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
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
- **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
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
lrintq: round to nearest integer value
lroundq: round to nearest integer value away from zero
modf: decompose the floating-point number
nan: return quiet NaN
nearbyint: round to nearest integer
nextafter: next representable floating-point number
pow: power function
remainder: remainder function
remquo: remainder and part of quotient
rint: round-to-nearest integral value
round: round-to-nearest integral value, return \texttt{__float128}
scalbln: compute exponent using FLT_RADIX
scalbn: compute exponent using FLT_RADIX
signbit: return sign bit
sincos: calculate sine and cosine simultaneously
sinh: hyperbolic sine function
sin: sine function
sqrt: square root function
tan: tangent function
tanh: hyperbolic tangent function
tgamma: true gamma function
trunc: round to integer, towards zero
y0: Bessel function of the second kind, first order
y1: Bessel function of the second kind, second order
yn: Bessel function of the second kind, \( n \)-th order
 cacosh: complex arc hyperbolic cosine function
cacos: complex arc cosine function
casinh: complex arc hyperbolic sine function
casin: complex arc sine function
catanh: complex arc hyperbolic tangent function
catan: complex arc tangent function
cos: complex cosine function
ccosh: complex hyperbolic cosine function
cexp: complex exponential function
cexpq: computes the exponential function of \( “i” \) times a real value
\text{clogq}: \text{complex natural logarithm}
\text{clog10q}: \text{complex base 10 logarithm}
\text{conjq}: \text{complex conjugate function}
\text{cpowq}: \text{complex power function}
\text{cprojq}: \text{project into Riemann Sphere}
\text{csinq}: \text{complex sine function}
\text{csinhq}: \text{complex hyperbolic sine function}
\text{csqrtq}: \text{complex square root}
\text{ctanq}: \text{complex tangent function}
\text{ctanhq}: \text{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

```c
__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;
r = sqrtq (r);
int n = quadmath_snprintf (buf, sizeof buf, "%+-#.20Qe", width, r);
if ((size_t) n < sizeof buf)
    printf("%s
", buf);
    /* Prints: +1.41421356237309504880e+00 */
quadmath_snprintf (buf, sizeof buf, "%Qa", r);
if ((size_t) n < sizeof buf)
    printf("%s
", buf);
    /* Prints: 0x1.6a09e667f3bcb908b2fb1366ea96p+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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