
- **nextup**, **nextdown**

Contents (6)

14: New `<math.h>` functions and macros (cont.):

- **fadd, faddl, daddl** round result to narrower type, and “fast” macros for them. Similar functions for subtract, multiply, divide, FMA, and square root.
- **iseqsig** -- == but with “invalid” on quiet NaN arguments.
- **iscanonical, issignaling, issubnormal, iszero**. **iszero** avoids triggering signaling NaNs.
- **totalorder, totalordermag** – total order for canonical numbers in the type.
- **canonicalize** – the IEC 60559 convertFormat operation for same-type conversions.
- **getpayload, setpayload, setpayloadsig** for NaN significand bits.

Contents (7)

15: Adds new **<fenv.h>** features:

- **fesetexcept** sets exceptions without signaling.
- **fetestexceptflag** tests saved exceptions, for fewer accesses to dynamic modes.
- **fegetmode**, **fesetmode**, **femode_t**, **FE_DFL_MODE** manage dynamic modes collectively.

16: **<tgmath.h>** update for new functions.

Summary

- C currently supports IEC 60559:1989. TS 18661-1 updates this support to the required features for binary FP in the current IEC 60559:2011.
- Changes are primarily in the library.
- Most features already implemented.

IEEE 754-2018 in progress. Mostly editorial updates. No new required features planned.

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TS 18661-2 for C2x

Overview

Contents

Summary

Overview

- C11 supports the 1989 version of the IEC 60559 standard.
- TS 18661-2 adds the required features for decimal floating-point arithmetic in the current IEC 60559 standard (2011).
- ISO/IEC TS 18661-2:2015 supersedes ISO/IEC TR 24732:2009.
- TS 18661-2 gives specific changes to C11 + TS 18661-1.
- Implementation may support IEC 60559 for binary or decimal FP, or both, or neither.

Contents

1-4: Boilerplate, introduction, terminology, etc.

5.1: Allows conformance for freestanding decimal implementations.

5.2: Conformance macro **__STDC_IEC_60559_DFP__**.
Updates F.1 so that annex F applies to decimal (and/or binary).

5.3: Lists all identifiers defined or declared by user-defined **__STDC_WANT_IEC_60559_DFP_EXT__**.

6: Adds *decimal floating types* **_Decimal32**, **_Decimal64**, **_Decimal128**. Complex and imaginary types not defined for decimal. Defines *standard floating types* to be **float**, **double**, and **long double**.

Contents

- 7: Adds characteristics for decimal floating types in **<float.h>**, analogous to binary. Defines view of FP model as triples (s, c, q). Specifies *preferred quantum exponents*.
- 8: Expands binding in annex F to include decimal.
- 9: Specifies conversions involving decimal floating types. Enhances usual arithmetic conversions to handle decimal.
- 10: Defines suffixes for decimal floating constants. Not for hexadecimal.
- 11: Prohibits operations mixing decimal with standard, complex, or imaginary floating types. Gives overview of details to come. Updates F.9.2 with expression-transformation issues specific to decimal.

Contents

12.2: Defines macros for decimal rounding modes, like binary, but including **FE_DEC_TONEARESTFROMZERO**. Binary and decimal use same exception flags. Adds constant rounding mode pragma for decimal.

12.3: Adds decimal analogs for binary features in **<math.h>**.

12.4: Adds decimal specific functions:

- **quantizedN** adjust quantum exponent.
- **samequantumdN** tests for same quantum exponents.
- **quantumdN** computes argument's quantum.
- **llquantexpdN** computes argument's quantum exponent.
- encode and decode functions for external data in the two allowed IEC 60559 decimal encodings.

Contents

12.5: Adds I/O specifiers for decimal. Style **a** formatting for decimal that preserves quantum exponents.

12.6-8: Adds **strto** and **strfrom** functions for decimal, similar to binary. **strto** functions preserves quantum exponent. Wide string versions too.

13: Adds **<tgmath.h>** support for decimal. Examples.

Summary

- C currently supports IEC 60559:1989. TS 18661-2 updates this support to the required features for decimal FP in the current IEC 60559:2011.
- Most features correspond to features for binary.
- Most features already implemented.