

# 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`: two  $\pi$

`M_PI_4q`: four  $\pi$

`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`: Euclidian distance function  
`ilogbq`: get exponent of the value  
`isinfq`: check for infinity  
`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  
`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 simulataneously  
`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  
`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  
`ctanq`: complex tangent function  
`ctanhq`: complex hyperbolic tangent function

## 3 I/O Library Routines

### 3.1 strtouf128 — Convert from string

The function `dmath_strtopQ` converts a string into a `__float128` number.

Syntax `__float128 strtouf128 (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 = strtouf128 ("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

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\n", buf);
/* Prints: +1.41421356237309504880e+00 */
quadmath_snprintf (buf, sizeof buf, "%Qa", r);
if ((size_t) n < sizeof buf)
    printf ("%s\n", buf);
/* Prints: 0x1.6a09e667f3bcc908b2fb1366ea96p+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;
}

```

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.



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