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 \texttt{typedef}.

\texttt{__complex128}: \texttt{__float128}-based complex number

The following macros are defined, which give the numeric limits of the \texttt{__float128} data type.

\texttt{FLT128\_MAX}: largest finite number
\texttt{FLT128\_MIN}: smallest positive number with full precision
\texttt{FLT128\_EPSILON}: difference between 1 and the next larger representable number
\texttt{FLT128\_DENORM\_MIN}: smallest positive denormalized number
\texttt{FLT128\_MANT\_DIG}: number of digits in the mantissa (bit precision)
\texttt{FLT128\_MIN\_EXP}: maximal negative exponent
\texttt{FLT128\_MAX\_EXP}: maximal positive exponent
\texttt{FLT128\_DIG}: number of decimal digits in the mantissa
\texttt{FLT128\_MIN\_10\_EXP}: maximal negative decimal exponent
\texttt{FLT128\_MAX\_10\_EXP}: maximal positive decimal exponent

The following mathematical constants of type \texttt{__float128} are defined.

\texttt{M\_Eq}: the constant e (Euler’s number)
\texttt{M\_LOG2Eq}: binary logarithm of 2
\texttt{M\_LOG10Eq}: common, decimal logarithm of 2
\texttt{M\_LN2q}: natural logarithm of 2
\texttt{M\_LN10q}: natural logarithm of 10
\texttt{M\_PIq}: pi
\texttt{M\_PI\_2q}: pi divided by two
\texttt{M\_PI\_4q}: pi divided by four
\texttt{M\_1\_PIq}: one over pi
\texttt{M\_2\_PIq}: one over two pi
\texttt{M\_2\_SQRTPIq}: two over square root of pi
\texttt{M\_SQRT2q}: square root of 2
\texttt{M\_SQRT1\_2q}: 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
- `erfq`: error function
- `erfcq`: complementary error 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
isnanq: check for not a number
isinfq: check for infinity
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
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, 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
catanq: complex arc tangent function
ccosq complex cosine function:
ccoshq: complex hyperbolic cosine function
cexpq: complex exponential function
cexpiq: computes the exponential function of “i” times a real value
clogq: complex natural logarithm
clog10q: 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
cтанq: 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**

```
__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: 0x1.6a09e667f3bcccc908b2f1366ea96p+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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