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.

__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
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
- `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**: 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
**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
catanhq complex arc hyperbolic tangent function
catangq 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: `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: 0x1.6a09e667f3bcc98b2fb1366ea96p+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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