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
- `copyq`: copy sign of a number
- `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
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
j0n: Bessel function of the first kind, n-th order
ldexpq: load exponent of the value
lgammaq: logarithmic gamma function
lrintq: round to nearest integer value
lroundq: 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
**Chapter 2: Math Library Routines**

- **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
- **ccosq**: complex cosine function
- **casinhq**: complex arc hyperbolic sine function
- **csinq**: complex sine function
- **ccoshq**: complex hyperbolic cosine function
- **ccosq**: complex cosine function
- **cexpq**: complex exponential function
- **ccosq**: complex cosine 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
cctanhq: complex hyperbolic tangent function
3 I/O Library Routines

3.1 \texttt{strtoflt128} — Convert from string
The function \texttt{dmath\_strtopQ} converts a string into a \texttt{__float128} number.

\textbf{Syntax} \quad \texttt{__float128 strtoflt128 (const char *s, char **sp)}

\textbf{Arguments}:

\begin{itemize}
  \item \texttt{s} \quad \text{input string}
  \item \texttt{sp} \quad \text{the address of the next character in the string}
\end{itemize}

The argument \texttt{sp} contains, if not NULL, the address of the next character following the parts of the string, which have been read.

\textbf{Example}

\begin{verbatim}
#include <quadmath.h>
int main ()
{
  __float128 r;
  r = strtoflt128 ("1.2345678", NULL);
  return 0;
}
\end{verbatim}

3.2 \texttt{quadmath\_snprintf} — Convert to string
The function \texttt{quadmath\_snprintf} converts a \texttt{__float128} floating-point number into a string. It is a specialized alternative to \texttt{snprintf}, where the format string is restricted to a single conversion specifier with \texttt{Q} modifier and conversion specifier \texttt{e}, \texttt{E}, \texttt{f}, \texttt{F}, \texttt{g}, \texttt{G}, \texttt{a} or \texttt{A}, with no extra characters before or after the conversion specifier. The \%m$ or \*m$ style must not be used in the format.

\textbf{Syntax} \quad \texttt{int quadmath\_snprintf (char *s, size_t size, const char *format, ...)}

\textbf{Arguments}:

\begin{itemize}
  \item \texttt{s} \quad \text{output string}
  \item \texttt{size} \quad \text{byte size of the string, including tailing NUL}
  \item \texttt{format} \quad \text{conversion specifier string}
\end{itemize}

\textbf{Example}

\begin{verbatim}
#include <quadmath.h>
#include <stdlib.h>
#include <stdio.h>
int main ()
{
  __float128 r;
  int prec = 20;
  int width = 46;
  char buf[128];
\end{verbatim}
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 */
quadracht_snprintf (buf, sizeof buf, "%Qa", r);
if ((size_t) n < sizeof buf)
    printf("%s\n", buf);
    /* Prints: 0x1.6a09e667f3bcb908b2fb1366ea96p+0 */
n = quadracht_snprintf (NULL, 0, "%+-#46.*Qe", prec, r);
if (n > -1)
{
    char *str = malloc (n + 1);
    if (str)
    {
        quadracht_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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