The GCC Quad-Precision Math Library
Short Contents

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Introduction

This manual documents the usage of libquadmath, the GCC Quad-Precision Math Library Application Programming Interface (API).
Chapter 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_Eq: the constant e (Euler’s number)
M_LOG2Eq: binary logarithm of 2
M_LOG10Eq: common, decimal logarithm of 2
M_LN2q: natural logarithm of 2
M_LN10q: natural logarithm of 10
M_PIq: pi
M_PI_2q: pi divided by two
M_PI_4q: pi divided by four
M_1_PIq: one over pi
M_2_PIq: one over two pi
M_2_SQRTPIq: two over square root of pi
M_SQRT2q: square root of 2
M_SQRT1_2q: one over square root of 2
```
The following mathematical functions are available:

- \texttt{acosq}: arc cosine function
- \texttt{acoshq}: inverse hyperbolic cosine function
- \texttt{asinq}: arc sine function
- \texttt{asinhq}: inverse hyperbolic sine function
- \texttt{atanq}: arc tangent function
- \texttt{atanhq}: inverse hyperbolic tangent function
- \texttt{atan2q}: arc tangent function
- \texttt{cbrtq}: cube root function
- \texttt{ceilq}: ceiling value function
- \texttt{copysignq}: copy sign of a number
- \texttt{coshq}: hyperbolic cosine function
- \texttt{cosq}: cosine function
- \texttt{erfq}: error function
- \texttt{erfcq}: complementary error function
- \texttt{expq}: exponential function
- \texttt{expm1q}: exponential minus 1 function
fabsq: absolute value function
fdimq: positive difference function
finiteq: check finiteness of value
floorq: floor value function
fmaq: fused multiply and add
fmaxq: determine maximum of two values
fminq: determine minimum of two values
fmodq: remainder value function
frexpq: extract mantissa and exponent
hypotq: Euclidian distance function
ilogbq: get exponent of the value
isinfq: check for infinity
isnanq: check for not a number
j0q: Bessel function of the first kind, first order
j1q: Bessel function of the first kind, second order
jnq: Bessel function of the first kind, n-th order
ldexpq: load exponent of the value
lgammaq: logarithmic gamma function
llrintq: round to nearest integer value
llroundq: round to nearest integer value away from zero
logq: natural logarithm function
log10q: base 10 logarithm function
log1pq: compute natural logarithm of the value plus one
log2q: base 2 logarithm function
lrin\texttt{t}q: round to nearest integer value
lr\texttt{ound}q: round to nearest integer value away from zero
mod\texttt{f}q: decompose the floating-point number
nan\texttt{q}: return quiet NaN
near\texttt{byint}q: round to nearest integer
next\texttt{after}q: next representable floating-point number
pow\texttt{q}: power function
rem\texttt{aind}q: remainder function
rem\texttt{quo}q: remainder and part of quotient
rint\texttt{q}: round-to-nearest integral value
round\texttt{q}: round-to-nearest integral value, return \texttt{float128}
scal\texttt{bin}q: compute exponent using FLT\_RADIX
scal\texttt{bn}q: compute exponent using FLT\_RADIX
sign\texttt{bit}q: return sign bit
sin\texttt{cos}q: calculate sine and cosine simultaneously
sinh\texttt{q}: hyperbolic sine function
sinq: sine function
sqrt\texttt{q}: square root function
tan\texttt{q}: tangent function
tanh\texttt{q}: hyperbolic tangent function
tg\texttt{amma}q: true gamma function
trunc\texttt{q}: round to integer, towards zero
y0\texttt{q}: Bessel function of the second kind, first order
y1\texttt{q}: Bessel function of the second kind, second order
yn\texttt{q}: Bessel function of the second kind, \(n\)-th order
cabs\texttt{q} complex absolute value function
carg\texttt{q}: calculate the argument
cimag\texttt{q} imaginary part of complex number
creal\texttt{q}: real part of complex number
cacosh\texttt{q}: complex arc hyperbolic cosine function
cacos\texttt{q}: complex arc cosine function
casinh\texttt{q}: complex arc hyperbolic sine function
casin\texttt{q}: complex arc sine function
catan\texttt{h}q: complex arc hyperbolic tangent function
catan\texttt{q}: complex arc tangent function
ccos\texttt{q} complex cosine function:
ccosh\texttt{q}: complex hyperbolic cosine function
cexp\texttt{q}: complex exponential function
cexp\texttt{i}q: computes the exponential function of \(i\) times a
real value
clogq: complex natural logarithm
cl\text{og}10q: complex base 10 logarithm
conjq: 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
c\text{tan}q: complex tangent function
c\text{tanh}q: 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

```
__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

```
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: 0x1.6a09e667f3bcc908b2fb1366ea96p+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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Version 1.3, 3 November 2008


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