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
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
j0q: Bessel function of the first kind, first order
j1q: Bessel function of the first kind, second order
jnx: 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
cacoshq: complex arc cosine function
cacoshq: complex arc hyperbolic sine 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
clogq: complex natural logarithm
clog10q: complex base 10 logarithm
conjgq: 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
cctanhq: 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
```
#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
```
#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
", buf);
    /* Prints: +1.41421356237309504880e+00 */
quadmath_snprintf (buf, sizeof buf, "%Qa", r);
if ((size_t) n < sizeof buf)
    printf ("%s
", buf);
    /* Prints: 0x1.6a09e667f3bce90b2fb1366ea96p+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
", str);
        /* Prints: +1.41421356237309504880e+00 */
    }
    free (str);
}
return 0;
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