The GCC Quad-Precision Math Library
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# Short Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1 Typedef and constants</td>
<td>3</td>
</tr>
<tr>
<td>2 Math Library Routines</td>
<td>5</td>
</tr>
<tr>
<td>3 I/O Library Routines</td>
<td>9</td>
</tr>
<tr>
<td>GNU Free Documentation License</td>
<td>11</td>
</tr>
<tr>
<td>4 Reporting Bugs</td>
<td>19</td>
</tr>
</tbody>
</table>
Table of Contents

Introduction .......................... 1

1 Typedef and constants ................. 3

2 Math Library Routines .................. 5

3 I/O Library Routines .................... 9
   3.1 strtoflt128 — Convert from string .......... 9
   3.2 quadmath_snprintf — Convert to string .... 9

GNU Free Documentation License ........ 11
   ADDENDUM: How to use this License for your documents ... 18

4 Reporting Bugs ......................... 19
Introduction

This manual documents the usage of libquadmath, the GCC Quad-Precision Math Library Application Programming Interface (API).
1 Typedef and constants

The following data type has been defined via `typedef`.

`__complex128`: `__float128`-based complex number

The following macros are defined, which give the numeric limits of the `__float128` data type.

- `FLT128_MAX`: largest finite number
- `FLT128_MIN`: smallest positive number with full precision
- `FLT128_EPSILON`: difference between 1 and the next larger representable number
- `FLT128_DENORM_MIN`: smallest positive denormalized number
- `FLT128_MANT_DIG`: number of digits in the mantissa (bit precision)
- `FLT128_MIN_EXP`: maximal negative exponent
- `FLT128_MAX_EXP`: maximal positive exponent
- `FLT128_DIG`: number of decimal digits in the mantissa
- `FLT128_MIN_10_EXP`: maximal negative decimal exponent
- `FLT128_MAX_10_EXP`: maximal positive decimal exponent

The following mathematical constants of type `__float128` are defined.

- `M_E`: the constant e (Euler’s number)
- `M_LOG2E`: binary logarithm of 2
- `M_LOG10E`: common, decimal logarithm of 2
- `M_LOG2`: natural logarithm of 2
- `M_LOG10`: natural logarithm of 10
- `M_PI`: pi
- `M_PI_2`: pi divided by two
- `M_PI_4`: pi divided by four
- `M_1_PI`: one over pi
- `M_2_PI`: one over two pi
- `M_2_SQRTPI`: two over square root of pi
- `M_SQRT2`: square root of 2
- `M_SQRT1_2`: one over square root of 2
2 Math Library Routines

The following mathematical functions are available:

- **acosq**: arc cosine function
- **acoshq**: inverse hyperbolic cosine function
- **asinq**: arc sine function
- **asinhq**: inverse hyperbolic sine function
- **atanq**: arc tangent function
- **atanhq**: inverse hyperbolic tangent function
- **atan2q**: arc tangent function
- **cbrtq**: cube root function
- **ceilq**: ceiling value function
- **copysignq**: copy sign of a number
- **erfq**: error function
- **erfcq**: complementary error function
- **exp2q**: base 2 exponential function
- **expq**: exponential function
- **expmlq**: exponential minus 1 function
\texttt{fabsq}: absolute value function
\texttt{fdimq}: positive difference function
\texttt{finiteq}: check finiteness of value
\texttt{floorq}: floor value function
\texttt{fmaq}: fused multiply and add
\texttt{fmaxq}: determine maximum of two values
\texttt{fminq}: determine minimum of two values
\texttt{fmodq}: remainder value function
\texttt{frexpq}: extract mantissa and exponent
\texttt{hypotq}: Euclidean distance function
\texttt{iexpq}: get exponent of the value
\texttt{isinfq}: check for infinity
\texttt{isnqnq}: check for not a number
\texttt{issignalingq}: check for signaling not a number
\texttt{j0q}: Bessel function of the first kind, first order
\texttt{j1q}: Bessel function of the first kind, second order
\texttt{jmqnq}: Bessel function of the first kind, \textit{n}-th order
\texttt{ldexpq}: load exponent of the value
\texttt{lgammaq}: logarithmic gamma function
\texttt{llrintq}: round to nearest integer value
\texttt{llroundq}: round to nearest integer value away from zero
\texttt{logbq}: get exponent of the value
\texttt{logq}: natural logarithm function
\texttt{log10q}: base 10 logarithm function
\texttt{log1pq}: compute natural logarithm of the value plus one
\texttt{log2q}: base 2 logarithm function
lrintq: round to nearest integer value
lroundq: round to nearest integer value away from zero
modfq: decompose the floating-point number
nanq: return quiet NaN
nearbyintq: round to nearest integer
nextafterq: next representable floating-point number
powq: power function
remainderq: remainder function
remquoq: remainder and part of quotient
rintq: round-to-nearest integral value
roundq: round-to-nearest integral value, return __float128
scalbing: compute exponent using FLT_RADIX
scalbnq: compute exponent using FLT_RADIX
signbitq: return sign bit
sincosq: calculate sine and cosine simultaneously
sinhq: hyperbolic sine function
sinq: sine function
sqrtq: square root function
tanq: tangent function
tanhq: hyperbolic tangent function
tgammaq: true gamma function
truncq: round to integer, towards zero
y0q: Bessel function of the second kind, first order
y1q: Bessel function of the second kind, second order
ynq: Bessel function of the second kind, n-th order
cabsq complex absolute value function
cargq: calculate the argument
cimagq imaginary part of complex number
crealq: real part of complex number
cacoshq: complex arc hyperbolic cosine function
cacosq: complex arc cosine function
casinhq: complex arc hyperbolic sine function
casinq: complex arc sine function
catanhq: complex arc hyperbolic tangent function
catanq: complex arc tangent function
cosq complex cosine function:
ccoshq: complex hyperbolic cosine function
cexpq: complex exponential function
cexpiq: computes the exponential function of “i” times a real value
search (the complex version of specific functions)
clogq: complex natural logarithm
clog10q: complex base 10 logarithm
cconjq: complex conjugate function
cpowq: complex power function
cprojq: project into Riemann Sphere
csinq: complex sine function
csinhq: complex hyperbolic sine function
csqrtq: complex square root
ctanq: complex tangent function
ctanhq: complex hyperbolic tangent function
3 I/O Library Routines

3.1 strtoflt128 — Convert from string
The function strtoflt128 converts a string into a __float128 number.
Syntax

\[
\text{__float128 strtoflt128 (const char *s, char **sp)}
\]

Arguments:
- \( s \) — input string
- \( sp \) — the address of the next character in the string

The argument \( sp \) contains, if not NULL, the address of the next character following the parts of the string, which have been read.

Example

```c
#include <quadmath.h>

int main ()
{
    __float128 r;
    r = strtoflt128 ("1.2345678", NULL);
    return 0;
}
```

3.2 quadmath_snprintf — Convert to string
The function quadmath_snprintf converts a __float128 floating-point number into a string. It is a specialized alternative to snprintf, where the format string is restricted to a single conversion specifier with Q modifier and conversion specifier e, E, f, F, g, G, a or A, with no extra characters before or after the conversion specifier. The %m$ or *m$ style must not be used in the format.
Syntax

\[
\text{int quadmath_snprintf (char *s, size_t size, const char *format, ...)}
\]

Arguments:
- \( s \) — output string
- \( size \) — byte size of the string, including tailing NUL
- \( format \) — conversion specifier string

Note On some targets when supported by the C library hooks are installed for printf family of functions, so that printf ("%Qe", 1.2Q); etc. works too.

Example

```c
#include <quadmath.h>
#include <stdlib.h>
#include <stdio.h>

int main ()
{
    __float128 r;
    int prec = 20;
    ```
int width = 46;
char buf[128];

r = 2.0q;
r = sqrtq (r);
int n = quadmath_snprintf (buf, sizeof buf, "%+-#*.20Qe", width, r);
if ((size_t) n < sizeof buf)
    printf ("%s\n", buf);
/* Prints: +1.41421356237309504880e+00 */
quadmath_snprintf (buf, sizeof buf, "%Qa", r);
if ((size_t) n < sizeof buf)
    printf ("%s\n", buf);
/* Prints: 0x1.6a09e667f3bccc908b2fb1366ea96p+0 */
n = quadmath_snprintf (NULL, 0, "%+-#46.*Qe", prec, r);
if (n > -1)
{
    char *str = malloc (n + 1);
    if (str)
    {
        quadmath_snprintf (str, n + 1, "%+-#46.*Qe", prec, r);
        printf ("%s\n", str);
        /* Prints: +1.41421356237309504880e+00 */
    }
    free (str);
}
return 0;
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