The GCC Quad-Precision Math Library
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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`.

```c
__complex128: __float128-based complex number
```

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

```c
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.

```c
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
```
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
- `coshq`: hyperbolic cosine function
- `cosq`: cosine function
- `erfq`: error function
- `erfcq`: complementary error function
- `exp2q`: base 2 exponential function
- `expq`: exponential function
- `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: Euclidean distance function
ilogbq: get exponent of the value
isinfq: check for infinity
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
lrintq: 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
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
scalblnq: 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, nth 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
\texttt{clogq}: complex natural logarithm
\texttt{clog10q}: complex base 10 logarithm
\texttt{conjq}: complex conjugate function
\texttt{cpowq}: complex power function
\texttt{cprojq}: project into Riemann Sphere
\texttt{csinq}: complex sine function
\texttt{csinhq}: complex hyperbolic sine function
\texttt{csqrtq}: complex square root
\texttt{ctanq}: complex tangent function
\texttt{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

__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

```c
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;
```
```c
int width = 46;
char buf[128];

r = 2.0q;
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: 0x1.6a09e667f3bfc908b2fb1366ea96p+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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Chapter 4: Reporting Bugs

4 Reporting Bugs

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