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).
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_LN2: natural logarithm of 2  
M_LN10: 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
```
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
- `coshq`: hyperbolic cosine function
- `cosq`: cosine function
- `erfq`: error function
- `erfcq`: complementary error function
- `exp2q`: base 2 exponential function
- `expq`: exponential function
- `expmlq`: 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
isnanq: check for not a number
issignalingq: check for signaling 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
logbq: get exponent of the value
logq: natural logarithm function
log10q: base 10 logarithm function
log1pq: compute natural logarithm of the value plus one
log2q: base 2 logarithm function
\texttt{lrintq}: round to nearest integer value
\texttt{lroundq}: round to nearest integer value away from zero
\texttt{modfq}: decompose the floating-point number
\texttt{nanq}: return quiet NaN
\texttt{nearbyintq}: round to nearest integer
\texttt{nextafterq}: next representable floating-point number
\texttt{powq}: power function
\texttt{remainderq}: remainder function
\texttt{remquoq}: remainder and part of quotient
\texttt{rintq}: round-to-nearest integral value
\texttt{roundq}: round-to-nearest integral value, return \texttt{__float128}
\texttt{scalblnq}: compute exponent using \texttt{FLT\_RADIX}
\texttt{scalbnq}: compute exponent using \texttt{FLT\_RADIX}
\texttt{signbitq}: return sign bit
\texttt{sincosq}: calculate sine and cosine simultaneously
\texttt{sinhq}: hyperbolic sine function
\texttt{sinq}: sine function
\texttt{sqrq}: square root function
\texttt{tanq}: tangent function
\texttt{tanhq}: hyperbolic tangent function
\texttt{tgammaq}: true gamma function
\texttt{truncq}: round to integer, towards zero
\texttt{y0q}: Bessel function of the second kind, first order
\texttt{y1q}: Bessel function of the second kind, second order
\texttt{ynq}: Bessel function of the second kind, \texttt{n}-th order
\texttt{cabsq} complex absolute value function
\texttt{cargq}: calculate the argument
\texttt{cimagq} imaginary part of complex number
\texttt{crealq}: real part of complex number
\texttt{cacoshq}: complex arc hyperbolic cosine function
\texttt{cacosq}: complex arc cosine function
\texttt{casinhq}: complex arc hyperbolic sine function
\texttt{casinq}: complex arc sine function
\texttt{catanhq}: complex arc hyperbolic tangent function
\texttt{catanq}: complex arc tangent function
\texttt{ccosq} complex cosine function:
\texttt{ccoshq}: complex hyperbolic cosine function
\texttt{cexpq}: complex exponential function
\texttt{cexpiq}: computes the exponential function of \texttt{“i”} times a real value
clogq: complex natural logarithm
clog10q: complex base 10 logarithm
conjg: 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
cтанhq: 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 trailing 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: 0x1.6a09e667f3bce98d2b1366ea96p+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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