



CUDA Math API Reference Manual

Release 12.6

NVIDIA Corporation

Sep 24, 2024

Contents

1	FP8 Intrinsic	3
1.1	C++ struct for handling fp8 data type of e4m3 kind.	3
1.2	C++ struct for handling fp8 data type of e5m2 kind.	3
1.3	C++ struct for handling vector type of four fp8 values of e4m3 kind.	4
1.4	C++ struct for handling vector type of four fp8 values of e5m2 kind.	4
1.5	C++ struct for handling vector type of two fp8 values of e4m3 kind.	4
1.6	C++ struct for handling vector type of two fp8 values of e5m2 kind.	4
1.7	FP8 Conversion and Data Movement	5
1.7.1	Enumerations	11
1.7.2	Functions	11
1.7.3	Typedefs	14
2	Half Precision Intrinsic	17
2.1	Half Arithmetic Constants	17
2.1.1	Macros	18
2.2	Half Arithmetic Functions	18
2.2.1	Functions	20
2.3	Half Comparison Functions	27
2.3.1	Functions	28
2.4	Half Math Functions	34
2.4.1	Functions	35
2.5	Half Precision Conversion and Data Movement	39
2.5.1	Functions	47
2.6	Half2 Arithmetic Functions	77
2.6.1	Functions	79
2.7	Half2 Comparison Functions	86
2.7.1	Functions	88
2.8	Half2 Math Functions	102
2.8.1	Functions	103
2.9	Typedefs	108
3	Bfloat16 Precision Intrinsic	111
3.1	Bfloat16 Arithmetic Constants	111
3.1.1	Macros	112
3.2	Bfloat16 Arithmetic Functions	113
3.2.1	Functions	114
3.3	Bfloat16 Comparison Functions	120
3.3.1	Functions	121
3.4	Bfloat16 Math Functions	127
3.4.1	Functions	128
3.5	Bfloat16 Precision Conversion and Data Movement	131
3.5.1	Functions	139
3.6	Bfloat162 Arithmetic Functions	168

3.6.1	Functions	170
3.7	Bfloat162 Comparison Functions	176
3.7.1	Functions	178
3.8	Bfloat162 Math Functions	192
3.8.1	Functions	193
3.9	Typedefs	197
4	Single Precision Mathematical Functions	199
4.1	Functions	203
5	Single Precision Intrinsics	235
5.1	Functions	237
6	Double Precision Mathematical Functions	255
6.1	Functions	260
7	Double Precision Intrinsics	291
7.1	Functions	292
8	Type Casting Intrinsics	307
8.1	Functions	310
9	Integer Mathematical Functions	325
9.1	Functions	327
10	Integer Intrinsics	331
10.1	Functions	333
11	SIMD Intrinsics	341
11.1	Functions	347
12	Structs	367
12.1	__half	367
12.2	__half2	371
12.3	__half2_raw	372
12.4	__half_raw	373
12.5	__nv_bfloat16	373
12.6	__nv_bfloat162	376
12.7	__nv_bfloat162_raw	377
12.8	__nv_bfloat16_raw	378
12.9	__nv_fp8_e4m3	378
12.10	__nv_fp8_e5m2	381
12.11	__nv_fp8x2_e4m3	384
12.12	__nv_fp8x2_e5m2	385
12.13	__nv_fp8x4_e4m3	386
12.14	__nv_fp8x4_e5m2	387
13	Notices	389
13.1	Notice	389
13.2	OpenCL	390
13.3	Trademarks	390

CUDA mathematical functions are always available in device code.

Host implementations of the common mathematical functions are mapped in a platform-specific way to standard math library functions, provided by the host compiler and respective host libm where available. Some functions, not available with the host compilers, are implemented in `crt/math_functions.hpp` header file. For example, see [`erfinv\(\)`](#). Other, less common functions, like [`rhy-pot\(\)`](#), [`cyl_besse_lj0\(\)`](#) are only available in device code.

CUDA Math device functions are no-throw for well-formed CUDA programs.

Note that many floating-point and integer functions names are overloaded for different argument types. For example, the [`log\(\)`](#) function has the following prototypes:

```
double log(double x);
float log(float x);
float logf(float x);
```

Note also that due to implementation constraints, certain math functions from `std::` namespace may be callable in device code even via explicitly qualified `std::` names. However, such use is discouraged, since this capability is unsupported, unverified, undocumented, not portable, and may change without notice.

Chapter 1. FP8 Intrinsics

This section describes fp8 intrinsic functions.

To use these functions, include the header file `cuda_fp8.h` in your program. The following macros are available to help users selectively enable/disable various definitions present in the header file:

- ▶ `__CUDA_NO_FP8_CONVERSIONS__` - If defined, this macro will prevent any use of the C++ type conversions (converting constructors and conversion operators) defined in the header.
- ▶ `__CUDA_NO_FP8_CONVERSION_OPERATORS__` - If defined, this macro will prevent any use of the C++ conversion operators from fp8 to other types.

1.1. C++ struct for handling fp8 data type of e4m3 kind.

Structs

`__nv_fp8_e4m3`
`__nv_fp8_e4m3` datatype

1.2. C++ struct for handling fp8 data type of e5m2 kind.

Structs

`__nv_fp8_e5m2`
`__nv_fp8_e5m2` datatype

1.3. C++ struct for handling vector type of four fp8 values of e4m3 kind.

Structs

`__nv_fp8x4_e4m3`
`__nv_fp8x4_e4m3` datatype

1.4. C++ struct for handling vector type of four fp8 values of e5m2 kind.

Structs

`__nv_fp8x4_e5m2`
`__nv_fp8x4_e5m2` datatype

1.5. C++ struct for handling vector type of two fp8 values of e4m3 kind.

Structs

`__nv_fp8x2_e4m3`
`__nv_fp8x2_e4m3` datatype

1.6. C++ struct for handling vector type of two fp8 values of e5m2 kind.

Structs

`__nv_fp8x2_e5m2`
`__nv_fp8x2_e5m2` datatype

1.7. FP8 Conversion and Data Movement

To use these functions, include the header file `cuda_fp8.h` in your program.

Enumerations

`__nv_fp8_interpretation_t`

Enumerates the possible interpretations of the 8-bit values when referring to them as fp8 types.

`__nv_saturation_t`

Enumerates the modes applicable when performing a narrowing conversion to fp8 destination types.

Functions

`__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_bfloat16raw2_to_fp8x2(const __nv_bfloat162_raw x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input vector of two `nv_bfloat16` precision numbers packed in `__nv_bfloat162_raw x` into a vector of two values of fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

`__host__ __device__ __nv_fp8_storage_t __nv_cvt_bfloat16raw_to_fp8(const __nv_bfloat16_raw x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input `nv_bfloat16` precision `x` to fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

`__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_double2_to_fp8x2(const double2 x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input vector of two `double` precision numbers packed in `double2 x` into a vector of two values of fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

`__host__ __device__ __nv_fp8_storage_t __nv_cvt_double_to_fp8(const double x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input `double` precision `x` to fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

`__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_float2_to_fp8x2(const float2 x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input vector of two `single` precision numbers packed in `float2 x` into a vector of two values of fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

`__host__ __device__ __nv_fp8_storage_t __nv_cvt_float_to_fp8(const float x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input `single` precision `x` to fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

`__host__ __device__ __half_raw __nv_cvt_fp8_to_halfraw(const __nv_fp8_storage_t x, const __nv_fp8_interpretation_t fp8_interpretation)`

Converts input fp8 `x` of the specified kind to `half` precision.

__host__ __device__ __half2_raw __nv_cvt_fp8x2_to_halfraw2(const __nv_fp8x2_storage_t x, const __nv_fp8_interpretation_t fp8_interpretation)

Converts input vector of two fp8 values of the specified kind to a vector of two half precision values packed in __half2_raw structure.

__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_halfraw2_to_fp8x2(const __half2_raw x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)

Converts input vector of two half precision numbers packed in __half2_raw x into a vector of two values of fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

__host__ __device__ __nv_fp8_storage_t __nv_cvt_halfraw_to_fp8(const __half_raw x, const __nv_saturation_t saturate, const __nv_fp8_interpretation_t fp8_interpretation)

Converts input half precision x to fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const int val)

Constructor from int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const unsigned long long int val)

Constructor from unsigned long long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const __nv_bfloat16 f)

Constructor from __nv_bfloat16 data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const long int val)

Constructor from long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const long long int val)

Constructor from long long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__nv_fp8_e4m3::__nv_fp8_e4m3()=default

Constructor by default.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const unsigned short int val)

Constructor from unsigned short int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const float f)

Constructor from float data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const __half f)

Constructor from __half data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const unsigned long int val)

Constructor from unsigned long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const double f)

Constructor from double data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const short int val)

Constructor from short int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e4m3::__nv_fp8_e4m3(const unsigned int val)

Constructor from unsigned int data type, relies on __NV_SATFINITE behavior for out-of-range

values.

- __host__ __device__ __nv_fp8_e4m3::operator __half() const**
Conversion operator to __half data type.
- __host__ __device__ __nv_fp8_e4m3::operator __nv_bfloat16() const**
Conversion operator to __nv_bfloat16 data type.
- __host__ __device__ __nv_fp8_e4m3::operator bool() const**
Conversion operator to bool data type.
- __host__ __device__ __nv_fp8_e4m3::operator char() const**
Conversion operator to an implementation defined char data type.
- __host__ __device__ __nv_fp8_e4m3::operator double() const**
Conversion operator to double data type.
- __host__ __device__ __nv_fp8_e4m3::operator float() const**
Conversion operator to float data type.
- __host__ __device__ __nv_fp8_e4m3::operator int() const**
Conversion operator to int data type.
- __host__ __device__ __nv_fp8_e4m3::operator long int() const**
Conversion operator to long int data type.
- __host__ __device__ __nv_fp8_e4m3::operator long long int() const**
Conversion operator to long long int data type.
- __host__ __device__ __nv_fp8_e4m3::operator short int() const**
Conversion operator to short int data type.
- __host__ __device__ __nv_fp8_e4m3::operator signed char() const**
Conversion operator to signed char data type.
- __host__ __device__ __nv_fp8_e4m3::operator unsigned char() const**
Conversion operator to unsigned char data type.
- __host__ __device__ __nv_fp8_e4m3::operator unsigned int() const**
Conversion operator to unsigned int data type.
- __host__ __device__ __nv_fp8_e4m3::operator unsigned long int() const**
Conversion operator to unsigned long int data type.
- __host__ __device__ __nv_fp8_e4m3::operator unsigned long long int() const**
Conversion operator to unsigned long long int data type.
- __host__ __device__ __nv_fp8_e4m3::operator unsigned short int() const**
Conversion operator to unsigned short int data type.
- __host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const __half f)**
Constructor from __half data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const long long int val)**
Constructor from long long int data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const unsigned int val)**
Constructor from unsigned int data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const float f)**
Constructor from float data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const unsigned short int val)

Constructor from unsigned short int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__nv_fp8_e5m2::__nv_fp8_e5m2()=default

Constructor by default.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const int val)

Constructor from int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const long int val)

Constructor from long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const double f)

Constructor from double data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const unsigned long int val)

Constructor from unsigned long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const short int val)

Constructor from short int data type.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const __nv_bfloat16 f)

Constructor from __nv_bfloat16 data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::__nv_fp8_e5m2(const unsigned long long int val)

Constructor from unsigned long long int data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8_e5m2::operator __half() const

Conversion operator to __half data type.

__host__ __device__ __nv_fp8_e5m2::operator __nv_bfloat16() const

Conversion operator to __nv_bfloat16 data type.

__host__ __device__ __nv_fp8_e5m2::operator bool() const

Conversion operator to bool data type.

__host__ __device__ __nv_fp8_e5m2::operator char() const

Conversion operator to an implementation defined char data type.

__host__ __device__ __nv_fp8_e5m2::operator double() const

Conversion operator to double data type.

__host__ __device__ __nv_fp8_e5m2::operator float() const

Conversion operator to float data type.

__host__ __device__ __nv_fp8_e5m2::operator int() const

Conversion operator to int data type.

__host__ __device__ __nv_fp8_e5m2::operator long int() const

Conversion operator to long int data type.

__host__ __device__ __nv_fp8_e5m2::operator long long int() const

Conversion operator to long long int data type.

__host__ __device__ __nv_fp8_e5m2::operator short int() const

Conversion operator to short int data type.

- __host__ __device__ __nv_fp8_e5m2::operator signed char() const**
Conversion operator to signed char data type.
- __host__ __device__ __nv_fp8_e5m2::operator unsigned char() const**
Conversion operator to unsigned char data type.
- __host__ __device__ __nv_fp8_e5m2::operator unsigned int() const**
Conversion operator to unsigned int data type.
- __host__ __device__ __nv_fp8_e5m2::operator unsigned long int() const**
Conversion operator to unsigned long int data type.
- __host__ __device__ __nv_fp8_e5m2::operator unsigned long long int() const**
Conversion operator to unsigned long long int data type.
- __host__ __device__ __nv_fp8_e5m2::operator unsigned short int() const**
Conversion operator to unsigned short int data type.
- __nv_fp8x2_e4m3::__nv_fp8x2_e4m3()=default**
Constructor by default.
- __host__ __device__ __nv_fp8x2_e4m3::__nv_fp8x2_e4m3(const __nv_bfloat162 f)**
Constructor from __nv_bfloat162 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e4m3::__nv_fp8x2_e4m3(const double2 f)**
Constructor from double2 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e4m3::__nv_fp8x2_e4m3(const __half2 f)**
Constructor from __half2 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e4m3::__nv_fp8x2_e4m3(const float2 f)**
Constructor from float2 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e4m3::operator __half2() const**
Conversion operator to __half2 data type.
- __host__ __device__ __nv_fp8x2_e4m3::operator float2() const**
Conversion operator to float2 data type.
- __host__ __device__ __nv_fp8x2_e5m2::__nv_fp8x2_e5m2(const __nv_bfloat162 f)**
Constructor from __nv_bfloat162 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e5m2::__nv_fp8x2_e5m2(const double2 f)**
Constructor from double2 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e5m2::__nv_fp8x2_e5m2(const __half2 f)**
Constructor from __half2 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __nv_fp8x2_e5m2::__nv_fp8x2_e5m2()=default**
Constructor by default.
- __host__ __device__ __nv_fp8x2_e5m2::__nv_fp8x2_e5m2(const float2 f)**
Constructor from float2 data type, relies on __NV_SATFINITE behavior for out-of-range values.
- __host__ __device__ __nv_fp8x2_e5m2::operator __half2() const**
Conversion operator to __half2 data type.

__host__ __device__ __nv_fp8x2_e5m2::operator float2() const

Conversion operator to float2 data type.

__host__ __device__ __nv_fp8x4_e4m3::__nv_fp8x4_e4m3(const __nv_bfloat162 flo, const __nv_bfloat162 fhi)

Constructor from a pair of __nv_bfloat162 data type values, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e4m3::__nv_fp8x4_e4m3(const double4 f)

Constructor from double4 vector data type, relies on __NV_SATFINITE behavior for out-of-range values.

__nv_fp8x4_e4m3::__nv_fp8x4_e4m3()=default

Constructor by default.

__host__ __device__ __nv_fp8x4_e4m3::__nv_fp8x4_e4m3(const float4 f)

Constructor from float4 vector data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e4m3::__nv_fp8x4_e4m3(const __half2 flo, const __half2 fhi)

Constructor from a pair of __half2 data type values, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e4m3::operator float4() const

Conversion operator to float4 vector data type.

__nv_fp8x4_e5m2::__nv_fp8x4_e5m2()=default

Constructor by default.

__host__ __device__ __nv_fp8x4_e5m2::__nv_fp8x4_e5m2(const double4 f)

Constructor from double4 vector data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e5m2::__nv_fp8x4_e5m2(const float4 f)

Constructor from float4 vector data type, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e5m2::__nv_fp8x4_e5m2(const __nv_bfloat162 flo, const __nv_bfloat162 fhi)

Constructor from a pair of __nv_bfloat162 data type values, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e5m2::__nv_fp8x4_e5m2(const __half2 flo, const __half2 fhi)

Constructor from a pair of __half2 data type values, relies on __NV_SATFINITE behavior for out-of-range values.

__host__ __device__ __nv_fp8x4_e5m2::operator float4() const

Conversion operator to float4 vector data type.

Typedefs

__nv_fp8_storage_t

8-bit unsigned integer type abstraction used to for fp8 floating-point numbers storage.

__nv_fp8x2_storage_t

16-bit unsigned integer type abstraction used to for storage of pairs of fp8 floating-point numbers.

__nv_fp8x4_storage_t

32-bit unsigned integer type abstraction used to for storage of tetrads of fp8 floating-point numbers.

1.7.1. Enumerations

enum __nv_fp8_interpretation_t

Enumerates the possible interpretations of the 8-bit values when referring to them as fp8 types.

Values:

enumerator **__NV_E4M3**

Stands for fp8 numbers of e4m3 kind.

enumerator **__NV_E5M2**

Stands for fp8 numbers of e5m2 kind.

enum __nv_saturation_t

Enumerates the modes applicable when performing a narrowing conversion to fp8 destination types.

Values:

enumerator **__NV_NOSAT**

Means no saturation to finite is performed when conversion results in rounding values outside the range of destination type.

NOTE: for fp8 type of e4m3 kind, the results that are larger than the maximum representable finite number of the target format become NaN.

enumerator **__NV_SATFINITE**

Means input larger than the maximum representable finite number MAXNORM of the target format round to the MAXNORM of the same sign as input.

1.7.2. Functions

```
__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_bfloat16raw2_to_fp8x2(const
                                                                    __nv_bfloat162_raw
                                                                    x, const
                                                                    __nv_saturation_t
                                                                    saturate, const
                                                                    __nv_fp8_interpretation_t
                                                                    fp8_interpretation)
```

Converts input vector of two nv_bfloat16 precision numbers packed in `__nv_bfloat162_raw` x into a vector of two values of fp8 type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input vector `x` to a vector of two `fp8` values of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- The `__nv_fp8x2_storage_t` value holds the result of conversion.

```
__host__ __device__ __nv_fp8_storage_t __nv_cvt_bfloat16raw_to_fp8(const
                                                                    __nv_bfloat16_raw x,
                                                                    const __nv_saturation_t
                                                                    saturate, const
                                                                    __nv_fp8_interpretation_t
                                                                    fp8_interpretation)
```

Converts input `nv_bfloat16` precision `x` to `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input `x` to `fp8` type of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- The `__nv_fp8_storage_t` value holds the result of conversion.

```
__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_double2_to_fp8x2(const double2 x, const
                                                                    __nv_saturation_t
                                                                    saturate, const
                                                                    __nv_fp8_interpretation_t
                                                                    fp8_interpretation)
```

Converts input vector of two `double` precision numbers packed in `double2` `x` into a vector of two values of `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input vector `x` to a vector of two `fp8` values of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- The `__nv_fp8x2_storage_t` value holds the result of conversion.

```
__host__ __device__ __nv_fp8_storage_t __nv_cvt_double_to_fp8(const double x, const
                                                                    __nv_saturation_t saturate,
                                                                    const
                                                                    __nv_fp8_interpretation_t
                                                                    fp8_interpretation)
```

Converts input `double` precision `x` to `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input `x` to `fp8` type of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- The `__nv_fp8_storage_t` value holds the result of conversion.


```
__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_float2_to_fp8x2(const float2 x, const
                                                                    __nv_saturation_t
                                                                    saturate, const
                                                                    __nv_fp8_interpretation_t
                                                                    fp8_interpretation)
```

Converts input vector of two single precision numbers packed in `float2 x` into a vector of two values of `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input vector `x` to a vector of two `fp8` values of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- ▶ The `__nv_fp8x2_storage_t` value holds the result of conversion.

```
__host__ __device__ __nv_fp8_storage_t __nv_cvt_float_to_fp8(const float x, const
                                                            __nv_saturation_t saturate,
                                                            const __nv_fp8_interpretation_t
                                                            fp8_interpretation)
```

Converts input single precision `x` to `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input `x` to `fp8` type of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- ▶ The `__nv_fp8_storage_t` value holds the result of conversion.

```
__host__ __device__ __half_raw __nv_cvt_fp8_to_halfraw(const __nv_fp8_storage_t x, const
                                                       __nv_fp8_interpretation_t
                                                       fp8_interpretation)
```

Converts input `fp8 x` of the specified kind to half precision.

Converts input `x` of `fp8` type of the kind specified by `fp8_interpretation` parameter to half precision.

Returns

- ▶ The `__half_raw` value holds the result of conversion.

```
__host__ __device__ __half2_raw __nv_cvt_fp8x2_to_halfraw2(const __nv_fp8x2_storage_t x,
                                                            const __nv_fp8_interpretation_t
                                                            fp8_interpretation)
```

Converts input vector of two `fp8` values of the specified kind to a vector of two half precision values packed in `__half2_raw` structure.

Converts input vector `x` of `fp8` type of the kind specified by `fp8_interpretation` parameter to a vector of two half precision values and returns as `__half2_raw` structure.

Returns

- ▶ The `__half2_raw` value holds the result of conversion.

```
__host__ __device__ __nv_fp8x2_storage_t __nv_cvt_halfraw2_to_fp8x2(const __half2_raw x,
                                                                    const
                                                                    __nv_saturation_t
                                                                    saturate, const
                                                                    __nv_fp8_interpretation_t
                                                                    fp8_interpretation)
```

Converts input vector of two half precision numbers packed in `__half2_raw` `x` into a vector of two values of `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input vector `x` to a vector of two `fp8` values of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- ▶ The `__nv_fp8x2_storage_t` value holds the result of conversion.

```
__host__ __device__ __nv_fp8_storage_t __nv_cvt_halfraw_to_fp8(const __half_raw x, const
                                                                __nv_saturation_t saturate,
                                                                const
                                                                __nv_fp8_interpretation_t
                                                                fp8_interpretation)
```

Converts input half precision `x` to `fp8` type of the requested kind using round-to-nearest-even rounding and requested saturation mode.

Converts input `x` to `fp8` type of the kind specified by `fp8_interpretation` parameter, using round-to-nearest-even rounding and saturation mode specified by `saturate` parameter.

Returns

- ▶ The `__nv_fp8_storage_t` value holds the result of conversion.

1.7.3. Typedefs

```
typedef unsigned char __nv_fp8_storage_t
```

8-bit unsigned integer type abstraction used to for `fp8` floating-point numbers storage.

```
typedef unsigned short int __nv_fp8x2_storage_t
```

16-bit unsigned integer type abstraction used to for storage of pairs of `fp8` floating-point numbers.

```
typedef unsigned int __nv_fp8x4_storage_t
```

32-bit unsigned integer type abstraction used to for storage of tetrads of `fp8` floating-point numbers.

Groups

C++ struct for handling fp8 data type of e4m3 kind.

C++ struct for handling fp8 data type of e5m2 kind.

C++ struct for handling vector type of four fp8 values of e4m3 kind.

C++ struct for handling vector type of four fp8 values of e5m2 kind.

C++ struct for handling vector type of two fp8 values of e4m3 kind.

C++ struct for handling vector type of two fp8 values of e5m2 kind.

FP8 Conversion and Data Movement

To use these functions, include the header file `cuda_fp8.h` in your program.

Chapter 2. Half Precision Intrinsics

This section describes half precision intrinsic functions.

To use these functions, include the header file `cuda_fp16.h` in your program. All of the functions defined here are available in device code. Some of the functions are also available to host compilers, please refer to respective functions' documentation for details.

NOTE: Aggressive floating-point optimizations performed by host or device compilers may affect numeric behavior of the functions implemented in this header.

The following macros are available to help users selectively enable/disable various definitions present in the header file:

- ▶ `CUDA_NO_HALF` - If defined, this macro will prevent the definition of additional type aliases in the global namespace, helping to avoid potential conflicts with symbols defined in the user program.
- ▶ `__CUDA_NO_HALF_CONVERSIONS__` - If defined, this macro will prevent the use of the C++ type conversions (converting constructors and conversion operators) that are common for built-in floating-point types, but may be undesirable for `half` which is essentially a user-defined type.
- ▶ `__CUDA_NO_HALF_OPERATORS__` and `__CUDA_NO_HALF2_OPERATORS__` - If defined, these macros will prevent the inadvertent use of usual arithmetic and comparison operators. This enforces the storage-only type semantics and prevents C++ style computations on `half` and `half2` types.

2.1. Half Arithmetic Constants

To use these constants, include the header file `cuda_fp16.h` in your program.

Macros

`CUDART_INF_FP16`

Defines floating-point positive infinity value for the `half` data type.

`CUDART_MAX_NORMAL_FP16`

Defines a maximum representable value for the `half` data type.

`CUDART_MIN_DENORM_FP16`

Defines a minimum representable (denormalized) value for the `half` data type.

`CUDART_NAN_FP16`

Defines canonical NaN value for the `half` data type.

CUDART_NEG_ZERO_FP16

Defines a negative zero value for the half data type.

CUDART_ONE_FP16

Defines a value of 1.0 for the half data type.

CUDART_ZERO_FP16

Defines a positive zero value for the half data type.

2.1.1. Macros

CUDART_INF_FP16 `__ushort_as_half`((unsigned short)0x7C00U)

Defines floating-point positive infinity value for the half data type.

CUDART_MAX_NORMAL_FP16 `__ushort_as_half`((unsigned short)0x7BFFU)

Defines a maximum representable value for the half data type.

CUDART_MIN_DENORM_FP16 `__ushort_as_half`((unsigned short)0x0001U)

Defines a minimum representable (denormalized) value for the half data type.

CUDART_NAN_FP16 `__ushort_as_half`((unsigned short)0x7FFFU)

Defines canonical NaN value for the half data type.

CUDART_NEG_ZERO_FP16 `__ushort_as_half`((unsigned short)0x8000U)

Defines a negative zero value for the half data type.

CUDART_ONE_FP16 `__ushort_as_half`((unsigned short)0x3C00U)

Defines a value of 1.0 for the half data type.

CUDART_ZERO_FP16 `__ushort_as_half`((unsigned short)0x0000U)

Defines a positive zero value for the half data type.

2.2. Half Arithmetic Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

- __host__ __device__ __half __habs(const __half a)**
 Calculates the absolute value of input half number and returns the result.
- __host__ __device__ __half __hadd(const __half a, const __half b)**
 Performs half addition in round-to-nearest-even mode.
- __host__ __device__ __half __hadd_rn(const __half a, const __half b)**
 Performs half addition in round-to-nearest-even mode.
- __host__ __device__ __half __hadd_sat(const __half a, const __half b)**
 Performs half addition in round-to-nearest-even mode, with saturation to [0.0, 1.0].
- __host__ __device__ __half __hdiv(const __half a, const __half b)**
 Performs half division in round-to-nearest-even mode.
- __device__ __half __hfma(const __half a, const __half b, const __half c)**
 Performs half fused multiply-add in round-to-nearest-even mode.
- __device__ __half __hfma_relu(const __half a, const __half b, const __half c)**
 Performs half fused multiply-add in round-to-nearest-even mode with relu saturation.
- __device__ __half __hfma_sat(const __half a, const __half b, const __half c)**
 Performs half fused multiply-add in round-to-nearest-even mode, with saturation to [0.0, 1.0].
- __host__ __device__ __half __hmul(const __half a, const __half b)**
 Performs half multiplication in round-to-nearest-even mode.
- __host__ __device__ __half __hmul_rn(const __half a, const __half b)**
 Performs half multiplication in round-to-nearest-even mode.
- __host__ __device__ __half __hmul_sat(const __half a, const __half b)**
 Performs half multiplication in round-to-nearest-even mode, with saturation to [0.0, 1.0].
- __host__ __device__ __half __hneg(const __half a)**
 Negates input half number and returns the result.
- __host__ __device__ __half __hsub(const __half a, const __half b)**
 Performs half subtraction in round-to-nearest-even mode.
- __host__ __device__ __half __hsub_rn(const __half a, const __half b)**
 Performs half subtraction in round-to-nearest-even mode.
- __host__ __device__ __half __hsub_sat(const __half a, const __half b)**
 Performs half subtraction in round-to-nearest-even mode, with saturation to [0.0, 1.0].
- __device__ __half atomicAdd(__half *const address, const __half val)**
 Adds val to the value stored at address in global or shared memory, and writes this value back to address .
- __host__ __device__ __half operator*(const __half &lh, const __half &rh)**
 Performs half multiplication operation.
- __host__ __device__ __half & operator*=(__half &lh, const __half &rh)**
 Performs half compound assignment with multiplication operation.
- __host__ __device__ __half operator+(const __half &h)**
 Implements half unary plus operator, returns input value.
- __host__ __device__ __half operator+(const __half &lh, const __half &rh)**
 Performs half addition operation.

`__host__ __device__ __half & operator++(__half &h)`

Performs half prefix increment operation.

`__host__ __device__ __half operator++(__half &h, const int ignored)`

Performs half postfix increment operation.

`__host__ __device__ __half & operator+=(__half &lh, const __half &rh)`

Performs half compound assignment with addition operation.

`__host__ __device__ __half operator-(const __half &lh, const __half &rh)`

Performs half subtraction operation.

`__host__ __device__ __half operator-(const __half &h)`

Implements half unary minus operator.

`__host__ __device__ __half operator--(__half &h, const int ignored)`

Performs half postfix decrement operation.

`__host__ __device__ __half & operator--(__half &h)`

Performs half prefix decrement operation.

`__host__ __device__ __half & operator-=(__half &lh, const __half &rh)`

Performs half compound assignment with subtraction operation.

`__host__ __device__ __half operator/(const __half &lh, const __half &rh)`

Performs half division operation.

`__host__ __device__ __half & operator/=(__half &lh, const __half &rh)`

Performs half compound assignment with division operation.

2.2.1. Functions

`__host__ __device__ __half __habs(const __half a)`

Calculates the absolute value of input half number and returns the result.

Calculates the absolute value of input half number and returns the result.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The absolute value of a.
- ▶ `__habs(±0)` returns +0.
- ▶ `__habs(±∞)` returns +∞.
- ▶ `__habs(NaN)` returns NaN.

`__host__ __device__ __half __hadd(const __half a, const __half b)`

Performs half addition in round-to-nearest-even mode.

Performs half addition of inputs a and b, in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - half. Is only being read.
- ▶ **b** – [in] - half. Is only being read.

Returns

half

- ▶ The sum of a and b.

`__host__ __device__ __half __hadd_rn(const __half a, const __half b)`

Performs half addition in round-to-nearest-even mode.

Performs half addition of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add into fma.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The sum of a and b.

`__host__ __device__ __half __hadd_sat(const __half a, const __half b)`

Performs half addition in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs half add of inputs a and b, in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The sum of a and b, with respect to saturation.

`__host__ __device__ __half __hdiv(const __half a, const __half b)`

Performs half division in round-to-nearest-even mode.

Divides half input a by input b in round-to-nearest-even mode.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The result of dividing a by b.

`__device__ __half __hfma(const __half a, const __half b, const __half c)`

Performs half fused multiply-add in round-to-nearest-even mode.

Performs half multiply on inputs a and b, then performs a half add of the result with c, rounding the result once in round-to-nearest-even mode.

Parameters

- ▶ **a** - [**in**] - half. Is only being read.
- ▶ **b** - [**in**] - half. Is only being read.
- ▶ **c** - [**in**] - half. Is only being read.

Returns

half

- ▶ The result of fused multiply-add operation on a, b, and c.

`__device__ __half __hfma_relu(const __half a, const __half b, const __half c)`

Performs half fused multiply-add in round-to-nearest-even mode with relu saturation.

Performs half multiply on inputs a and b, then performs a half add of the result with c, rounding the result once in round-to-nearest-even mode. Then negative result is clamped to 0. NaN result is converted to canonical NaN.

Parameters

- ▶ **a** - [**in**] - half. Is only being read.
- ▶ **b** - [**in**] - half. Is only being read.
- ▶ **c** - [**in**] - half. Is only being read.

Returns

half

- ▶ The result of fused multiply-add operation on a, b, and c with relu saturation.

`__device__ __half __hfma_sat(const __half a, const __half b, const __half c)`

Performs half fused multiply-add in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs half multiply on inputs a and b, then performs a half add of the result with c, rounding the result once in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [**in**] - half. Is only being read.
- ▶ **b** - [**in**] - half. Is only being read.
- ▶ **c** - [**in**] - half. Is only being read.

Returns

half

- ▶ The result of fused multiply-add operation on a, b, and c, with respect to saturation.

`__host__ __device__ __half __hmul(const __half a, const __half b)`

Performs half multiplication in round-to-nearest-even mode.

Performs half multiplication of inputs a and b, in round-to-nearest-even mode.

Parameters

- ▶ **a** - [**in**] - half. Is only being read.
- ▶ **b** - [**in**] - half. Is only being read.

Returns

half

- ▶ The result of multiplying a and b.

`__host__ __device__ __half __hmul_rn(const __half a, const __half b)`

Performs half multiplication in round-to-nearest-even mode.

Performs half multiplication of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add or sub into fma.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The result of multiplying a and b.

`__host__ __device__ __half __hmul_sat(const __half a, const __half b)`

Performs half multiplication in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs half multiplication of inputs a and b, in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The result of multiplying a and b, with respect to saturation.

`__host__ __device__ __half __hneg(const __half a)`

Negates input half number and returns the result.

Negates input half number and returns the result.

Parameters

a - [in] - half. Is only being read.

Returns

half

- ▶ Negated input a.
- ▶ `__hneg(±0)` returns ∓0.
- ▶ `__hneg(±∞)` returns ∓∞.
- ▶ `__hneg(NaN)` returns NaN.

`__host__ __device__ __half __hsub(const __half a, const __half b)`

Performs half subtraction in round-to-nearest-even mode.

Subtracts half input b from input a in round-to-nearest-even mode.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The result of subtracting b from a.

`__host__ __device__ __half __hsub_rn(const __half a, const __half b)`

Performs half subtraction in round-to-nearest-even mode.

Subtracts half input b from input a in round-to-nearest-even mode. Prevents floating-point contractions of mul+sub into fma.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The result of subtracting b from a.

`__host__ __device__ __half __hsub_sat(const __half a, const __half b)`

Performs half subtraction in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Subtracts half input b from input a in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

- ▶ The result of subtraction of b from a, with respect to saturation.

`__device__ __half atomicAdd(__half *const address, const __half val)`

Adds val to the value stored at address in global or shared memory, and writes this value back to address.

This operation is performed in one atomic operation.

The location of address must be in global or shared memory. This operation has undefined behavior otherwise. This operation is only supported by devices of compute capability 7.x and higher.

Note: For more details for this function see the Atomic Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **address** - [**in**] - half*. An address in global or shared memory.
- ▶ **val** - [**in**] - half. The value to be added.

Returns

half

- ▶ The old value read from address.

`__host__ __device__ __half operator*(const __half &lh, const __half &rh)`
 Performs half multiplication operation.

See also:

`__hmul(__half, __half)`

`__host__ __device__ __half &operator*=(__half &lh, const __half &rh)`
 Performs half compound assignment with multiplication operation.

See also:

`__hmul(__half, __half)`

`__host__ __device__ __half operator+(const __half &h)`
 Implements half unary plus operator, returns input value.

`__host__ __device__ __half operator+(const __half &lh, const __half &rh)`
 Performs half addition operation.

See also:

`__hadd(__half, __half)`

`__host__ __device__ __half &operator++(__half &h)`
 Performs half prefix increment operation.

See also:

`__hadd(__half, __half)`

`__host__ __device__ __half operator++(__half &h, const int ignored)`
 Performs half postfix increment operation.

See also:

`__hadd(__half, __half)`

`__host__ __device__ __half &operator+=(__half &lh, const __half &rh)`
 Performs half compound assignment with addition operation.

See also:

[__hadd\(__half, __half\)](#)

`__host__ __device__ __half operator- (const __half &lh, const __half &rh)`
 Performs half subtraction operation.

See also:

[__hsub\(__half, __half\)](#)

`__host__ __device__ __half operator- (const __half &h)`
 Implements half unary minus operator.

See also:

[__hneg\(__half\)](#)

`__host__ __device__ __half operator-- (__half &h, const int ignored)`
 Performs half postfix decrement operation.

See also:

[__hsub\(__half, __half\)](#)

`__host__ __device__ __half &operator-- (__half &h)`
 Performs half prefix decrement operation.

See also:

[__hsub\(__half, __half\)](#)

`__host__ __device__ __half &operator-= (__half &lh, const __half &rh)`
 Performs half compound assignment with subtraction operation.

See also:

[__hsub\(__half, __half\)](#)

`__host__ __device__ __half operator/ (const __half &lh, const __half &rh)`
 Performs half division operation.

See also:

[__hdiv\(__half, __half\)](#)

`__host__ __device__ __half &operator/= (__half &lh, const __half &rh)`
 Performs half compound assignment with division operation.

See also:

[__hdiv\(__half, __half\)](#)

2.3. Half Comparison Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

- `__host__ __device__ bool __heq(const __half a, const __half b)`**
Performs half if-equal comparison.
- `__host__ __device__ bool __hequ(const __half a, const __half b)`**
Performs half unordered if-equal comparison.
- `__host__ __device__ bool __hge(const __half a, const __half b)`**
Performs half greater-equal comparison.
- `__host__ __device__ bool __hgeu(const __half a, const __half b)`**
Performs half unordered greater-equal comparison.
- `__host__ __device__ bool __hgt(const __half a, const __half b)`**
Performs half greater-than comparison.
- `__host__ __device__ bool __hgtu(const __half a, const __half b)`**
Performs half unordered greater-than comparison.
- `__host__ __device__ int __hisinf(const __half a)`**
Checks if the input half number is infinite.
- `__host__ __device__ bool __hisnan(const __half a)`**
Determine whether half argument is a NaN.
- `__host__ __device__ bool __hle(const __half a, const __half b)`**
Performs half less-equal comparison.
- `__host__ __device__ bool __hleu(const __half a, const __half b)`**
Performs half unordered less-equal comparison.
- `__host__ __device__ bool __hlt(const __half a, const __half b)`**
Performs half less-than comparison.
- `__host__ __device__ bool __hltu(const __half a, const __half b)`**
Performs half unordered less-than comparison.
- `__host__ __device__ __half __hmax(const __half a, const __half b)`**
Calculates half maximum of two input values.
- `__host__ __device__ __half __hmax_nan(const __half a, const __half b)`**
Calculates half maximum of two input values, NaNs pass through.
- `__host__ __device__ __half __hmin(const __half a, const __half b)`**
Calculates half minimum of two input values.
- `__host__ __device__ __half __hmin_nan(const __half a, const __half b)`**
Calculates half minimum of two input values, NaNs pass through.
- `__host__ __device__ bool __hne(const __half a, const __half b)`**
Performs half not-equal comparison.
- `__host__ __device__ bool __hneu(const __half a, const __half b)`**
Performs half unordered not-equal comparison.

`__host__ __device__ bool operator!=(const __half &lh, const __half &rh)`
 Performs half unordered compare not-equal operation.

`__host__ __device__ bool operator<(const __half &lh, const __half &rh)`
 Performs half ordered less-than compare operation.

`__host__ __device__ bool operator<=(const __half &lh, const __half &rh)`
 Performs half ordered less-or-equal compare operation.

`__host__ __device__ bool operator==(const __half &lh, const __half &rh)`
 Performs half ordered compare equal operation.

`__host__ __device__ bool operator>(const __half &lh, const __half &rh)`
 Performs half ordered greater-than compare operation.

`__host__ __device__ bool operator>=(const __half &lh, const __half &rh)`
 Performs half ordered greater-or-equal compare operation.

2.3.1. Functions

`__host__ __device__ bool __heq(const __half a, const __half b)`
 Performs half if-equal comparison.

Performs half if-equal comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of if-equal comparison of a and b.

`__host__ __device__ bool __hequ(const __half a, const __half b)`
 Performs half unordered if-equal comparison.

Performs half if-equal comparison of inputs a and b. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of unordered if-equal comparison of a and b.

`__host__ __device__ bool __hge(const __half a, const __half b)`
 Performs half greater-equal comparison.

Performs half greater-equal comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** – [**in**] - half. Is only being read.
- ▶ **b** – [**in**] - half. Is only being read.

Returns

bool

- ▶ The boolean result of greater-equal comparison of a and b.

`__host__ __device__ bool __hgeu(const __half a, const __half b)`

Performs half unordered greater-equal comparison.

Performs half greater-equal comparison of inputs a and b. NaN inputs generate true results.

Parameters

- ▶ **a** – [**in**] - half. Is only being read.
- ▶ **b** – [**in**] - half. Is only being read.

Returns

bool

- ▶ The boolean result of unordered greater-equal comparison of a and b.

`__host__ __device__ bool __hgt(const __half a, const __half b)`

Performs half greater-than comparison.

Performs half greater-than comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** – [**in**] - half. Is only being read.
- ▶ **b** – [**in**] - half. Is only being read.

Returns

bool

- ▶ The boolean result of greater-than comparison of a and b.

`__host__ __device__ bool __hgtu(const __half a, const __half b)`

Performs half unordered greater-than comparison.

Performs half greater-than comparison of inputs a and b. NaN inputs generate true results.

Parameters

- ▶ **a** – [**in**] - half. Is only being read.
- ▶ **b** – [**in**] - half. Is only being read.

Returns

bool

- ▶ The boolean result of unordered greater-than comparison of a and b.

`__host__ __device__ int __hisinf(const __half a)`

Checks if the input half number is infinite.

Checks if the input half number a is infinite.

Parameters

a – [**in**] - half. Is only being read.

Returns

int

- ▶ -1 if a is equal to negative infinity,
- ▶ 1 if a is equal to positive infinity,
- ▶ 0 otherwise.

`__host__ __device__ bool __hisnan(const __half a)`

Determine whether half argument is a NaN.

Determine whether half value a is a NaN.

Parameters

a – [in] - half. Is only being read.

Returns

bool

- ▶ true if argument is NaN.

`__host__ __device__ bool __hle(const __half a, const __half b)`

Performs half less-equal comparison.

Performs half less-equal comparison of inputs a and b. NaN inputs generate false results.

Parameters

▶ **a** – [in] - half. Is only being read.

▶ **b** – [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of less-equal comparison of a and b.

`__host__ __device__ bool __hleu(const __half a, const __half b)`

Performs half unordered less-equal comparison.

Performs half less-equal comparison of inputs a and b. NaN inputs generate true results.

Parameters

▶ **a** – [in] - half. Is only being read.

▶ **b** – [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of unordered less-equal comparison of a and b.

`__host__ __device__ bool __hlt(const __half a, const __half b)`

Performs half less-than comparison.

Performs half less-than comparison of inputs a and b. NaN inputs generate false results.

Parameters

▶ **a** – [in] - half. Is only being read.

- ▶ **b** - [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of less-than comparison of a and b.

`__host__ __device__ bool __hltu(const __half a, const __half b)`

Performs half unordered less-than comparison.

Performs half less-than comparison of inputs a and b. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of unordered less-than comparison of a and b.

`__host__ __device__ __half __hmax(const __half a, const __half b)`

Calculates half maximum of two input values.

Calculates half $\max(a, b)$ defined as $(a > b) ? a : b$.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

`__host__ __device__ __half __hmax_nan(const __half a, const __half b)`

Calculates half maximum of two input values, NaNs pass through.

Calculates half $\max(a, b)$ defined as $(a > b) ? a : b$.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** - [in] - half. Is only being read.
- ▶ **b** - [in] - half. Is only being read.

Returns

half

`__host__ __device__ __half __hmin(const __half a, const __half b)`

Calculates half minimum of two input values.

Calculates half $\min(a, b)$ defined as $(a < b) ? a : b$.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** – [in] - half. Is only being read.
- ▶ **b** – [in] - half. Is only being read.

Returns

half

`__host__ __device__ __half __hmin_nan(const __half a, const __half b)`

Calculates half minimum of two input values, NaNs pass through.

Calculates half $\min(a, b)$ defined as $(a < b) ? a : b$.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** – [in] - half. Is only being read.
- ▶ **b** – [in] - half. Is only being read.

Returns

half

`__host__ __device__ bool __hne(const __half a, const __half b)`

Performs half not-equal comparison.

Performs half not-equal comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half. Is only being read.
- ▶ **b** – [in] - half. Is only being read.

Returns

bool

- ▶ The boolean result of not-equal comparison of a and b.

`__host__ __device__ bool __hneu(const __half a, const __half b)`

Performs half unordered not-equal comparison.

Performs half not-equal comparison of inputs a and b. NaN inputs generate true results.

Parameters

► **a** - [**in**] - half. Is only being read.

► **b** - [**in**] - half. Is only being read.

Returns

bool

► The boolean result of unordered not-equal comparison of a and b.

`__host__ __device__ bool operator !=(const __half &lh, const __half &rh)`

Performs half unordered compare not-equal operation.

See also:

__hneu(__half, __half)

`__host__ __device__ bool operator <(const __half &lh, const __half &rh)`

Performs half ordered less-than compare operation.

See also:

__hlt(__half, __half)

`__host__ __device__ bool operator <=(const __half &lh, const __half &rh)`

Performs half ordered less-or-equal compare operation.

See also:

__hle(__half, __half)

`__host__ __device__ bool operator ==(const __half &lh, const __half &rh)`

Performs half ordered compare equal operation.

See also:

__heq(__half, __half)

`__host__ __device__ bool operator >(const __half &lh, const __half &rh)`

Performs half ordered greater-than compare operation.

See also:

__hgt(__half, __half)

`__host__ __device__ bool operator >=(const __half &lh, const __half &rh)`

Performs half ordered greater-or-equal compare operation.

See also:

__hge(__half, __half)

2.4. Half Math Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

`__device__ __half hceil(const __half h)`

Calculate ceiling of the input argument.

`__device__ __half hcos(const __half a)`

Calculates half cosine in round-to-nearest-even mode.

`__device__ __half hexp(const __half a)`

Calculates half natural exponential function in round-to-nearest-even mode.

`__device__ __half hexp10(const __half a)`

Calculates half decimal exponential function in round-to-nearest-even mode.

`__device__ __half hexp2(const __half a)`

Calculates half binary exponential function in round-to-nearest-even mode.

`__device__ __half hfloor(const __half h)`

Calculate the largest integer less than or equal to `h`.

`__device__ __half hlog(const __half a)`

Calculates half natural logarithm in round-to-nearest-even mode.

`__device__ __half hlog10(const __half a)`

Calculates half decimal logarithm in round-to-nearest-even mode.

`__device__ __half hlog2(const __half a)`

Calculates half binary logarithm in round-to-nearest-even mode.

`__device__ __half hrcp(const __half a)`

Calculates half reciprocal in round-to-nearest-even mode.

`__device__ __half hrint(const __half h)`

Round input to nearest integer value in half-precision floating-point number.

`__device__ __half hrsqrt(const __half a)`

Calculates half reciprocal square root in round-to-nearest-even mode.

`__device__ __half hsin(const __half a)`

Calculates half sine in round-to-nearest-even mode.

`__device__ __half hsqrt(const __half a)`

Calculates half square root in round-to-nearest-even mode.

`__device__ __half htrunc(const __half h)`

Truncate input argument to the integral part.

2.4.1. Functions

`__device__ __half hceil(const __half h)`

Calculate ceiling of the input argument.

Compute the smallest integer value not less than h.

Parameters

h – [in] - half. Is only being read.

Returns

half

- ▶ The smallest integer value not less than h.
- ▶ `hceil(±0)` returns ± 0 .
- ▶ `hceil(±∞)` returns $\pm\infty$.
- ▶ `hceil(NaN)` returns NaN.

`__device__ __half hcos(const __half a)`

Calculates half cosine in round-to-nearest-even mode.

Calculates half cosine of input a in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The cosine of a.
- ▶ `hcos(±0)` returns 1.
- ▶ `hcos(±∞)` returns NaN.
- ▶ `hcos(NaN)` returns NaN.

`__device__ __half hexp(const __half a)`

Calculates half natural exponential function in round-to-nearest-even mode.

Calculates half natural exponential function of input: e^a in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The natural exponential function on a.
- ▶ `hexp(±0)` returns 1.
- ▶ `hexp(-∞)` returns +0.
- ▶ `hexp(+∞)` returns $+\infty$.
- ▶ `hexp(NaN)` returns NaN.

`__device__ __half hexp10(const __half a)`

Calculates half decimal exponential function in round-to-nearest-even mode.

Calculates half decimal exponential function of input: 10^a in round-to-nearest-even mode.

Parameters

a – **[in]** - half. Is only being read.

Returns

half

- ▶ The decimal exponential function on a.
- ▶ `hexp10(±0)` returns 1.
- ▶ `hexp10(-∞)` returns +0.
- ▶ `hexp10(+∞)` returns +∞.
- ▶ `hexp10(NaN)` returns NaN.

`__device__ __half hexp2(const __half a)`

Calculates half binary exponential function in round-to-nearest-even mode.

Calculates half binary exponential function of input: 2^a in round-to-nearest-even mode.

Parameters

a – **[in]** - half. Is only being read.

Returns

half

- ▶ The binary exponential function on a.
- ▶ `hexp2(±0)` returns 1.
- ▶ `hexp2(-∞)` returns +0.
- ▶ `hexp2(+∞)` returns +∞.
- ▶ `hexp2(NaN)` returns NaN.

`__device__ __half hfloor(const __half h)`

Calculate the largest integer less than or equal to h.

Calculate the largest integer value which is less than or equal to h.

Parameters

h – **[in]** - half. Is only being read.

Returns

half

- ▶ The largest integer value which is less than or equal to h.
- ▶ `hfloor(±0)` returns ± 0 .
- ▶ `hfloor(±∞)` returns $\pm \infty$.
- ▶ `hfloor(NaN)` returns NaN.

`__device__ __half hlog(const __half a)`

Calculates half natural logarithm in round-to-nearest-even mode.

Calculates half natural logarithm of input: $\ln(a)$ in round-to-nearest-even mode.

Parameters

a – **[in]** - half. Is only being read.

Returns

half

- ▶ The natural logarithm of a.
- ▶ $\text{hlog}(\pm 0)$ returns $-\infty$.
- ▶ $\text{hlog}(1)$ returns +0.
- ▶ $\text{hlog}(x)$, $x < 0$ returns NaN.
- ▶ $\text{hlog}(+\infty)$ returns $+\infty$.
- ▶ $\text{hlog}(\text{NaN})$ returns NaN.

`__device__ __half hlog10(const __half a)`

Calculates half decimal logarithm in round-to-nearest-even mode.

Calculates half decimal logarithm of input: $\log_{10}(a)$ in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The decimal logarithm of a.
- ▶ $\text{hlog10}(\pm 0)$ returns $-\infty$.
- ▶ $\text{hlog10}(1)$ returns +0.
- ▶ $\text{hlog10}(x)$, $x < 0$ returns NaN.
- ▶ $\text{hlog10}(+\infty)$ returns $+\infty$.
- ▶ $\text{hlog10}(\text{NaN})$ returns NaN.

`__device__ __half hlog2(const __half a)`

Calculates half binary logarithm in round-to-nearest-even mode.

Calculates half binary logarithm of input: $\log_2(a)$ in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The binary logarithm of a.
- ▶ $\text{hlog2}(\pm 0)$ returns $-\infty$.
- ▶ $\text{hlog2}(1)$ returns +0.
- ▶ $\text{hlog2}(x)$, $x < 0$ returns NaN.
- ▶ $\text{hlog2}(+\infty)$ returns $+\infty$.
- ▶ $\text{hlog2}(\text{NaN})$ returns NaN.

`__device__ __half hrcp(const __half a)`

Calculates half reciprocal in round-to-nearest-even mode.

Calculates half reciprocal of input: $\frac{1}{a}$ in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The reciprocal of a.
- ▶ `hrcp(±0)` returns $\pm\infty$.
- ▶ `hrcp(±∞)` returns ± 0 .
- ▶ `hrcp(NaN)` returns NaN.

`__device__ __half hrint(const __half h)`

Round input to nearest integer value in half-precision floating-point number.

Round `h` to the nearest integer value in half-precision floating-point format, with halfway cases rounded to the nearest even integer value.

Parameters

h – [in] - half. Is only being read.

Returns

half

- ▶ The nearest integer to `h`.
- ▶ `hrint(±0)` returns ± 0 .
- ▶ `hrint(±∞)` returns $\pm\infty$.
- ▶ `hrint(NaN)` returns NaN.

`__device__ __half hrsqrt(const __half a)`

Calculates half reciprocal square root in round-to-nearest-even mode.

Calculates half reciprocal square root of input: $\frac{1}{\sqrt{a}}$ in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The reciprocal square root of `a`.
- ▶ `hrsqrt(±0)` returns $\pm\infty$.
- ▶ `hrsqrt(+∞)` returns `+0`.
- ▶ `hrsqrt(x), x < 0.0` returns NaN.
- ▶ `hrsqrt(NaN)` returns NaN.

`__device__ __half hsin(const __half a)`

Calculates half sine in round-to-nearest-even mode.

Calculates half sine of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The sine of `a`.
- ▶ `hsin(±0)` returns (± 0) .
- ▶ `hsin(±∞)` returns NaN.
- ▶ `hsin(NaN)` returns NaN.

`__device__ __half hsqrt(const __half a)`

Calculates half square root in round-to-nearest-even mode.

Calculates half square root of input: \sqrt{a} in round-to-nearest-even mode.

Parameters

a – [in] - half. Is only being read.

Returns

half

- ▶ The square root of a.
- ▶ `hsqrt(+∞)` returns $+\infty$.
- ▶ `hsqrt(±0)` returns ± 0 .
- ▶ `hsqrt(x), x < 0.0` returns NaN.
- ▶ `hsqrt(NaN)` returns NaN.

`__device__ __half htrunc(const __half h)`

Truncate input argument to the integral part.

Round h to the largest integer value that does not exceed h in magnitude.

Parameters

h – [in] - half. Is only being read.

Returns

half

- ▶ The truncated value.
- ▶ `htrunc(±0)` returns ± 0 .
- ▶ `htrunc(±∞)` returns $\pm \infty$.
- ▶ `htrunc(NaN)` returns NaN.

2.5. Half Precision Conversion and Data Movement

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

`__host__ __device__ __half __double2half(const double a)`

Converts double number to half precision in round-to-nearest-even mode and returns half with converted value.

`__host__ __device__ __half2 __float2half2_rn(const float2 a)`

Converts both components of float2 number to half precision in round-to-nearest-even mode and returns half2 with converted values.

`__host__ __device__ __half __float2half(const float a)`

Converts float number to half precision in round-to-nearest-even mode and returns half with converted value.

__host__ __device__ __half2 __float2half2_rn(const float a)

Converts input to half precision in round-to-nearest-even mode and populates both halves of `half2` with converted value.

__host__ __device__ __half __float2half_rd(const float a)

Converts float number to half precision in round-down mode and returns `half` with converted value.

__host__ __device__ __half __float2half_rn(const float a)

Converts float number to half precision in round-to-nearest-even mode and returns `half` with converted value.

__host__ __device__ __half __float2half_ru(const float a)

Converts float number to half precision in round-up mode and returns `half` with converted value.

__host__ __device__ __half __float2half_rz(const float a)

Converts float number to half precision in round-towards-zero mode and returns `half` with converted value.

__host__ __device__ __half2 __floats2half2_rn(const float a, const float b)

Converts both input floats to half precision in round-to-nearest-even mode and returns `half2` with converted values.

__host__ __device__ float2 __half2float2(const __half2 a)

Converts both halves of `half2` to `float2` and returns the result.

__host__ __device__ __half2::__half2(const __half2_raw &h2r)

Constructor from `__half2_raw`.

__host__ __device__ constexpr __half2::__half2(const __half &a, const __half &b)

Constructor from two `__half` variables.

__host__ __device__ __half2::__half2(const __half2 &&src)

Move constructor, available for C++11 and later dialects.

__host__ __device__ __half2::__half2(const __half2 &src)

Copy constructor.

__half2::__half2()=default

Constructor by default.

__host__ __device__ __half2::__operator __half2_raw() const

Conversion operator to `__half2_raw`.

__host__ __device__ __half2 & __half2::__operator=(const __half2_raw &h2r)

Assignment operator from `__half2_raw`.

__host__ __device__ __half2 & __half2::__operator=(const __half2 &&src)

Move assignment operator, available for C++11 and later dialects.

__host__ __device__ __half2 & __half2::__operator=(const __half2 &src)

Copy assignment operator.

__host__ __device__ signed char __half2char_rz(const __half h)

Convert a half to a signed char in round-towards-zero mode.

__host__ __device__ float __half2float(const __half a)

Converts `half` number to float.

__host__ __device__ __half2 __half2half2(const __half a)

Returns `half2` with both halves equal to the input value.

- __device__ int __half2int_rd(const __half h)**
Convert a half to a signed integer in round-down mode.
- __device__ int __half2int_rn(const __half h)**
Convert a half to a signed integer in round-to-nearest-even mode.
- __device__ int __half2int_ru(const __half h)**
Convert a half to a signed integer in round-up mode.
- __host__ __device__ int __half2int_rz(const __half h)**
Convert a half to a signed integer in round-towards-zero mode.
- __device__ long long int __half2ll_rd(const __half h)**
Convert a half to a signed 64-bit integer in round-down mode.
- __device__ long long int __half2ll_rn(const __half h)**
Convert a half to a signed 64-bit integer in round-to-nearest-even mode.
- __device__ long long int __half2ll_ru(const __half h)**
Convert a half to a signed 64-bit integer in round-up mode.
- __host__ __device__ long long int __half2ll_rz(const __half h)**
Convert a half to a signed 64-bit integer in round-towards-zero mode.
- __device__ short int __half2short_rd(const __half h)**
Convert a half to a signed short integer in round-down mode.
- __device__ short int __half2short_rn(const __half h)**
Convert a half to a signed short integer in round-to-nearest-even mode.
- __device__ short int __half2short_ru(const __half h)**
Convert a half to a signed short integer in round-up mode.
- __host__ __device__ short int __half2short_rz(const __half h)**
Convert a half to a signed short integer in round-towards-zero mode.
- __host__ __device__ unsigned char __half2uchar_rz(const __half h)**
Convert a half to an unsigned char in round-towards-zero mode.
- __device__ unsigned int __half2uint_rd(const __half h)**
Convert a half to an unsigned integer in round-down mode.
- __device__ unsigned int __half2uint_rn(const __half h)**
Convert a half to an unsigned integer in round-to-nearest-even mode.
- __device__ unsigned int __half2uint_ru(const __half h)**
Convert a half to an unsigned integer in round-up mode.
- __host__ __device__ unsigned int __half2uint_rz(const __half h)**
Convert a half to an unsigned integer in round-towards-zero mode.
- __device__ unsigned long long int __half2ull_rd(const __half h)**
Convert a half to an unsigned 64-bit integer in round-down mode.
- __device__ unsigned long long int __half2ull_rn(const __half h)**
Convert a half to an unsigned 64-bit integer in round-to-nearest-even mode.
- __device__ unsigned long long int __half2ull_ru(const __half h)**
Convert a half to an unsigned 64-bit integer in round-up mode.
- __host__ __device__ unsigned long long int __half2ull_rz(const __half h)**
Convert a half to an unsigned 64-bit integer in round-towards-zero mode.

__device__ unsigned short int __half2ushort_rd(const __half h)

Convert a half to an unsigned short integer in round-down mode.

__device__ unsigned short int __half2ushort_rn(const __half h)

Convert a half to an unsigned short integer in round-to-nearest-even mode.

__device__ unsigned short int __half2ushort_ru(const __half h)

Convert a half to an unsigned short integer in round-up mode.

__host__ __device__ unsigned short int __half2ushort_rz(const __half h)

Convert a half to an unsigned short integer in round-towards-zero mode.

__host__ __device__ constexpr __half::__half(const __half_raw &hr)

Constructor from __half_raw.

__host__ __device__ __half::__half(const unsigned short val)

Construct __half from unsigned short integer input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const unsigned int val)

Construct __half from unsigned int input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const short val)

Construct __half from short integer input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const double f)

Construct __half from double input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const unsigned long val)

Construct __half from unsigned long input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const float f)

Construct __half from float input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const int val)

Construct __half from int input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const long val)

Construct __half from long input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const long long val)

Construct __half from long long input using default round-to-nearest-even rounding mode.

__half::__half()=default

Constructor by default.

__host__ __device__ __half::__half(const __nv_bfloat16 f)

Construct __half from __nv_bfloat16 input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::__half(const unsigned long long val)

Construct __half from unsigned long long input using default round-to-nearest-even rounding mode.

__host__ __device__ __half::operator __half_raw() const volatile

Type cast to __half_raw operator with volatile input.

__host__ __device__ __half::operator __half_raw() const

Type cast to __half_raw operator.

- __host__ __device__ constexpr __half::operator bool() const**
Conversion operator to bool data type.
- __host__ __device__ __half::operator char() const**
Conversion operator to an implementation defined char data type.
- __host__ __device__ __half::operator float() const**
Type cast to float operator.
- __host__ __device__ __half::operator int() const**
Conversion operator to int data type.
- __host__ __device__ __half::operator long() const**
Conversion operator to long data type.
- __host__ __device__ __half::operator long long() const**
Conversion operator to long long data type.
- __host__ __device__ __half::operator short() const**
Conversion operator to short data type.
- __host__ __device__ __half::operator signed char() const**
Conversion operator to signed char data type.
- __host__ __device__ __half::operator unsigned char() const**
Conversion operator to unsigned char data type.
- __host__ __device__ __half::operator unsigned int() const**
Conversion operator to unsigned int data type.
- __host__ __device__ __half::operator unsigned long() const**
Conversion operator to unsigned long data type.
- __host__ __device__ __half::operator unsigned long long() const**
Conversion operator to unsigned long long data type.
- __host__ __device__ __half::operator unsigned short() const**
Conversion operator to unsigned short data type.
- __host__ __device__ __half & __half::operator=(const float f)**
Type cast to __half assignment operator from float input using default round-to-nearest-even rounding mode.
- __host__ __device__ volatile __half & __half::operator=(const volatile __half_raw &hr) volatile**
Assignment operator from volatile __half_raw to volatile __half.
- __host__ __device__ __half & __half::operator=(const long long val)**
Type cast from long long assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ volatile __half & __half::operator=(const __half_raw &hr) volatile**
Assignment operator from __half_raw to volatile __half.
- __host__ __device__ __half & __half::operator=(const unsigned int val)**
Type cast from unsigned int assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __half & __half::operator=(const unsigned short val)**
Type cast from unsigned short assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __half & __half::operator=(const short val)**
Type cast from short assignment operator, using default round-to-nearest-even rounding mode.

- __host__ __device__ __half & __half::operator=(const double f)**
 Type cast to __half assignment operator from double input using default round-to-nearest-even rounding mode.
- __host__ __device__ __half & __half::operator=(const __half_raw &hr)**
 Assignment operator from __half_raw .
- __host__ __device__ __half & __half::operator=(const unsigned long long val)**
 Type cast from unsigned long long assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __half & __half::operator=(const int val)**
 Type cast from int assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ short int __half_as_short(const __half h)**
 Reinterprets bits in a half as a signed short integer.
- __host__ __device__ unsigned short int __half_as_ushort(const __half h)**
 Reinterprets bits in a half as an unsigned short integer.
- __host__ __device__ __half2 __halves2half2(const __half a, const __half b)**
 Combines two half numbers into one half2 number.
- __host__ __device__ float __high2float(const __half2 a)**
 Converts high 16 bits of half2 to float and returns the result.
- __host__ __device__ __half __high2half(const __half2 a)**
 Returns high 16 bits of half2 input.
- __host__ __device__ __half2 __high2half2(const __half2 a)**
 Extracts high 16 bits from half2 input.
- __host__ __device__ __half2 __highs2half2(const __half2 a, const __half2 b)**
 Extracts high 16 bits from each of the two half2 inputs and combines into one half2 number.
- __host__ __device__ __half __int2half_rd(const int i)**
 Convert a signed integer to a half in round-down mode.
- __host__ __device__ __half __int2half_rn(const int i)**
 Convert a signed integer to a half in round-to-nearest-even mode.
- __host__ __device__ __half __int2half_ru(const int i)**
 Convert a signed integer to a half in round-up mode.
- __host__ __device__ __half __int2half_rz(const int i)**
 Convert a signed integer to a half in round-towards-zero mode.
- __device__ __half2 __ldca(const __half2 *const ptr)**
 Generates a ld.global.ca load instruction.
- __device__ __half __ldca(const __half *const ptr)**
 Generates a ld.global.ca load instruction.
- __device__ __half __ldcg(const __half *const ptr)**
 Generates a ld.global.cg load instruction.
- __device__ __half2 __ldcg(const __half2 *const ptr)**
 Generates a ld.global.cg load instruction.
- __device__ __half __ldcs(const __half *const ptr)**
 Generates a ld.global.cs load instruction.
- __device__ __half2 __ldcs(const __half2 *const ptr)**
 Generates a ld.global.cs load instruction.

- __device__ __half2 __ldcv(const __half2 *const ptr)**
Generates a ld.global.cv load instruction.
- __device__ __half __ldcv(const __half *const ptr)**
Generates a ld.global.cv load instruction.
- __device__ __half2 __ldg(const __half2 *const ptr)**
Generates a ld.global.nc load instruction.
- __device__ __half __ldg(const __half *const ptr)**
Generates a ld.global.nc load instruction.
- __device__ __half __ldlu(const __half *const ptr)**
Generates a ld.global.lu load instruction.
- __device__ __half2 __ldlu(const __half2 *const ptr)**
Generates a ld.global.lu load instruction.
- __host__ __device__ __half __ll2half_rd(const long long int i)**
Convert a signed 64-bit integer to a half in round-down mode.
- __host__ __device__ __half __ll2half_rn(const long long int i)**
Convert a signed 64-bit integer to a half in round-to-nearest-even mode.
- __host__ __device__ __half __ll2half_ru(const long long int i)**
Convert a signed 64-bit integer to a half in round-up mode.
- __host__ __device__ __half __ll2half_rz(const long long int i)**
Convert a signed 64-bit integer to a half in round-towards-zero mode.
- __host__ __device__ float __low2float(const __half2 a)**
Converts low 16 bits of half2 to float and returns the result.
- __host__ __device__ __half __low2half(const __half2 a)**
Returns low 16 bits of half2 input.
- __host__ __device__ __half2 __low2half2(const __half2 a)**
Extracts low 16 bits from half2 input.
- __host__ __device__ __half2 __lowhigh2highlow(const __half2 a)**
Swaps both halves of the half2 input.
- __host__ __device__ __half2 __lows2half2(const __half2 a, const __half2 b)**
Extracts low 16 bits from each of the two half2 inputs and combines into one half2 number.
- __device__ __half __shfl_down_sync(const unsigned int mask, const __half var, const unsigned int delta, const int width=warpSize)**
Exchange a variable between threads within a warp.
- __device__ __half2 __shfl_down_sync(const unsigned int mask, const __half2 var, const unsigned int delta, const int width=warpSize)**
Exchange a variable between threads within a warp.
- __device__ __half2 __shfl_sync(const unsigned int mask, const __half2 var, const int srcLane, const int width=warpSize)**
Exchange a variable between threads within a warp.
- __device__ __half __shfl_sync(const unsigned int mask, const __half var, const int srcLane, const int width=warpSize)**
Exchange a variable between threads within a warp.

__device__ __half2 __shfl_up_sync(const unsigned int mask, const __half2 var, const unsigned int delta, const int width=warpSize)

Exchange a variable between threads within a warp.

__device__ __half __shfl_up_sync(const unsigned int mask, const __half var, const unsigned int delta, const int width=warpSize)

Exchange a variable between threads within a warp.

__device__ __half2 __shfl_xor_sync(const unsigned int mask, const __half2 var, const int laneMask, const int width=warpSize)

Exchange a variable between threads within a warp.

__device__ __half __shfl_xor_sync(const unsigned int mask, const __half var, const int laneMask, const int width=warpSize)

Exchange a variable between threads within a warp.

__host__ __device__ __half __short2half_rd(const short int i)

Convert a signed short integer to a half in round-down mode.

__host__ __device__ __half __short2half_rn(const short int i)

Convert a signed short integer to a half in round-to-nearest-even mode.

__host__ __device__ __half __short2half_ru(const short int i)

Convert a signed short integer to a half in round-up mode.

__host__ __device__ __half __short2half_rz(const short int i)

Convert a signed short integer to a half in round-towards-zero mode.

__host__ __device__ __half __short_as_half(const short int i)

Reinterprets bits in a signed short integer as a half .

__device__ void __stcg(__half2 *const ptr, const __half2 value)

Generates a st.global.cg store instruction.

__device__ void __stcg(__half *const ptr, const __half value)

Generates a st.global.cg store instruction.

__device__ void __stcs(__half2 *const ptr, const __half2 value)

Generates a st.global.cs store instruction.

__device__ void __stcs(__half *const ptr, const __half value)

Generates a st.global.cs store instruction.

__device__ void __stwb(__half2 *const ptr, const __half2 value)

Generates a st.global.wb store instruction.

__device__ void __stwb(__half *const ptr, const __half value)

Generates a st.global.wb store instruction.

__device__ void __stwt(__half *const ptr, const __half value)

Generates a st.global.wt store instruction.

__device__ void __stwt(__half2 *const ptr, const __half2 value)

Generates a st.global.wt store instruction.

__host__ __device__ __half __uint2half_rd(const unsigned int i)

Convert an unsigned integer to a half in round-down mode.

__host__ __device__ __half __uint2half_rn(const unsigned int i)

Convert an unsigned integer to a half in round-to-nearest-even mode.

__host__ __device__ __half __uint2half_ru(const unsigned int i)

Convert an unsigned integer to a half in round-up mode.

- __host__ __device__ __half __uint2half_rz(const unsigned int i)**
Convert an unsigned integer to a half in round-towards-zero mode.
- __host__ __device__ __half __ull2half_rd(const unsigned long long int i)**
Convert an unsigned 64-bit integer to a half in round-down mode.
- __host__ __device__ __half __ull2half_rn(const unsigned long long int i)**
Convert an unsigned 64-bit integer to a half in round-to-nearest-even mode.
- __host__ __device__ __half __ull2half_ru(const unsigned long long int i)**
Convert an unsigned 64-bit integer to a half in round-up mode.
- __host__ __device__ __half __ull2half_rz(const unsigned long long int i)**
Convert an unsigned 64-bit integer to a half in round-towards-zero mode.
- __host__ __device__ __half __ushort2half_rd(const unsigned short int i)**
Convert an unsigned short integer to a half in round-down mode.
- __host__ __device__ __half __ushort2half_rn(const unsigned short int i)**
Convert an unsigned short integer to a half in round-to-nearest-even mode.
- __host__ __device__ __half __ushort2half_ru(const unsigned short int i)**
Convert an unsigned short integer to a half in round-up mode.
- __host__ __device__ __half __ushort2half_rz(const unsigned short int i)**
Convert an unsigned short integer to a half in round-towards-zero mode.
- __host__ __device__ __half __ushort_as_half(const unsigned short int i)**
Reinterprets bits in an unsigned short integer as a half .
- __host__ __device__ __half2 make_half2(const __half x, const __half y)**
Vector function, combines two __half numbers into one __half2 number.

2.5.1. Functions

- __host__ __device__ __half __double2half(const double a)**
Converts double number to half precision in round-to-nearest-even mode and returns half with converted value.
Converts double number a to half precision in round-to-nearest-even mode.
Parameters
a – [in] - double. Is only being read.
Returns
half
 - ▶ a converted to half precision using round-to-nearest-even mode.
 - ▶ __double2half (± 0) returns ± 0 .
 - ▶ __double2half ($\pm \infty$) returns $\pm \infty$.
 - ▶ __double2half(NaN) returns NaN.
- __host__ __device__ __half2 __float2half2_rn(const float2 a)**
Converts both components of float2 number to half precision in round-to-nearest-even mode and returns half2 with converted values.

Converts both components of `float2` to half precision in round-to-nearest-even mode and combines the results into one `half2` number. Low 16 bits of the return value correspond to a .x and high 16 bits of the return value correspond to a .y.

See also:

[__float2half_rn\(float\)](#) for further details.

Parameters

a – [in] - `float2`. Is only being read.

Returns

`half2`

- ▶ The `half2` which has corresponding halves equal to the converted `float2` components.

`__host__ __device__ __half __float2half`(const float a)

Converts float number to half precision in round-to-nearest-even mode and returns `half` with converted value.

Converts float number a to half precision in round-to-nearest-even mode.

See also:

[__float2half_rn\(float\)](#) for further details.

Parameters

a – [in] - `float`. Is only being read.

Returns

`half`

- ▶ a converted to half precision using round-to-nearest-even mode.

`__host__ __device__ __half2 __float2half2_rn`(const float a)

Converts input to half precision in round-to-nearest-even mode and populates both halves of `half2` with converted value.

Converts input a to half precision in round-to-nearest-even mode and populates both halves of `half2` with converted value.

See also:

[__float2half_rn\(float\)](#) for further details.

Parameters

a – [in] - `float`. Is only being read.

Returns

`half2`

- ▶ The `half2` value with both halves equal to the converted half precision number.

`__host__ __device__ __half __float2half_rd`(const float a)

Converts float number to half precision in round-down mode and returns `half` with converted value.

Converts float number a to half precision in round-down mode.

Parameters

a – [in] - float. Is only being read.

Returns

half

- ▶ a converted to half precision using round-down mode.
- ▶ `__float2half_rd` (± 0) returns ± 0 .
- ▶ `__float2half_rd` ($\pm \infty$) returns $\pm \infty$.
- ▶ `__float2half_rd`(NaN) returns NaN.

`__host__ __device__ __half __float2half_rn`(const float a)

Converts float number to half precision in round-to-nearest-even mode and returns `half` with converted value.

Converts float number a to half precision in round-to-nearest-even mode.

Parameters

a – [in] - float. Is only being read.

Returns

half

- ▶ a converted to half precision using round-to-nearest-even mode.
- ▶ `__float2half_rn` (± 0) returns ± 0 .
- ▶ `__float2half_rn` ($\pm \infty$) returns $\pm \infty$.
- ▶ `__float2half_rn`(NaN) returns NaN.

`__host__ __device__ __half __float2half_ru`(const float a)

Converts float number to half precision in round-up mode and returns `half` with converted value.

Converts float number a to half precision in round-up mode.

Parameters

a – [in] - float. Is only being read.

Returns

half

- ▶ a converted to half precision using round-up mode.
- ▶ `__float2half_ru` (± 0) returns ± 0 .
- ▶ `__float2half_ru` ($\pm \infty$) returns $\pm \infty$.
- ▶ `__float2half_ru`(NaN) returns NaN.

`__host__ __device__ __half __float2half_rz`(const float a)

Converts float number to half precision in round-towards-zero mode and returns `half` with converted value.

Converts float number a to half precision in round-towards-zero mode.

Parameters

a – [in] - float. Is only being read.

Returns

half

- ▶ a converted to half precision using round-towards-zero mode.

- ▶ `__float2half_rz` (± 0) returns ± 0 .
- ▶ `__float2half_rz` ($\pm \infty$) returns $\pm \infty$.
- ▶ `__float2half_rz`(NaN) returns NaN.

`__host__ __device__ __half2 __floats2half2_rn`(const float a, const float b)

Converts both input floats to half precision in round-to-nearest-even mode and returns `half2` with converted values.

Converts both input floats to half precision in round-to-nearest-even mode and combines the results into one `half2` number. Low 16 bits of the return value correspond to the input a, high 16 bits correspond to the input b.

See also:

[`__float2half_rn\(float\)`](#) for further details.

Parameters

- ▶ **a** - [in] - float. Is only being read.
- ▶ **b** - [in] - float. Is only being read.

Returns

`half2`

- ▶ The `half2` value with corresponding halves equal to the converted input floats.

`__host__ __device__ float2 __half22float2`(const `__half2` a)

Converts both halves of `half2` to `float2` and returns the result.

Converts both halves of `half2` input a to `float2` and returns the result.

See also:

[`__half2float\(__half\)`](#) for further details.

Parameters

a - [in] - `half2`. Is only being read.

Returns

`float2`

- ▶ a converted to `float2`.

`__host__ __device__ signed char __half2char_rz`(const `__half` h)

Convert a half to a signed char in round-towards-zero mode.

Convert the half-precision floating-point value h to a signed char integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h - [in] - `half`. Is only being read.

Returns

signed char

- ▶ h converted to a signed char using round-towards-zero mode.
- ▶ `__half2char_rz` (± 0) returns 0.
- ▶ `__half2char_rz` (x), $x > 127$ returns `SCHAR_MAX` = 0x7F.

- ▶ `__half2char_rz(x)`, $x < -128$ returns `SCHAR_MIN = 0x80`.
- ▶ `__half2char_rz(NaN)` returns 0.

`__host__ __device__ float __half2float(const __half a)`

Converts half number to float.

Converts half number a to float.

Parameters

a – [in] - float. Is only being read.

Returns

float

- ▶ a converted to float.
- ▶ `__half2float(±0)` returns $±0$.
- ▶ `__half2float(±∞)` returns $±∞$.
- ▶ `__half2float(NaN)` returns NaN.

`__host__ __device__ __half2 __half2half2(const __half a)`

Returns half2 with both halves equal to the input value.

Returns half2 number with both halves equal to the input a half number.

Parameters

a – [in] - half. Is only being read.

Returns

half2

- ▶ The vector which has both its halves equal to the input a.

`__device__ int __half2int_rd(const __half h)`

Convert a half to a signed integer in round-down mode.

Convert the half-precision floating-point value h to a signed integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

int

- ▶ h converted to a signed integer using round-down mode.
- ▶ `__half2int_rd(±0)` returns 0.
- ▶ `__half2int_rd(+∞)` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__half2int_rd(-∞)` returns `INT_MIN = 0x80000000`.
- ▶ `__half2int_rd(NaN)` returns 0.

`__device__ int __half2int_rn(const __half h)`

Convert a half to a signed integer in round-to-nearest-even mode.

Convert the half-precision floating-point value h to a signed integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

int

- ▶ h converted to a signed integer using round-to-nearest-even mode.
- ▶ `__half2int_rn(±0)` returns 0.
- ▶ `__half2int_rn(+∞)` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__half2int_rn(-∞)` returns `INT_MIN = 0x80000000`.
- ▶ `__half2int_rn(NaN)` returns 0.

`__device__ int __half2int_ru(const __half h)`

Convert a half to a signed integer in round-up mode.

Convert the half-precision floating-point value h to a signed integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

int

- ▶ h converted to a signed integer using round-up mode.
- ▶ `__half2int_ru(±0)` returns 0.
- ▶ `__half2int_ru(+∞)` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__half2int_ru(-∞)` returns `INT_MIN = 0x80000000`.
- ▶ `__half2int_ru(NaN)` returns 0.

`__host__ __device__ int __half2int_rz(const __half h)`

Convert a half to a signed integer in round-towards-zero mode.

Convert the half-precision floating-point value h to a signed integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

int

- ▶ h converted to a signed integer using round-towards-zero mode.
- ▶ `__half2int_rz(±0)` returns 0.
- ▶ `__half2int_rz(+∞)` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__half2int_rz(-∞)` returns `INT_MIN = 0x80000000`.
- ▶ `__half2int_rz(NaN)` returns 0.

`__device__ long long int __half211_rd(const __half h)`

Convert a half to a signed 64-bit integer in round-down mode.

Convert the half-precision floating-point value h to a signed 64-bit integer in round-down mode. NaN inputs return a long long int with hex value of `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

long long int

- ▶ h converted to a signed 64-bit integer using round-down mode.
- ▶ `__half2ll_rd(±0)` returns 0.
- ▶ `__half2ll_rd(+∞)` returns `LLONG_MAX = 0x7FFFFFFFFFFFFFFF`.
- ▶ `__half2ll_rd(-∞)` returns `LLONG_MIN = 0x8000000000000000`.
- ▶ `__half2ll_rd(NaN)` returns `0x8000000000000000`.

`__device__` long long int `__half2ll_rn(const __half h)`

Convert a half to a signed 64-bit integer in round-to-nearest-even mode.

Convert the half-precision floating-point value h to a signed 64-bit integer in round-to-nearest-even mode. NaN inputs return a long long int with hex value of `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

long long int

- ▶ h converted to a signed 64-bit integer using round-to-nearest-even mode.
- ▶ `__half2ll_rn(±0)` returns 0.
- ▶ `__half2ll_rn(+∞)` returns `LLONG_MAX = 0x7FFFFFFFFFFFFFFF`.
- ▶ `__half2ll_rn(-∞)` returns `LLONG_MIN = 0x8000000000000000`.
- ▶ `__half2ll_rn(NaN)` returns `0x8000000000000000`.

`__device__` long long int `__half2ll_ru(const __half h)`

Convert a half to a signed 64-bit integer in round-up mode.

Convert the half-precision floating-point value h to a signed 64-bit integer in round-up mode. NaN inputs return a long long int with hex value of `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

long long int

- ▶ h converted to a signed 64-bit integer using round-up mode.
- ▶ `__half2ll_ru(±0)` returns 0.
- ▶ `__half2ll_ru(+∞)` returns `LLONG_MAX = 0x7FFFFFFFFFFFFFFF`.
- ▶ `__half2ll_ru(-∞)` returns `LLONG_MIN = 0x8000000000000000`.
- ▶ `__half2ll_ru(NaN)` returns `0x8000000000000000`.

`__host__ __device__` long long int `__half2ll_rz(const __half h)`

Convert a half to a signed 64-bit integer in round-towards-zero mode.

Convert the half-precision floating-point value h to a signed 64-bit integer in round-towards-zero mode. NaN inputs return a long long int with hex value of `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

long long int

- ▶ h converted to a signed 64-bit integer using round-towards-zero mode.
- ▶ `__half2ll_rz` (± 0) returns 0.
- ▶ `__half2ll_rz` ($+\infty$) returns `LLONG_MAX` = 0x7FFFFFFFFFFFFFFF.
- ▶ `__half2ll_rz` ($-\infty$) returns `LLONG_MIN` = 0x8000000000000000.
- ▶ `__half2ll_rz`(NaN) returns 0x8000000000000000.

`__device__` short int `__half2short_rd`(const `__half` h)

Convert a half to a signed short integer in round-down mode.

Convert the half-precision floating-point value h to a signed short integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

short int

- ▶ h converted to a signed short integer using round-down mode.
- ▶ `__half2short_rd` (± 0) returns 0.
- ▶ `__half2short_rd` (x), $x > 32767$ returns `SHRT_MAX` = 0x7FFF.
- ▶ `__half2short_rd` (x), $x < -32768$ returns `SHRT_MIN` = 0x8000.
- ▶ `__half2short_rd`(NaN) returns 0.

`__device__` short int `__half2short_rn`(const `__half` h)

Convert a half to a signed short integer in round-to-nearest-even mode.

Convert the half-precision floating-point value h to a signed short integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

short int

- ▶ h converted to a signed short integer using round-to-nearest-even mode.
- ▶ `__half2short_rn` (± 0) returns 0.
- ▶ `__half2short_rn` (x), $x > 32767$ returns `SHRT_MAX` = 0x7FFF.
- ▶ `__half2short_rn` (x), $x < -32768$ returns `SHRT_MIN` = 0x8000.
- ▶ `__half2short_rn`(NaN) returns 0.

`__device__` short int `__half2short_ru`(const `__half` h)

Convert a half to a signed short integer in round-up mode.

Convert the half-precision floating-point value h to a signed short integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

short int

- ▶ h converted to a signed short integer using round-up mode.
- ▶ `__half2short_ru(±0)` returns 0.
- ▶ `__half2short_ru(x), x > 32767` returns `SHRT_MAX = 0x7FFF`.
- ▶ `__half2short_ru(x), x < -32768` returns `SHRT_MIN = 0x8000`.
- ▶ `__half2short_ru(NaN)` returns 0.

`__host__ __device__ short int __half2short_rz(const __half h)`

Convert a half to a signed short integer in round-towards-zero mode.

Convert the half-precision floating-point value h to a signed short integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

short int

- ▶ h converted to a signed short integer using round-towards-zero mode.
- ▶ `__half2short_rz(±0)` returns 0.
- ▶ `__half2short_rz(x), x > 32767` returns `SHRT_MAX = 0x7FFF`.
- ▶ `__half2short_rz(x), x < -32768` returns `SHRT_MIN = 0x8000`.
- ▶ `__half2short_rz(NaN)` returns 0.

`__host__ __device__ unsigned char __half2uchar_rz(const __half h)`

Convert a half to an unsigned char in round-towards-zero mode.

Convert the half-precision floating-point value h to an unsigned char in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned char

- ▶ h converted to an unsigned char using round-towards-zero mode.
- ▶ `__half2uchar_rz(±0)` returns 0.
- ▶ `__half2uchar_rz(x), x > 255` returns `UCHAR_MAX = 0xFF`.
- ▶ `__half2uchar_rz(x), x < 0.0` returns 0.
- ▶ `__half2uchar_rz(NaN)` returns 0.

`__device__ unsigned int __half2uint_rd(const __half h)`

Convert a half to an unsigned integer in round-down mode.

Convert the half-precision floating-point value h to an unsigned integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned int

- ▶ h converted to an unsigned integer using round-down mode.
- ▶ `__half2uint_rd(±0)` returns 0.
- ▶ `__half2uint_rd(+∞)` returns `UINT_MAX = 0xFFFFFFFF`.
- ▶ `__half2uint_rd(x), x < 0.0` returns 0.
- ▶ `__half2uint_rd(NaN)` returns 0.

`__device__` unsigned int `__half2uint_rn(const __half h)`

Convert a half to an unsigned integer in round-to-nearest-even mode.

Convert the half-precision floating-point value h to an unsigned integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned int

- ▶ h converted to an unsigned integer using round-to-nearest-even mode.
- ▶ `__half2uint_rn(±0)` returns 0.
- ▶ `__half2uint_rn(+∞)` returns `UINT_MAX = 0xFFFFFFFF`.
- ▶ `__half2uint_rn(x), x < 0.0` returns 0.
- ▶ `__half2uint_rn(NaN)` returns 0.

`__device__` unsigned int `__half2uint_ru(const __half h)`

Convert a half to an unsigned integer in round-up mode.

Convert the half-precision floating-point value h to an unsigned integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned int

- ▶ h converted to an unsigned integer using round-up mode.
- ▶ `__half2uint_ru(±0)` returns 0.
- ▶ `__half2uint_ru(+∞)` returns `UINT_MAX = 0xFFFFFFFF`.
- ▶ `__half2uint_ru(x), x < 0.0` returns 0.
- ▶ `__half2uint_ru(NaN)` returns 0.

`__host__ __device__` unsigned int `__half2uint_rz(const __half h)`

Convert a half to an unsigned integer in round-towards-zero mode.

Convert the half-precision floating-point value h to an unsigned integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned int

- ▶ `h` converted to an unsigned integer using round-towards-zero mode.
- ▶ `__half2uint_rz(±0)` returns 0.
- ▶ `__half2uint_rz(+∞)` returns `UINT_MAX = 0xFFFFFFFF`.
- ▶ `__half2uint_rz(x), x < 0.0` returns 0.
- ▶ `__half2uint_rz(NaN)` returns 0.

`__device__` unsigned long long int `__half2ull_rd(const __half h)`

Convert a half to an unsigned 64-bit integer in round-down mode.

Convert the half-precision floating-point value `h` to an unsigned 64-bit integer in round-down mode. NaN inputs return `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned long long int

- ▶ `h` converted to an unsigned 64-bit integer using round-down mode.
- ▶ `__half2ull_rd(±0)` returns 0.
- ▶ `__half2ull_rd(+∞)` returns `ULLONG_MAX = 0xFFFFFFFFFFFFFFFF`.
- ▶ `__half2ull_rd(x), x < 0.0` returns 0.
- ▶ `__half2ull_rd(NaN)` returns `0x8000000000000000`.

`__device__` unsigned long long int `__half2ull_rn(const __half h)`

Convert a half to an unsigned 64-bit integer in round-to-nearest-even mode.

Convert the half-precision floating-point value `h` to an unsigned 64-bit integer in round-to-nearest-even mode. NaN inputs return `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned long long int

- ▶ `h` converted to an unsigned 64-bit integer using round-to-nearest-even mode.
- ▶ `__half2ull_rn(±0)` returns 0.
- ▶ `__half2ull_rn(+∞)` returns `ULLONG_MAX = 0xFFFFFFFFFFFFFFFF`.
- ▶ `__half2ull_rn(x), x < 0.0` returns 0.
- ▶ `__half2ull_rn(NaN)` returns `0x8000000000000000`.

`__device__` unsigned long long int `__half2ull_ru(const __half h)`

Convert a half to an unsigned 64-bit integer in round-up mode.

Convert the half-precision floating-point value `h` to an unsigned 64-bit integer in round-up mode. NaN inputs return `0x8000000000000000`.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned long long int

- ▶ `h` converted to an unsigned 64-bit integer using round-up mode.
- ▶ `__half2ull_ru(±0)` returns 0.
- ▶ `__half2ull_ru(+∞)` returns `ULLONG_MAX = 0xFFFFFFFFFFFFFFFF`.
- ▶ `__half2ull_ru(x), x < 0.0` returns 0.
- ▶ `__half2ull_ru(NaN)` returns `0x8000000000000000`.

`__host__ __device__` unsigned long long int `__half2ull_rz(const __half h)`

Convert a half to an unsigned 64-bit integer in round-towards-zero mode.

Convert the half-precision floating-point value `h` to an unsigned 64-bit integer in round-towards-zero mode. NaN inputs return `0x8000000000000000`.

Parameters

`h` – [in] - half. Is only being read.

Returns

unsigned long long int

- ▶ `h` converted to an unsigned 64-bit integer using round-towards-zero mode.
- ▶ `__half2ull_rz(±0)` returns 0.
- ▶ `__half2ull_rz(+∞)` returns `ULLONG_MAX = 0xFFFFFFFFFFFFFFFF`.
- ▶ `__half2ull_rz(x), x < 0.0` returns 0.
- ▶ `__half2ull_rz(NaN)` returns `0x8000000000000000`.

`__device__` unsigned short int `__half2ushort_rd(const __half h)`

Convert a half to an unsigned short integer in round-down mode.

Convert the half-precision floating-point value `h` to an unsigned short integer in round-down mode. NaN inputs are converted to 0.

Parameters

`h` – [in] - half. Is only being read.

Returns

unsigned short int

- ▶ `h` converted to an unsigned short integer using round-down mode.
- ▶ `__half2ushort_rd(±0)` returns 0.
- ▶ `__half2ushort_rd(+∞)` returns `USHRT_MAX = 0xFFFF`.
- ▶ `__half2ushort_rd(x), x < 0.0` returns 0.
- ▶ `__half2ushort_rd(NaN)` returns 0.

`__device__` unsigned short int `__half2ushort_rn(const __half h)`

Convert a half to an unsigned short integer in round-to-nearest-even mode.

Convert the half-precision floating-point value `h` to an unsigned short integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

`h` – [in] - half. Is only being read.

Returns

unsigned short int

- ▶ `h` converted to an unsigned short integer using round-to-nearest-even mode.
- ▶ `__half2ushort_rn(±0)` returns 0.
- ▶ `__half2ushort_rn(+∞)` returns `USHRT_MAX = 0xFFFF`.
- ▶ `__half2ushort_rn(x), x < 0.0` returns 0.
- ▶ `__half2ushort_rn(NaN)` returns 0.

`__device__` unsigned short int **__half2ushort_ru**(const `__half` `h`)

Convert a half to an unsigned short integer in round-up mode.

Convert the half-precision floating-point value `h` to an unsigned short integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned short int

- ▶ `h` converted to an unsigned short integer using round-up mode.
- ▶ `__half2ushort_ru(±0)` returns 0.
- ▶ `__half2ushort_ru(+∞)` returns `USHRT_MAX = 0xFFFF`.
- ▶ `__half2ushort_ru(x), x < 0.0` returns 0.
- ▶ `__half2ushort_ru(NaN)` returns 0.

`__host__ __device__` unsigned short int **__half2ushort_rz**(const `__half` `h`)

Convert a half to an unsigned short integer in round-towards-zero mode.

Convert the half-precision floating-point value `h` to an unsigned short integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - half. Is only being read.

Returns

unsigned short int

- ▶ `h` converted to an unsigned short integer using round-towards-zero mode.
- ▶ `__half2ushort_rz(±0)` returns 0.
- ▶ `__half2ushort_rz(+∞)` returns `USHRT_MAX = 0xFFFF`.
- ▶ `__half2ushort_rz(x), x < 0.0` returns 0.
- ▶ `__half2ushort_rz(NaN)` returns 0.

`__host__ __device__` short int **__half_as_short**(const `__half` `h`)

Reinterprets bits in a half as a signed short integer.

Reinterprets the bits in the half-precision floating-point number `h` as a signed short integer.

Parameters

h – [in] - half. Is only being read.

Returns

short int

- ▶ The reinterpreted value.

`__host__ __device__ unsigned short int __half_as_ushort(const __half h)`

Reinterprets bits in a `half` as an unsigned short integer.

Reinterprets the bits in the half-precision floating-point `h` as an unsigned short number.

Parameters

h – [in] - `half`. Is only being read.

Returns

unsigned short int

- ▶ The reinterpreted value.

`__host__ __device__ __half2 __halves2half2(const __half a, const __half b)`

Combines two `half` numbers into one `half2` number.

Combines two input `half` number `a` and `b` into one `half2` number. Input `a` is stored in low 16 bits of the return value, input `b` is stored in high 16 bits of the return value.

Parameters

- ▶ **a** – [in] - `half`. Is only being read.

- ▶ **b** – [in] - `half`. Is only being read.

Returns

`half2`

- ▶ The `half2` with one `half` equal to `a` and the other to `b`.

`__host__ __device__ float __high2float(const __half2 a)`

Converts high 16 bits of `half2` to `float` and returns the result.

Converts high 16 bits of `half2` input `a` to 32-bit floating-point number and returns the result.

See also:

[`__half2float\(__half\)`](#) for further details.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`float`

- ▶ The high 16 bits of `a` converted to `float`.

`__host__ __device__ __half __high2half(const __half2 a)`

Returns high 16 bits of `half2` input.

Returns high 16 bits of `half2` input `a`.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half`

- ▶ The high 16 bits of the input.

`__host__ __device__ __half2 __high2half2(const __half2 a)`

Extracts high 16 bits from half2 input.

Extracts high 16 bits from half2 input a and returns a new half2 number which has both halves equal to the extracted bits.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The half2 with both halves equal to the high 16 bits of the input.

`__host__ __device__ __half2 __highs2half2(const __half2 a, const __half2 b)`

Extracts high 16 bits from each of the two half2 inputs and combines into one half2 number.

Extracts high 16 bits from each of the two half2 inputs and combines into one half2 number. High 16 bits from input a is stored in low 16 bits of the return value, high 16 bits from input b is stored in high 16 bits of the return value.

Parameters

- ▶ **a** – [in] - half2. Is only being read.

- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The high 16 bits of a and of b.

`__host__ __device__ __half __int2half_rd(const int i)`

Convert a signed integer to a half in round-down mode.

Convert the signed integer value i to a half-precision floating-point value in round-down mode.

Parameters

i – [in] - int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __int2half_rn(const int i)`

Convert a signed integer to a half in round-to-nearest-even mode.

Convert the signed integer value i to a half-precision floating-point value in round-to-nearest-even mode.

Parameters

i – [in] - int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __int2half_ru(const int i)`

Convert a signed integer to a half in round-up mode.

Convert the signed integer value i to a half-precision floating-point value in round-up mode.

Parameters

i – [in] - int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __int2half_rz(const int i)`

Convert a signed integer to a half in round-towards-zero mode.

Convert the signed integer value *i* to a half-precision floating-point value in round-towards-zero mode.

Parameters

i – [in] - int. Is only being read.

Returns

half

- ▶ i converted to half.

`__device__ __half2 __ldca(const __half2 *const ptr)`

Generates a `ld.global.ca` load instruction.

Parameters

ptr – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __half __ldca(const __half *const ptr)`

Generates a `ld.global.ca` load instruction.

Parameters

ptr – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __half __ldcg(const __half *const ptr)`

Generates a `ld.global.cg` load instruction.

Parameters

ptr – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __half2 __ldcg(const __half2 *const ptr)`

Generates a `ld.global.cg` load instruction.

Parameters

ptr – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __half __ldcs(const __half *const ptr)`

Generates a `ld.global.cs` load instruction.

Parameters

ptr – [in] - memory location

Returns

The value pointed by ptr

`__device__ __half2 __ldcs(const __half2 *const ptr)`

Generates a `ld.global.cs` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by ptr

`__device__ __half2 __ldcv(const __half2 *const ptr)`

Generates a `ld.global.cv` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by ptr

`__device__ __half __ldcv(const __half *const ptr)`

Generates a `ld.global.cv` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by ptr

`__device__ __half2 __ldg(const __half2 *const ptr)`

Generates a `ld.global.nc` load instruction.

`defined(CUDA_ARCH) || (CUDA_ARCH >= 300)`

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by ptr

`__device__ __half __ldg(const __half *const ptr)`

Generates a `ld.global.nc` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by ptr

`__device__ __half __ldlu(const __half *const ptr)`

Generates a `ld.global.lu` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by ptr

`__device__ __half2 __ldlu(const __half2 *const ptr)`

Generates a `ld.global.lu` load instruction.

Parameters

ptr – [in] - memory location

Returns

The value pointed by ptr

`__host__ __device__ __half __112half_rd(const long long int i)`

Convert a signed 64-bit integer to a half in round-down mode.

Convert the signed 64-bit integer value `i` to a half-precision floating-point value in round-down mode.

Parameters

i – [in] - long long int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __112half_rn(const long long int i)`

Convert a signed 64-bit integer to a half in round-to-nearest-even mode.

Convert the signed 64-bit integer value `i` to a half-precision floating-point value in round-to-nearest-even mode.

Parameters

i – [in] - long long int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __112half_ru(const long long int i)`

Convert a signed 64-bit integer to a half in round-up mode.

Convert the signed 64-bit integer value `i` to a half-precision floating-point value in round-up mode.

Parameters

i – [in] - long long int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __112half_rz(const long long int i)`

Convert a signed 64-bit integer to a half in round-towards-zero mode.

Convert the signed 64-bit integer value `i` to a half-precision floating-point value in round-towards-zero mode.

Parameters

i – [in] - long long int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ float __low2float(const __half2 a)`

Converts low 16 bits of `half2` to float and returns the result.

Converts low 16 bits of `half2` input `a` to 32-bit floating-point number and returns the result.

See also:

`__half2float(__half)` for further details.

Parameters

a – [in] - `half2`. Is only being read.

Returns

float

- ▶ The low 16 bits of `a` converted to float.

`__host__ __device__ __half __low2half(const __half2 a)`

Returns low 16 bits of `half2` input.

Returns low 16 bits of `half2` input `a`.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half`

- ▶ Returns `half` which contains low 16 bits of the input `a`.

`__host__ __device__ __half2 __low2half2(const __half2 a)`

Extracts low 16 bits from `half2` input.

Extracts low 16 bits from `half2` input `a` and returns a new `half2` number which has both halves equal to the extracted bits.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The `half2` with both halves equal to the low 16 bits of the input.

`__host__ __device__ __half2 __lowhigh2highlow(const __half2 a)`

Swaps both halves of the `half2` input.

Swaps both halves of the `half2` input and returns a new `half2` number with swapped halves.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ `a` with its halves being swapped.

`__host__ __device__ __half2 __lows2half2(const __half2 a, const __half2 b)`

Extracts low 16 bits from each of the two `half2` inputs and combines into one `half2` number.

Extracts low 16 bits from each of the two `half2` inputs and combines into one `half2` number. Low 16 bits from input `a` is stored in low 16 bits of the return value, low 16 bits from input `b` is stored in high 16 bits of the return value.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The low 16 bits of a and of b.

`__device__ __half __shfl_down_sync` (const unsigned int mask, const `__half` var, const unsigned int delta, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread with higher ID relative to the caller.

Calculates a source thread ID by adding `delta` to the caller's thread ID. The value of `var` held by the resulting thread ID is returned: this has the effect of shifting `var` down the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. As for `__shfl_up_sync()`, the ID number of the source thread will not wrap around the value of `width` and so the upper `delta` threads will remain unchanged. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – [in] - half. Is only being read.
- ▶ **delta** – [in] - unsigned int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `half`.

`__device__ __half2 __shfl_down_sync` (const unsigned int mask, const `__half2` var, const unsigned int delta, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread with higher ID relative to the caller.

Calculates a source thread ID by adding `delta` to the caller's thread ID. The value of `var` held by the resulting thread ID is returned: this has the effect of shifting `var` down the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. As for `__shfl_up_sync()`, the ID number of the source thread will not wrap around the value of `width` and so the upper `delta` threads will remain unchanged. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – [in] - half2. Is only being read.
- ▶ **delta** – [in] - unsigned int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 4-byte word referenced by `var` from the source thread ID as `half2`.

```
__device__ __half2 __shfl_sync(const unsigned int mask, const __half2 var, const int srcLane,
                               const int width = warpSize)
```

Exchange a variable between threads within a warp.

Direct copy from indexed thread.

Returns the value of `var` held by the thread whose ID is given by `srcLane`. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. If `srcLane` is outside the range `[0:width-1]`, the value returned corresponds to the value of `var` held by the `srcLane` modulo `width` (i.e. within the same subsection). `width` must have a value which is a power of 2; results are undefined if `width` is not a power of 2, or is a number greater than `warpSize`. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – **[in]** - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the **mask** and all non-exited threads named in **mask** must execute the same intrinsic with the same **mask**, or the result is undefined.
- ▶ **var** – **[in]** - half2. Is only being read.
- ▶ **srcLane** – **[in]** - int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 4-byte word referenced by **var** from the source thread ID as **half2**.

`__device__ __half __shfl_sync` (const unsigned int mask, const `__half` var, const int srcLane, const int width = warpSize)

Exchange a variable between threads within a warp.

Direct copy from indexed thread.

Returns the value of **var** held by the thread whose ID is given by **srcLane**. If **width** is less than **warpSize** then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. If **srcLane** is outside the range [0:width-1], the value returned corresponds to the value of **var** held by the **srcLane** modulo **width** (i.e. within the same subsection). **width** must have a value which is a power of 2; results are undefined if **width** is not a power of 2, or is a number greater than **warpSize**. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – **[in]** - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the **mask** and all non-exited threads named in **mask** must execute the same intrinsic with the same **mask**, or the result is undefined.
- ▶ **var** – **[in]** - half. Is only being read.
- ▶ **srcLane** – **[in]** - int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `half`.

`__device__ __half __shfl_up_sync` (const unsigned int mask, const `__half` var, const unsigned int delta, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread with lower ID relative to the caller.

Calculates a source thread ID by subtracting `delta` from the caller's lane ID. The value of `var` held by the resulting lane ID is returned: in effect, `var` is shifted up the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. The source thread index will not wrap around the value of `width`, so effectively the lower `delta` threads will be unchanged. `width` must have a value which is a power of 2; results are undefined if `width` is not a power of 2, or is a number greater than `warpSize`. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – [in] - `half2`. Is only being read.
- ▶ **delta** – [in] - unsigned int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 4-byte word referenced by `var` from the source thread ID as `half2`.

`__device__ __half __shfl_up_sync` (const unsigned int mask, const `__half` var, const unsigned int delta, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread with lower ID relative to the caller.

Calculates a source thread ID by subtracting `delta` from the caller's lane ID. The value of `var` held by the resulting lane ID is returned: in effect, `var` is shifted up the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. The source thread index will not wrap around the value of `width`, so effectively the lower `delta` threads will be unchanged. `width` must have a value which is a power of 2; results are undefined if `width` is not a power of 2, or is a number greater than

warpSize. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread’s lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – [in] - half. Is only being read.
- ▶ **delta** – [in] - unsigned int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `half`.

`__device__ __half2 __shfl_xor_sync`(const unsigned int mask, const `__half2` var, const int laneMask, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread based on bitwise XOR of own thread ID.

Calculates a source thread ID by performing a bitwise XOR of the caller’s thread ID with `laneMask`: the value of `var` held by the resulting thread ID is returned. If `width` is less than `warpSize` then each group of `width` consecutive threads are able to access elements from earlier groups of threads, however if they attempt to access elements from later groups of threads their own value of `var` will be returned. This mode implements a butterfly addressing pattern such as is used in tree reduction and broadcast. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.

- ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
- ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** - [**in**] - half2. Is only being read.
- ▶ **laneMask** - [**in**] - int. Is only being read.
- ▶ **width** - [**in**] - int. Is only being read.

Returns

Returns the 4-byte word referenced by `var` from the source thread ID as `half2`.

`__device__ __half __shfl_xor_sync`(const unsigned int mask, const `__half` var, const int laneMask, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread based on bitwise XOR of own thread ID.

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with `laneMask`: the value of `var` held by the resulting thread ID is returned. If `width` is less than `warpSize` then each group of `width` consecutive threads are able to access elements from earlier groups of threads, however if they attempt to access elements from later groups of threads their own value of `var` will be returned. This mode implements a butterfly addressing pattern such as is used in tree reduction and broadcast. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** - [**in**] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** - [**in**] - half. Is only being read.
- ▶ **laneMask** - [**in**] - int. Is only being read.
- ▶ **width** - [**in**] - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `half`.

`__host__ __device__ __half __short2half_rd`(const short int i)

Convert a signed short integer to a half in round-down mode.

Convert the signed short integer value `i` to a half-precision floating-point value in round-down mode.

Parameters

`i` – [in] - short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __short2half_rn`(const short int i)

Convert a signed short integer to a half in round-to-nearest-even mode.

Convert the signed short integer value `i` to a half-precision floating-point value in round-to-nearest-even mode.

Parameters

`i` – [in] - short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __short2half_ru`(const short int i)

Convert a signed short integer to a half in round-up mode.

Convert the signed short integer value `i` to a half-precision floating-point value in round-up mode.

Parameters

`i` – [in] - short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __short2half_rz`(const short int i)

Convert a signed short integer to a half in round-towards-zero mode.

Convert the signed short integer value `i` to a half-precision floating-point value in round-towards-zero mode.

Parameters

`i` – [in] - short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __short_as_half`(const short int i)

Reinterprets bits in a signed short integer as a half.

Reinterprets the bits in the signed short integer `i` as a half-precision floating-point number.

Parameters

`i` – [in] - short int. Is only being read.

Returns

half

- ▶ The reinterpreted value.

`__device__ void __stcg(__half2 *const ptr, const __half2 value)`

Generates a `st.global.cg` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stcg(__half *const ptr, const __half value)`

Generates a `st.global.cg` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stcs(__half2 *const ptr, const __half2 value)`

Generates a `st.global.cs` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stcs(__half *const ptr, const __half value)`

Generates a `st.global.cs` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stwb(__half2 *const ptr, const __half2 value)`

Generates a `st.global.wb` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stwb(__half *const ptr, const __half value)`

Generates a `st.global.wb` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stwt(__half *const ptr, const __half value)`

Generates a `st.global.wt` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__device__ void __stwt(__half2 *const ptr, const __half2 value)`

Generates a `st.global.wt` store instruction.

Parameters

- ▶ **ptr** - [out] - memory location
- ▶ **value** - [in] - the value to be stored

`__host__ __device__ __half __uint2half_rd(const unsigned int i)`

Convert an unsigned integer to a half in round-down mode.

Convert the unsigned integer value `i` to a half-precision floating-point value in round-down mode.

Parameters

- i** - [in] - unsigned int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __uint2half_rn(const unsigned int i)`

Convert an unsigned integer to a half in round-to-nearest-even mode.

Convert the unsigned integer value `i` to a half-precision floating-point value in round-to-nearest-even mode.

Parameters

- i** - [in] - unsigned int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __uint2half_ru(const unsigned int i)`

Convert an unsigned integer to a half in round-up mode.

Convert the unsigned integer value `i` to a half-precision floating-point value in round-up mode.

Parameters

- i** - [in] - unsigned int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __uint2half_rz(const unsigned int i)`

Convert an unsigned integer to a half in round-towards-zero mode.

Convert the unsigned integer value `i` to a half-precision floating-point value in round-towards-zero mode.

Parameters

i – [in] - unsigned int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __u112half_rd(const unsigned long long int i)`

Convert an unsigned 64-bit integer to a half in round-down mode.

Convert the unsigned 64-bit integer value *i* to a half-precision floating-point value in round-down mode.

Parameters

i – [in] - unsigned long long int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __u112half_rn(const unsigned long long int i)`

Convert an unsigned 64-bit integer to a half in round-to-nearest-even mode.

Convert the unsigned 64-bit integer value *i* to a half-precision floating-point value in round-to-nearest-even mode.

Parameters

i – [in] - unsigned long long int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __u112half_ru(const unsigned long long int i)`

Convert an unsigned 64-bit integer to a half in round-up mode.

Convert the unsigned 64-bit integer value *i* to a half-precision floating-point value in round-up mode.

Parameters

i – [in] - unsigned long long int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __u112half_rz(const unsigned long long int i)`

Convert an unsigned 64-bit integer to a half in round-towards-zero mode.

Convert the unsigned 64-bit integer value *i* to a half-precision floating-point value in round-towards-zero mode.

Parameters

i – [in] - unsigned long long int. Is only being read.

Returns

half

- ▶ i converted to half.

`__host__ __device__ __half __ushort2half_rd`(const unsigned short int i)

Convert an unsigned short integer to a half in round-down mode.

Convert the unsigned short integer value `i` to a half-precision floating-point value in round-down mode.

Parameters

`i` - [in] - unsigned short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __ushort2half_rn`(const unsigned short int i)

Convert an unsigned short integer to a half in round-to-nearest-even mode.

Convert the unsigned short integer value `i` to a half-precision floating-point value in round-to-nearest-even mode.

Parameters

`i` - [in] - unsigned short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __ushort2half_ru`(const unsigned short int i)

Convert an unsigned short integer to a half in round-up mode.

Convert the unsigned short integer value `i` to a half-precision floating-point value in round-up mode.

Parameters

`i` - [in] - unsigned short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __ushort2half_rz`(const unsigned short int i)

Convert an unsigned short integer to a half in round-towards-zero mode.

Convert the unsigned short integer value `i` to a half-precision floating-point value in round-towards-zero mode.

Parameters

`i` - [in] - unsigned short int. Is only being read.

Returns

half

- ▶ `i` converted to half.

`__host__ __device__ __half __ushort_as_half`(const unsigned short int i)

Reinterprets bits in an unsigned short integer as a half.

Reinterprets the bits in the unsigned short integer `i` as a half-precision floating-point number.

Parameters

`i` - [in] - unsigned short int. Is only being read.

Returns

half

- ▶ The reinterpreted value.

`__host__ __device__ __half2 make_half2(const __half x, const __half y)`

Vector function, combines two `__half` numbers into one `__half2` number.

Combines two input `__half` number x and y into one `__half2` number. Input x is stored in low 16 bits of the return value, input y is stored in high 16 bits of the return value.

Parameters

- ▶ **x** - [in] - half. Is only being read.
- ▶ **y** - [in] - half. Is only being read.

Returns

`__half2`

- ▶ The `__half2` vector with one half equal to x and the other to y.

2.6. Half2 Arithmetic Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

`__host__ __device__ __half2 h2div(const __half2 a, const __half2 b)`

Performs `half2` vector division in round-to-nearest-even mode.

`__host__ __device__ __half2 habs2(const __half2 a)`

Calculates the absolute value of both halves of the input `half2` number and returns the result.

`__host__ __device__ __half2 hadd2(const __half2 a, const __half2 b)`

Performs `half2` vector addition in round-to-nearest-even mode.

`__host__ __device__ __half2 hadd2_rn(const __half2 a, const __half2 b)`

Performs `half2` vector addition in round-to-nearest-even mode.

`__host__ __device__ __half2 hadd2_sat(const __half2 a, const __half2 b)`

Performs `half2` vector addition in round-to-nearest-even mode, with saturation to [0.0, 1.0].

`__device__ __half2 hcmadd(const __half2 a, const __half2 b, const __half2 c)`

Performs fast complex multiply-accumulate.

`__device__ __half2 hfma2(const __half2 a, const __half2 b, const __half2 c)`

Performs `half2` vector fused multiply-add in round-to-nearest-even mode.

`__device__ __half2 hfma2_relu(const __half2 a, const __half2 b, const __half2 c)`

Performs `half2` vector fused multiply-add in round-to-nearest-even mode with relu saturation.

`__device__ __half2 hfma2_sat(const __half2 a, const __half2 b, const __half2 c)`

Performs `half2` vector fused multiply-add in round-to-nearest-even mode, with saturation to [0.0, 1.0].

- __host__ __device__ __half2 __hmul2(const __half2 a, const __half2 b)**
 Performs half2 vector multiplication in round-to-nearest-even mode.
- __host__ __device__ __half2 __hmul2_rn(const __half2 a, const __half2 b)**
 Performs half2 vector multiplication in round-to-nearest-even mode.
- __host__ __device__ __half2 __hmul2_sat(const __half2 a, const __half2 b)**
 Performs half2 vector multiplication in round-to-nearest-even mode, with saturation to [0.0, 1.0].
- __host__ __device__ __half2 __hneg2(const __half2 a)**
 Negates both halves of the input half2 number and returns the result.
- __host__ __device__ __half2 __hsub2(const __half2 a, const __half2 b)**
 Performs half2 vector subtraction in round-to-nearest-even mode.
- __host__ __device__ __half2 __hsub2_rn(const __half2 a, const __half2 b)**
 Performs half2 vector subtraction in round-to-nearest-even mode.
- __host__ __device__ __half2 __hsub2_sat(const __half2 a, const __half2 b)**
 Performs half2 vector subtraction in round-to-nearest-even mode, with saturation to [0.0, 1.0].
- __device__ __half2 atomicAdd(__half2 *const address, const __half2 val)**
 Vector add val to the value stored at address in global or shared memory, and writes this value back to address .
- __host__ __device__ __half2 operator*(const __half2 &lh, const __half2 &rh)**
 Performs packed half multiplication operation.
- __host__ __device__ __half2 & operator*=(__half2 &lh, const __half2 &rh)**
 Performs packed half compound assignment with multiplication operation.
- __host__ __device__ __half2 operator+(const __half2 &h)**
 Implements packed half unary plus operator, returns input value.
- __host__ __device__ __half2 operator+(const __half2 &lh, const __half2 &rh)**
 Performs packed half addition operation.
- __host__ __device__ __half2 operator++(__half2 &h, const int ignored)**
 Performs packed half postfix increment operation.
- __host__ __device__ __half2 & operator++(__half2 &h)**
 Performs packed half prefix increment operation.
- __host__ __device__ __half2 & operator+=(__half2 &lh, const __half2 &rh)**
 Performs packed half compound assignment with addition operation.
- __host__ __device__ __half2 operator-(const __half2 &h)**
 Implements packed half unary minus operator.
- __host__ __device__ __half2 operator-(const __half2 &lh, const __half2 &rh)**
 Performs packed half subtraction operation.
- __host__ __device__ __half2 & operator--(__half2 &h)**
 Performs packed half prefix decrement operation.
- __host__ __device__ __half2 operator--(__half2 &h, const int ignored)**
 Performs packed half postfix decrement operation.
- __host__ __device__ __half2 & operator-=(__half2 &lh, const __half2 &rh)**
 Performs packed half compound assignment with subtraction operation.
- __host__ __device__ __half2 operator/(const __half2 &lh, const __half2 &rh)**
 Performs packed half division operation.

__host__ __device__ __half2 & operator/=(__half2 &lh, const __half2 &rh)
 Performs packed half compound assignment with division operation.

2.6.1. Functions

__host__ __device__ __half2 __h2div(const __half2 a, const __half2 b)
 Performs half2 vector division in round-to-nearest-even mode.
 Divides half2 input vector a by input vector b in round-to-nearest-even mode.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise division of a with b.

__host__ __device__ __half2 __habs2(const __half2 a)
 Calculates the absolute value of both halves of the input half2 number and returns the result.
 Calculates the absolute value of both halves of the input half2 number and returns the result.

See also:

[__habs\(__half\)](#) for further details.

Parameters

- a** - [in] - half2. Is only being read.

Returns

half2

- ▶ Returns a with the absolute value of both halves.

__host__ __device__ __half2 __hadd2(const __half2 a, const __half2 b)
 Performs half2 vector addition in round-to-nearest-even mode.
 Performs half2 vector add of inputs a and b, in round-to-nearest-even mode.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The sum of vectors a and b.

__host__ __device__ __half2 __hadd2_rn(const __half2 a, const __half2 b)
 Performs half2 vector addition in round-to-nearest-even mode.
 Performs half2 vector add of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add into fma.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The sum of vectors a and b.

`__host__ __device__ __half2 __hadd2_sat(const __half2 a, const __half2 b)`

Performs half2 vector addition in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs half2 vector add of inputs a and b, in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The sum of a and b, with respect to saturation.

`__device__ __half2 __hcmadd(const __half2 a, const __half2 b, const __half2 c)`

Performs fast complex multiply-accumulate.

Interprets vector half2 input pairs a, b, and c as complex numbers in half precision: (a.x + I*a.y), (b.x + I*b.y), (c.x + I*c.y) and performs complex multiply-accumulate operation: a*b + c in a simple way: ((a.x*b.x + c.x) - a.y*b.y) + I*((a.x*b.y + c.y) + a.y*b.x)

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.
- ▶ **c** - [in] - half2. Is only being read.

Returns

half2

- ▶ The result of complex multiply-accumulate operation on complex numbers a, b, and c
- ▶ `__half2` result = `__hcmadd(a, b, c)` is numerically in agreement with:
- ▶ `result.x = __hfma(-a.y, b.y, __hfma(a.x, b.x, c.x))`
- ▶ `result.y = __hfma(a.y, b.x, __hfma(a.x, b.y, c.y))`

`__device__ __half2 __hfma2(const __half2 a, const __half2 b, const __half2 c)`

Performs half2 vector fused multiply-add in round-to-nearest-even mode.

Performs half2 vector multiply on inputs a and b, then performs a half2 vector add of the result with c, rounding the result once in round-to-nearest-even mode.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.
- ▶ **c** - [**in**] - half2. Is only being read.

Returns

half2

- ▶ The result of elementwise fused multiply-add operation on vectors a, b, and c.

`__device__ __half2 __hfma2_relu(const __half2 a, const __half2 b, const __half2 c)`

Performs half2 vector fused multiply-add in round-to-nearest-even mode with relu saturation.

Performs half2 vector multiply on inputs a and b, then performs a half2 vector add of the result with c, rounding the result once in round-to-nearest-even mode. Then negative result is clamped to 0. NaN result is converted to canonical NaN.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.
- ▶ **c** - [**in**] - half2. Is only being read.

Returns

half2

- ▶ The result of elementwise fused multiply-add operation on vectors a, b, and c with relu saturation.

`__device__ __half2 __hfma2_sat(const __half2 a, const __half2 b, const __half2 c)`

Performs half2 vector fused multiply-add in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs half2 vector multiply on inputs a and b, then performs a half2 vector add of the result with c, rounding the result once in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.
- ▶ **c** - [**in**] - half2. Is only being read.

Returns

half2

- ▶ The result of elementwise fused multiply-add operation on vectors a, b, and c, with respect to saturation.

`__host__ __device__ __half2 __hmul2(const __half2 a, const __half2 b)`

Performs half2 vector multiplication in round-to-nearest-even mode.

Performs half2 vector multiplication of inputs a and b, in round-to-nearest-even mode.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.

- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The result of elementwise multiplying the vectors a and b.

`__host__ __device__ __half2 __hmul2_rn(const __half2 a, const __half2 b)`

Performs half2 vector multiplication in round-to-nearest-even mode.

Performs half2 vector multiplication of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add or sub into fma.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The result of elementwise multiplying the vectors a and b.

`__host__ __device__ __half2 __hmul2_sat(const __half2 a, const __half2 b)`

Performs half2 vector multiplication in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs half2 vector multiplication of inputs a and b, in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The result of elementwise multiplication of vectors a and b, with respect to saturation.

`__host__ __device__ __half2 __hneg2(const __half2 a)`

Negates both halves of the input half2 number and returns the result.

Negates both halves of the input half2 number a and returns the result.

See also:

[__hneg\(__half\)](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ Returns a with both halves negated.

`__host__ __device__ __half2 __hsub2(const __half2 a, const __half2 b)`

Performs `half2` vector subtraction in round-to-nearest-even mode.

Subtracts `half2` input vector `b` from input vector `a` in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `half2`. Is only being read.
- ▶ **b** – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The subtraction of vector `b` from `a`.

`__host__ __device__ __half2 __hsub2_rn(const __half2 a, const __half2 b)`

Performs `half2` vector subtraction in round-to-nearest-even mode.

Subtracts `half2` input vector `b` from input vector `a` in round-to-nearest-even mode. Prevents floating-point contractions of `mul+sub` into `fma`.

Parameters

- ▶ **a** – [in] - `half2`. Is only being read.
- ▶ **b** – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The subtraction of vector `b` from `a`.

`__host__ __device__ __half2 __hsub2_sat(const __half2 a, const __half2 b)`

Performs `half2` vector subtraction in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.

Subtracts `half2` input vector `b` from input vector `a` in round-to-nearest-even mode, and clamps the results to range `[0.0, 1.0]`. NaN results are flushed to `+0.0`.

Parameters

- ▶ **a** – [in] - `half2`. Is only being read.
- ▶ **b** – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The subtraction of vector `b` from `a`, with respect to saturation.

`__device__ __half2 atomicAdd(__half2 *const address, const __half2 val)`

Vector add `val` to the value stored at `address` in global or shared memory, and writes this value back to `address`.

The atomicity of the add operation is guaranteed separately for each of the two `__half` elements; the entire `__half2` is not guaranteed to be atomic as a single 32-bit access.

The location of `address` must be in global or shared memory. This operation has undefined behavior otherwise. This operation is natively supported by devices of compute capability 6.x and higher, older devices use emulation path.

Note: For more details for this function see the Atomic Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **address** – [**in**] - half2*. An address in global or shared memory.
- ▶ **val** – [**in**] - half2. The value to be added.

Returns

half2

- ▶ The old value read from address.

`__host__ __device__ __half2 operator*(const __half2 &lh, const __half2 &rh)`
 Performs packed half multiplication operation.

See also:

[`__hmul2\(__half2, __half2\)`](#)

`__host__ __device__ __half2 &operator*=(__half2 &lh, const __half2 &rh)`
 Performs packed half compound assignment with multiplication operation.

See also:

[`__hmul2\(__half2, __half2\)`](#)

`__host__ __device__ __half2 operator+(const __half2 &h)`
 Implements packed half unary plus operator, returns input value.

`__host__ __device__ __half2 operator+(const __half2 &lh, const __half2 &rh)`
 Performs packed half addition operation.

See also:

[`__hadd2\(__half2, __half2\)`](#)

`__host__ __device__ __half2 operator++(__half2 &h, const int ignored)`
 Performs packed half postfix increment operation.

See also:

[`__hadd2\(__half2, __half2\)`](#)

`__host__ __device__ __half2 &operator++(__half2 &h)`
 Performs packed half prefix increment operation.

See also:

[`__hadd2\(__half2, __half2\)`](#)

`__host__ __device__ __half2 &operator+=(__half2 &lh, const __half2 &rh)`
 Performs packed half compound assignment with addition operation.

See also:

`__hadd2(__half2, __half2)`

`__host__ __device__ __half2 operator-(const __half2 &h)`
 Implements packed half unary minus operator.

See also:

`__hneg2(__half2)`

`__host__ __device__ __half2 operator-(const __half2 &lh, const __half2 &rh)`
 Performs packed half subtraction operation.

See also:

`__hsub2(__half2, __half2)`

`__host__ __device__ __half2 &operator--(__half2 &h)`
 Performs packed half prefix decrement operation.

See also:

`__hsub2(__half2, __half2)`

`__host__ __device__ __half2 operator--(__half2 &h, const int ignored)`
 Performs packed half postfix decrement operation.

See also:

`__hsub2(__half2, __half2)`

`__host__ __device__ __half2 &operator--=__ (__half2 &lh, const __half2 &rh)`
 Performs packed half compound assignment with subtraction operation.

See also:

`__hsub2(__half2, __half2)`

`__host__ __device__ __half2 operator/(const __half2 &lh, const __half2 &rh)`
 Performs packed half division operation.

See also:

`__h2div(__half2, __half2)`

`__host__ __device__ __half2 &operator /=(__half2 &lh, const __half2 &rh)`
 Performs packed half compound assignment with division operation.

See also:

`__h2div(__half2, __half2)`

2.7. Half2 Comparison Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

`__host__ __device__ bool __hbeq2(const __half2 a, const __half2 b)`
 Performs half2 vector if-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbequ2(const __half2 a, const __half2 b)`
 Performs half2 vector unordered if-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbge2(const __half2 a, const __half2 b)`
 Performs half2 vector greater-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbgeu2(const __half2 a, const __half2 b)`
 Performs half2 vector unordered greater-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbgt2(const __half2 a, const __half2 b)`
 Performs half2 vector greater-than comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbgtu2(const __half2 a, const __half2 b)`
 Performs half2 vector unordered greater-than comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hble2(const __half2 a, const __half2 b)`
 Performs half2 vector less-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbleu2(const __half2 a, const __half2 b)`
 Performs half2 vector unordered less-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hblt2(const __half2 a, const __half2 b)`
 Performs half2 vector less-than comparison and returns boolean true if both half results are true, boolean false otherwise.

`__host__ __device__ bool __hbltu2(const __half2 a, const __half2 b)`
 Performs half2 vector unordered less-than comparison and returns boolean true if both half results are true, boolean false otherwise.

- __host__ __device__ bool __hbne2(const __half2 a, const __half2 b)**
 Performs half2 vector not-equal comparison and returns boolean true if both half results are true, boolean false otherwise.
- __host__ __device__ bool __hbneu2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered not-equal comparison and returns boolean true if both half results are true, boolean false otherwise.
- __host__ __device__ __half2 __heq2(const __half2 a, const __half2 b)**
 Performs half2 vector if-equal comparison.
- __host__ __device__ unsigned int __heq2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector if-equal comparison.
- __host__ __device__ __half2 __hequ2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered if-equal comparison.
- __host__ __device__ unsigned int __hequ2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector unordered if-equal comparison.
- __host__ __device__ __half2 __hge2(const __half2 a, const __half2 b)**
 Performs half2 vector greater-equal comparison.
- __host__ __device__ unsigned int __hge2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector greater-equal comparison.
- __host__ __device__ __half2 __hgeu2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered greater-equal comparison.
- __host__ __device__ unsigned int __hgeu2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector unordered greater-equal comparison.
- __host__ __device__ __half2 __hgt2(const __half2 a, const __half2 b)**
 Performs half2 vector greater-than comparison.
- __host__ __device__ unsigned int __hgt2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector greater-than comparison.
- __host__ __device__ __half2 __hgtu2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered greater-than comparison.
- __host__ __device__ unsigned int __hgtu2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector unordered greater-than comparison.
- __host__ __device__ __half2 __hisnan2(const __half2 a)**
 Determine whether half2 argument is a NaN.
- __host__ __device__ __half2 __hle2(const __half2 a, const __half2 b)**
 Performs half2 vector less-equal comparison.
- __host__ __device__ unsigned int __hle2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector less-equal comparison.
- __host__ __device__ __half2 __hleu2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered less-equal comparison.
- __host__ __device__ unsigned int __hleu2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector unordered less-equal comparison.
- __host__ __device__ __half2 __hlt2(const __half2 a, const __half2 b)**
 Performs half2 vector less-than comparison.
- __host__ __device__ unsigned int __hlt2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector less-than comparison.

- __host__ __device__ __half2 __hltu2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered less-than comparison.
- __host__ __device__ unsigned int __hltu2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector unordered less-than comparison.
- __host__ __device__ __half2 __hmax2(const __half2 a, const __half2 b)**
 Calculates half2 vector maximum of two inputs.
- __host__ __device__ __half2 __hmax2_nan(const __half2 a, const __half2 b)**
 Calculates half2 vector maximum of two inputs, NaNs pass through.
- __host__ __device__ __half2 __hmin2(const __half2 a, const __half2 b)**
 Calculates half2 vector minimum of two inputs.
- __host__ __device__ __half2 __hmin2_nan(const __half2 a, const __half2 b)**
 Calculates half2 vector minimum of two inputs, NaNs pass through.
- __host__ __device__ __half2 __hne2(const __half2 a, const __half2 b)**
 Performs half2 vector not-equal comparison.
- __host__ __device__ unsigned int __hne2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector not-equal comparison.
- __host__ __device__ __half2 __hneu2(const __half2 a, const __half2 b)**
 Performs half2 vector unordered not-equal comparison.
- __host__ __device__ unsigned int __hneu2_mask(const __half2 a, const __half2 b)**
 Performs half2 vector unordered not-equal comparison.
- __host__ __device__ bool operator!=(const __half2 &lh, const __half2 &rh)**
 Performs packed half unordered compare not-equal operation.
- __host__ __device__ bool operator<(const __half2 &lh, const __half2 &rh)**
 Performs packed half ordered less-than compare operation.
- __host__ __device__ bool operator<=(const __half2 &lh, const __half2 &rh)**
 Performs packed half ordered less-or-equal compare operation.
- __host__ __device__ bool operator==(const __half2 &lh, const __half2 &rh)**
 Performs packed half ordered compare equal operation.
- __host__ __device__ bool operator>(const __half2 &lh, const __half2 &rh)**
 Performs packed half ordered greater-than compare operation.
- __host__ __device__ bool operator>=(const __half2 &lh, const __half2 &rh)**
 Performs packed half ordered greater-or-equal compare operation.

2.7.1. Functions

- __host__ __device__ bool __hbeq2(const __half2 a, const __half2 b)**
 Performs half2 vector if-equal comparison and returns boolean true if both half results are true, boolean false otherwise.
- Performs half2 vector if-equal comparison of inputs a and b. The bool result is set to true only if both half if-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

bool

- ▶ true if both half results of if-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbequ2(const __half2 a, const __half2 b)`

Performs half2 vector unordered if-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector if-equal comparison of inputs a and b. The bool result is set to true only if both half if-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

bool

- ▶ true if both half results of unordered if-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbge2(const __half2 a, const __half2 b)`

Performs half2 vector greater-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector greater-equal comparison of inputs a and b. The bool result is set to true only if both half greater-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

bool

- ▶ true if both half results of greater-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbgeu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered greater-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector greater-equal comparison of inputs a and b. The bool result is set to true only if both half greater-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - half2. Is only being read.
- ▶ **b** – **[in]** - half2. Is only being read.

Returns

bool

- ▶ true if both half results of unordered greater-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbgt2(const __half2 a, const __half2 b)`

Performs half2 vector greater-than comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector greater-than comparison of inputs a and b. The bool result is set to true only if both half greater-than comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - half2. Is only being read.
- ▶ **b** – **[in]** - half2. Is only being read.

Returns

bool

- ▶ true if both half results of greater-than comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbgtu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered greater-than comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector greater-than comparison of inputs a and b. The bool result is set to true only if both half greater-than comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - half2. Is only being read.
- ▶ **b** – **[in]** - half2. Is only being read.

Returns

bool

- ▶ true if both half results of unordered greater-than comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1e2(const __half2 a, const __half2 b)`

Performs half2 vector less-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector less-equal comparison of inputs a and b. The bool result is set to true only if both half less-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

bool

- ▶ true if both half results of less-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbleu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered less-equal comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector less-equal comparison of inputs a and b. The bool result is set to true only if both half less-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

bool

- ▶ true if both half results of unordered less-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1t2(const __half2 a, const __half2 b)`

Performs half2 vector less-than comparison and returns boolean true if both half results are true, boolean false otherwise.

Performs half2 vector less-than comparison of inputs a and b. The bool result is set to true only if both half less-than comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

bool

- ▶ true if both half results of less-than comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1tu2(const __half2 a, const __half2 b)`

Performs `half2` vector unordered less-than comparison and returns boolean true if both `half` results are true, boolean false otherwise.

Performs `half2` vector less-than comparison of inputs `a` and `b`. The `bool` result is set to true only if both `half` less-than comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `half2`. Is only being read.
- ▶ **b** – [in] - `half2`. Is only being read.

Returns

`bool`

- ▶ true if both `half` results of unordered less-than comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbne2(const __half2 a, const __half2 b)`

Performs `half2` vector not-equal comparison and returns boolean true if both `half` results are true, boolean false otherwise.

Performs `half2` vector not-equal comparison of inputs `a` and `b`. The `bool` result is set to true only if both `half` not-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `half2`. Is only being read.
- ▶ **b** – [in] - `half2`. Is only being read.

Returns

`bool`

- ▶ true if both `half` results of not-equal comparison of vectors `a` and `b` are true,
- ▶ false otherwise.

`__host__ __device__ bool __hbneu2(const __half2 a, const __half2 b)`

Performs `half2` vector unordered not-equal comparison and returns boolean true if both `half` results are true, boolean false otherwise.

Performs `half2` vector not-equal comparison of inputs `a` and `b`. The `bool` result is set to true only if both `half` not-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `half2`. Is only being read.
- ▶ **b** – [in] - `half2`. Is only being read.

Returns

`bool`

- ▶ true if both half results of unordered not-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ __half2 __heq2(const __half2 a, const __half2 b)`

Performs half2 vector if-equal comparison.

Performs half2 vector if-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The vector result of if-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __heq2_mask(const __half2 a, const __half2 b)`

Performs half2 vector if-equal comparison.

Performs half2 vector if-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of if-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hequ2(const __half2 a, const __half2 b)`

Performs half2 vector unordered if-equal comparison.

Performs half2 vector if-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The vector result of unordered if-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hequ2_mask(const __half2 a, const __half2 b)`

Performs half2 vector unordered if-equal comparison.

Performs half2 vector if-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered if-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hge2(const __half2 a, const __half2 b)`

Performs half2 vector greater-equal comparison.

Performs half2 vector greater-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The vector result of greater-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hge2_mask(const __half2 a, const __half2 b)`

Performs half2 vector greater-equal comparison.

Performs half2 vector greater-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of greater-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hgeu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered greater-equal comparison.

Performs half2 vector greater-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The half2 vector result of unordered greater-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hgeu2_mask(const __half2 a, const __half2 b)`

Performs half2 vector unordered greater-equal comparison.

Performs half2 vector greater-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered greater-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hgt2(const __half2 a, const __half2 b)`

Performs half2 vector greater-than comparison.

Performs half2 vector greater-than comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The vector result of greater-than comparison of vectors a and b.

`__host__ __device__ unsigned int __hgt2_mask(const __half2 a, const __half2 b)`

Performs half2 vector greater-than comparison.

Performs half2 vector greater-than comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of greater-than comparison of vectors a and b.

`__host__ __device__ __half2 __hgtu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered greater-than comparison.

Performs half2 vector greater-than comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.

- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The half2 vector result of unordered greater-than comparison of vectors a and b.

`__host__ __device__ unsigned int __hgtu2_mask(const __half2 a, const __half2 b)`

Performs half2 vector unordered greater-than comparison.

Performs half2 vector greater-than comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered greater-than comparison of vectors a and b.

`__host__ __device__ __half2 __hisnan2(const __half2 a)`

Determine whether half2 argument is a NaN.

Determine whether each half of input half2 number a is a NaN.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The half2 with the corresponding half results set to 1.0 for NaN, 0.0 otherwise.

`__host__ __device__ __half2 __hle2(const __half2 a, const __half2 b)`

Performs half2 vector less-equal comparison.

Performs half2 vector less-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The half2 result of less-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hle2_mask(const __half2 a, const __half2 b)`

Performs half2 vector less-equal comparison.

Performs half2 vector less-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of less-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hleu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered less-equal comparison.

Performs half2 vector less-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The vector result of unordered less-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hleu2_mask(const __half2 a, const __half2 b)`

Performs half2 vector unordered less-equal comparison.

Performs half2 vector less-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered less-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hlt2(const __half2 a, const __half2 b)`

Performs half2 vector less-than comparison.

Performs half2 vector less-than comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

- ▶ The half2 vector result of less-than comparison of vectors a and b.

`__host__ __device__ unsigned int __hlt2_mask(const __half2 a, const __half2 b)`

Performs half2 vector less-than comparison.

Performs half2 vector less-than comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of less-than comparison of vectors a and b.

`__host__ __device__ __half2 __hltu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered less-than comparison.

Performs half2 vector less-than comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

half2

- ▶ The vector result of unordered less-than comparison of vectors a and b.

`__host__ __device__ unsigned int __hltu2_mask(const __half2 a, const __half2 b)`

Performs half2 vector unordered less-than comparison.

Performs half2 vector less-than comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered less-than comparison of vectors a and b.

`__host__ __device__ __half2 __hmax2(const __half2 a, const __half2 b)`

Calculates half2 vector maximum of two inputs.

Calculates half2 vector max(a, b). Elementwise half operation is defined as $(a > b) ? a : b$.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$
- ▶ The result of elementwise maximum of vectors a and b

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

`__host__ __device__ __half2 __hmax2_nan(const __half2 a, const __half2 b)`

Calculates half2 vector maximum of two inputs, NaNs pass through.

Calculates half2 vector max(a, b). Elementwise half operation is defined as $(a > b) ? a : b$.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$
- ▶ The result of elementwise maximum of vectors a and b, with NaNs pass through

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

`__host__ __device__ __half2 __hmin2(const __half2 a, const __half2 b)`

Calculates half2 vector minimum of two inputs.

Calculates half2 vector min(a, b). Elementwise half operation is defined as $(a < b) ? a : b$.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$
- ▶ The result of elementwise minimum of vectors a and b

Parameters

- ▶ **a** - [in] - half2. Is only being read.
- ▶ **b** - [in] - half2. Is only being read.

Returns

half2

`__host__ __device__ __half2 __hmin2_nan(const __half2 a, const __half2 b)`

Calculates half2 vector minimum of two inputs, NaNs pass through.

Calculates half2 vector min(a, b). Elementwise half operation is defined as $(a < b) ? a : b$.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$
- ▶ The result of elementwise minimum of vectors a and b, with NaNs pass through

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

half2

`__host__ __device__ __half2 __hne2(const __half2 a, const __half2 b)`

Performs half2 vector not-equal comparison.

Performs half2 vector not-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

half2

- ▶ The vector result of not-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hne2_mask(const __half2 a, const __half2 b)`

Performs half2 vector not-equal comparison.

Performs half2 vector not-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of not-equal comparison of vectors a and b.

`__host__ __device__ __half2 __hneu2(const __half2 a, const __half2 b)`

Performs half2 vector unordered not-equal comparison.

Performs half2 vector not-equal comparison of inputs a and b. The corresponding half results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** - [**in**] - half2. Is only being read.
- ▶ **b** - [**in**] - half2. Is only being read.

Returns

half2

- ▶ The vector result of unordered not-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hneu2_mask(const __half2 a, const __half2 b)`

Performs half2 vector unordered not-equal comparison.

Performs half2 vector not-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - half2. Is only being read.
- ▶ **b** – [in] - half2. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered not-equal comparison of vectors a and b.

`__host__ __device__ bool operator!=(const __half2 &lh, const __half2 &rh)`

Performs packed half unordered compare not-equal operation.

See also:

[`__hbneu2\(__half2, __half2\)`](#)

`__host__ __device__ bool operator<(const __half2 &lh, const __half2 &rh)`

Performs packed half ordered less-than compare operation.

See also:

[`__hblt2\(__half2, __half2\)`](#)

`__host__ __device__ bool operator<=(const __half2 &lh, const __half2 &rh)`

Performs packed half ordered less-or-equal compare operation.

See also:

[`__hble2\(__half2, __half2\)`](#)

`__host__ __device__ bool operator==(const __half2 &lh, const __half2 &rh)`

Performs packed half ordered compare equal operation.

See also:

[`__hbeq2\(__half2, __half2\)`](#)

`__host__ __device__ bool operator>(const __half2 &lh, const __half2 &rh)`

Performs packed half ordered greater-than compare operation.

See also:

[`__hbgt2\(__half2, __half2\)`](#)

`__host__ __device__ bool operator>=(const __half2 &lh, const __half2 &rh)`
 Performs packed half ordered greater-or-equal compare operation.

See also:

[`__hbge2\(__half2, __half2\)`](#)

2.8. Half2 Math Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Functions

- `__device__ __half2 h2ceil(const __half2 h)`**
 Calculate half2 vector ceiling of the input argument.
- `__device__ __half2 h2cos(const __half2 a)`**
 Calculates half2 vector cosine in round-to-nearest-even mode.
- `__device__ __half2 h2exp(const __half2 a)`**
 Calculates half2 vector exponential function in round-to-nearest-even mode.
- `__device__ __half2 h2exp10(const __half2 a)`**
 Calculates half2 vector decimal exponential function in round-to-nearest-even mode.
- `__device__ __half2 h2exp2(const __half2 a)`**
 Calculates half2 vector binary exponential function in round-to-nearest-even mode.
- `__device__ __half2 h2floor(const __half2 h)`**
 Calculate the largest integer less than or equal to h.
- `__device__ __half2 h2log(const __half2 a)`**
 Calculates half2 vector natural logarithm in round-to-nearest-even mode.
- `__device__ __half2 h2log10(const __half2 a)`**
 Calculates half2 vector decimal logarithm in round-to-nearest-even mode.
- `__device__ __half2 h2log2(const __half2 a)`**
 Calculates half2 vector binary logarithm in round-to-nearest-even mode.
- `__device__ __half2 h2rcp(const __half2 a)`**
 Calculates half2 vector reciprocal in round-to-nearest-even mode.
- `__device__ __half2 h2rint(const __half2 h)`**
 Round input to nearest integer value in half-precision floating-point number.
- `__device__ __half2 h2rsqrt(const __half2 a)`**
 Calculates half2 vector reciprocal square root in round-to-nearest-even mode.
- `__device__ __half2 h2sin(const __half2 a)`**
 Calculates half2 vector sine in round-to-nearest-even mode.
- `__device__ __half2 h2sqrt(const __half2 a)`**
 Calculates half2 vector square root in round-to-nearest-even mode.

`__device__ __half2 h2trunc(const __half2 h)`

Truncate `half2` vector input argument to the integral part.

2.8.1. Functions

`__device__ __half2 h2ceil(const __half2 h)`

Calculate `half2` vector ceiling of the input argument.

For each component of vector `h` compute the smallest integer value not less than `h`.

See also:

[`hceil\(__half\)`](#) for further details.

Parameters

h – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The vector of smallest integers not less than `h`.

`__device__ __half2 h2cos(const __half2 a)`

Calculates `half2` vector cosine in round-to-nearest-even mode.

Calculates `half2` cosine of input vector `a` in round-to-nearest-even mode.

See also:

[`hcos\(__half\)`](#) for further details.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The elementwise cosine on vector `a`.

`__device__ __half2 h2exp(const __half2 a)`

Calculates `half2` vector exponential function in round-to-nearest-even mode.

Calculates `half2` exponential function of input vector `a` in round-to-nearest-even mode.

See also:

[`hexp\(__half\)`](#) for further details.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The elementwise exponential function on vector `a`.

`__device__ __half2 h2exp10(const __half2 a)`

Calculates half2 vector decimal exponential function in round-to-nearest-even mode.

Calculates half2 decimal exponential function of input vector a in round-to-nearest-even mode.

See also:

[*hexp10\(__half\)*](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise decimal exponential function on vector a.

`__device__ __half2 h2exp2(const __half2 a)`

Calculates half2 vector binary exponential function in round-to-nearest-even mode.

Calculates half2 binary exponential function of input vector a in round-to-nearest-even mode.

See also:

[*hexp2\(__half\)*](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise binary exponential function on vector a.

`__device__ __half2 h2floor(const __half2 h)`

Calculate the largest integer less than or equal to h.

For each component of vector h calculate the largest integer value which is less than or equal to h.

See also:

[*hfloor\(__half\)*](#) for further details.

Parameters

h – [in] - half2. Is only being read.

Returns

half2

- ▶ The vector of largest integers which is less than or equal to h.

`__device__ __half2 h2log(const __half2 a)`

Calculates half2 vector natural logarithm in round-to-nearest-even mode.

Calculates half2 natural logarithm of input vector a in round-to-nearest-even mode.

See also:

[*hlog\(__half\)*](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise natural logarithm on vector a.

`__device__ __half2 h2log10(const __half2 a)`

Calculates half2 vector decimal logarithm in round-to-nearest-even mode.

Calculates half2 decimal logarithm of input vector a in round-to-nearest-even mode.

See also:

[hlog10\(__half\)](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise decimal logarithm on vector a.

`__device__ __half2 h2log2(const __half2 a)`

Calculates half2 vector binary logarithm in round-to-nearest-even mode.

Calculates half2 binary logarithm of input vector a in round-to-nearest-even mode.

See also:

[hlog2\(__half\)](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise binary logarithm on vector a.

`__device__ __half2 h2rcp(const __half2 a)`

Calculates half2 vector reciprocal in round-to-nearest-even mode.

Calculates half2 reciprocal of input vector a in round-to-nearest-even mode.

See also:

[hrcp\(__half\)](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise reciprocal on vector a.

`__device__ __half2 h2rint(const __half2 h)`

Round input to nearest integer value in half-precision floating-point number.

Round each component of `half2` vector `h` to the nearest integer value in half-precision floating-point format, with halfway cases rounded to the nearest even integer value.

See also:

[`hrint\(__half\)`](#) for further details.

Parameters

h – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The vector of rounded integer values.

`__device__ __half2 h2rsqrt(const __half2 a)`

Calculates `half2` vector reciprocal square root in round-to-nearest-even mode.

Calculates `half2` reciprocal square root of input vector `a` in round-to-nearest-even mode.

See also:

[`hrsqrt\(__half\)`](#) for further details.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The elementwise reciprocal square root on vector `a`.

`__device__ __half2 h2sin(const __half2 a)`

Calculates `half2` vector sine in round-to-nearest-even mode.

Calculates `half2` sine of input vector `a` in round-to-nearest-even mode.

See also:

[`hsin\(__half\)`](#) for further details.

Parameters

a – [in] - `half2`. Is only being read.

Returns

`half2`

- ▶ The elementwise sine on vector `a`.

`__device__ __half2 h2sqrt(const __half2 a)`

Calculates `half2` vector square root in round-to-nearest-even mode.

Calculates `half2` square root of input vector `a` in round-to-nearest-even mode.

See also:

[`hsqrt\(__half\)`](#) for further details.

Parameters

a – [in] - half2. Is only being read.

Returns

half2

- ▶ The elementwise square root on vector a.

`__device__ __half2 h2trunc(const __half2 h)`

Truncate half2 vector input argument to the integral part.

Round each component of vector h to the largest integer value that does not exceed h in magnitude.

See also:

[`htrunc\(__half\)`](#) for further details.

Parameters

h – [in] - half2. Is only being read.

Returns

half2

- ▶ The truncated h.

Groups**Half Arithmetic Constants**

To use these constants, include the header file `cuda_fp16.h` in your program.

Half Arithmetic Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Half Comparison Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Half Math Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Half Precision Conversion and Data Movement

To use these functions, include the header file `cuda_fp16.h` in your program.

Half2 Arithmetic Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Half2 Comparison Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Half2 Math Functions

To use these functions, include the header file `cuda_fp16.h` in your program.

Structs

__half

__half data type

__half2

__half2 data type

__half2_raw

__half2_raw data type

__half_raw

__half_raw data type

Typedefs

__nv_half

This datatype is an `__nv_` prefixed alias.

__nv_half2

This datatype is an `__nv_` prefixed alias.

__nv_half2_raw

This datatype is an `__nv_` prefixed alias.

__nv_half_raw

This datatype is an `__nv_` prefixed alias.

half This datatype is meant to be the first-class or fundamental implementation of the half-precision numbers format.

half2

This datatype is meant to be the first-class or fundamental implementation of type for pairs of half-precision numbers.

nv_half

This datatype is an `nv_` prefixed alias.

nv_half2

This datatype is an `nv_` prefixed alias.

2.9. Typedefs

```
typedef __half __nv_half
```

This datatype is an `__nv_` prefixed alias.

```
typedef __half2 __nv_half2
```

This datatype is an `__nv_` prefixed alias.

```
typedef __half2_raw __nv_half2_raw
```

This datatype is an `__nv_` prefixed alias.

typedef ***__half_raw*** **__nv_half_raw**

This datatype is an `__nv_` prefixed alias.

typedef ***__half*** **half**

This datatype is meant to be the first-class or fundamental implementation of the half-precision numbers format.

Should be implemented in the compiler in the future. Current implementation is a simple typedef to a respective user-level type with underscores.

typedef ***__half2*** **half2**

This datatype is meant to be the first-class or fundamental implementation of type for pairs of half-precision numbers.

Should be implemented in the compiler in the future. Current implementation is a simple typedef to a respective user-level type with underscores.

typedef ***__half*** **nv_half**

This datatype is an `nv_` prefixed alias.

typedef ***__half2*** **nv_half2**

This datatype is an `nv_` prefixed alias.

Chapter 3. Bfloat16 Precision Intrinsics

This section describes `nv_bfloat16` precision intrinsic functions.

To use these functions, include the header file `cuda_bf16.h` in your program. All of the functions defined here are available in device code. Some of the functions are also available to host compilers, please refer to respective functions' documentation for details.

NOTE: Aggressive floating-point optimizations performed by host or device compilers may affect numeric behavior of the functions implemented in this header. Specific examples are:

- ▶ `hsin(__nv_bfloat16);`
- ▶ `hcos(__nv_bfloat16);`
- ▶ `h2sin(__nv_bfloat162);`
- ▶ `h2cos(__nv_bfloat162);`

The following macros are available to help users selectively enable/disable various definitions present in the header file:

- ▶ `CUDA_NO_BFLOAT16` - If defined, this macro will prevent the definition of additional type aliases in the global namespace, helping to avoid potential conflicts with symbols defined in the user program.
- ▶ `__CUDA_NO_BFLOAT16_CONVERSIONS__` - If defined, this macro will prevent the use of the C++ type conversions (converting constructors and conversion operators) that are common for built-in floating-point types, but may be undesirable for `__nv_bfloat16` which is essentially a user-defined type.
- ▶ `__CUDA_NO_BFLOAT16_OPERATORS__` and `__CUDA_NO_BFLOAT162_OPERATORS__` - If defined, these macros will prevent the inadvertent use of usual arithmetic and comparison operators. This enforces the storage-only type semantics and prevents C++ style computations on `__nv_bfloat16` and `__nv_bfloat162` types.

3.1. Bfloat16 Arithmetic Constants

To use these constants, include the header file `cuda_bf16.h` in your program.

Macros

CUDART_INF_BF16

Defines floating-point positive infinity value for the `nv_bfloat16` data type.

CUDART_MAX_NORMAL_BF16

Defines a maximum representable value for the `nv_bfloat16` data type.

CUDART_MIN_DENORM_BF16

Defines a minimum representable (denormalized) value for the `nv_bfloat16` data type.

CUDART_NAN_BF16

Defines canonical NaN value for the `nv_bfloat16` data type.

CUDART_NEG_ZERO_BF16

Defines a negative zero value for the `nv_bfloat16` data type.

CUDART_ONE_BF16

Defines a value of 1.0 for the `nv_bfloat16` data type.

CUDART_ZERO_BF16

Defines a positive zero value for the `nv_bfloat16` data type.

3.1.1. Macros

CUDART_INF_BF16 `__ushort_as_bfloat16`((unsigned short)0x7F80U)

Defines floating-point positive infinity value for the `nv_bfloat16` data type.

CUDART_MAX_NORMAL_BF16 `__ushort_as_bfloat16`((unsigned short)0x7F7FU)

Defines a maximum representable value for the `nv_bfloat16` data type.

CUDART_MIN_DENORM_BF16 `__ushort_as_bfloat16`((unsigned short)0x0001U)

Defines a minimum representable (denormalized) value for the `nv_bfloat16` data type.

CUDART_NAN_BF16 `__ushort_as_bfloat16`((unsigned short)0x7FFFU)

Defines canonical NaN value for the `nv_bfloat16` data type.

CUDART_NEG_ZERO_BF16 `__ushort_as_bfloat16`((unsigned short)0x8000U)

Defines a negative zero value for the `nv_bfloat16` data type.

CUDART_ONE_BF16 `__ushort_as_bfloat16`((unsigned short)0x3F80U)

Defines a value of 1.0 for the `nv_bfloat16` data type.

CUDART_ZERO_BF16 `__ushort_as_bfloat16`((unsigned short)0x0000U)

Defines a positive zero value for the `nv_bfloat16` data type.

3.2. Bfloat16 Arithmetic Functions

To use these functions, include the header file `cuda_bfloat16.h` in your program.

Functions

- __host__ __device__ __nv_bfloat16 __habs(const __nv_bfloat16 a)**
Calculates the absolute value of input `nv_bfloat16` number and returns the result.
- __host__ __device__ __nv_bfloat16 __hadd(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` addition in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat16 __hadd_rn(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` addition in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat16 __hadd_sat(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` addition in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.
- __host__ __device__ __nv_bfloat16 __hdiv(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` division in round-to-nearest-even mode.
- __device__ __nv_bfloat16 __hfma(const __nv_bfloat16 a, const __nv_bfloat16 b, const __nv_bfloat16 c)**
Performs `nv_bfloat16` fused multiply-add in round-to-nearest-even mode.
- __device__ __nv_bfloat16 __hfma_relu(const __nv_bfloat16 a, const __nv_bfloat16 b, const __nv_bfloat16 c)**
Performs `nv_bfloat16` fused multiply-add in round-to-nearest-even mode with relu saturation.
- __device__ __nv_bfloat16 __hfma_sat(const __nv_bfloat16 a, const __nv_bfloat16 b, const __nv_bfloat16 c)**
Performs `nv_bfloat16` fused multiply-add in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.
- __host__ __device__ __nv_bfloat16 __hmul(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` multiplication in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat16 __hmul_rn(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` multiplication in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat16 __hmul_sat(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` multiplication in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.
- __host__ __device__ __nv_bfloat16 __hneg(const __nv_bfloat16 a)**
Negates input `nv_bfloat16` number and returns the result.
- __host__ __device__ __nv_bfloat16 __hsub(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` subtraction in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat16 __hsub_rn(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` subtraction in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat16 __hsub_sat(const __nv_bfloat16 a, const __nv_bfloat16 b)**
Performs `nv_bfloat16` subtraction in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.
- __device__ __nv_bfloat16 atomicAdd(__nv_bfloat16 *const address, const __nv_bfloat16 val)**
Adds `val` to the value stored at `address` in global or shared memory, and writes this value back to `address`.

`__host__ __device__ __nv_bfloat16 operator*(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` multiplication operation.

`__host__ __device__ __nv_bfloat16 & operator*=(__nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` compound assignment with multiplication operation.

`__host__ __device__ __nv_bfloat16 operator+(const __nv_bfloat16 &h)`
 Implements `nv_bfloat16` unary plus operator, returns input value.

`__host__ __device__ __nv_bfloat16 operator+(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` addition operation.

`__host__ __device__ __nv_bfloat16 operator++(__nv_bfloat16 &h, const int ignored)`
 Performs `nv_bfloat16` postfix increment operation.

`__host__ __device__ __nv_bfloat16 & operator++(__nv_bfloat16 &h)`
 Performs `nv_bfloat16` prefix increment operation.

`__host__ __device__ __nv_bfloat16 & operator+=(__nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` compound assignment with addition operation.

`__host__ __device__ __nv_bfloat16 operator-(const __nv_bfloat16 &h)`
 Implements `nv_bfloat16` unary minus operator.

`__host__ __device__ __nv_bfloat16 operator-(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` subtraction operation.

`__host__ __device__ __nv_bfloat16 & operator--(__nv_bfloat16 &h)`
 Performs `nv_bfloat16` prefix decrement operation.

`__host__ __device__ __nv_bfloat16 operator--(__nv_bfloat16 &h, const int ignored)`
 Performs `nv_bfloat16` postfix decrement operation.

`__host__ __device__ __nv_bfloat16 & operator-=(__nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` compound assignment with subtraction operation.

`__host__ __device__ __nv_bfloat16 operator/(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` division operation.

`__host__ __device__ __nv_bfloat16 & operator/=(__nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` compound assignment with division operation.

3.2.1. Functions

`__host__ __device__ __nv_bfloat16 __habs(const __nv_bfloat16 a)`
 Calculates the absolute value of input `nv_bfloat16` number and returns the result.
 Calculates the absolute value of input `nv_bfloat16` number and returns the result.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The absolute value of `a`.

`__host__ __device__ __nv_bfloat16 __hadd(const __nv_bfloat16 a, const __nv_bfloat16 b)`
 Performs `nv_bfloat16` addition in round-to-nearest-even mode.
 Performs `nv_bfloat16` addition of inputs `a` and `b`, in round-to-nearest-even mode.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The sum of a and b.

`__host__ __device__ __nv_bfloat16 __hadd_rn(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 addition in round-to-nearest-even mode.

Performs nv_bfloat16 addition of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add into fma.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The sum of a and b.

`__host__ __device__ __nv_bfloat16 __hadd_sat(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 addition in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs nv_bfloat16 add of inputs a and b, in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The sum of a and b, with respect to saturation.

`__host__ __device__ __nv_bfloat16 __hdiv(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 division in round-to-nearest-even mode.

Divides nv_bfloat16 input a by input b in round-to-nearest-even mode.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The result of dividing a by b.

`__device__ __nv_bfloat16 __hfma(const __nv_bfloat16 a, const __nv_bfloat16 b, const __nv_bfloat16 c)`

Performs `nv_bfloat16` fused multiply-add in round-to-nearest-even mode.

Performs `nv_bfloat16` multiply on inputs `a` and `b`, then performs a `nv_bfloat16` add of the result with `c`, rounding the result once in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **c** – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The result of fused multiply-add operation on `a`, `b`, and `c`.

`__device__ __nv_bfloat16 __hfma_relu(const __nv_bfloat16 a, const __nv_bfloat16 b, const __nv_bfloat16 c)`

Performs `nv_bfloat16` fused multiply-add in round-to-nearest-even mode with `relu` saturation.

Performs `nv_bfloat16` multiply on inputs `a` and `b`, then performs a `nv_bfloat16` add of the result with `c`, rounding the result once in round-to-nearest-even mode. Then negative result is clamped to 0. NaN result is converted to canonical NaN.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **c** – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The result of fused multiply-add operation on `a`, `b`, and `c` with `relu` saturation.

`__device__ __nv_bfloat16 __hfma_sat(const __nv_bfloat16 a, const __nv_bfloat16 b, const __nv_bfloat16 c)`

Performs `nv_bfloat16` fused multiply-add in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.

Performs `nv_bfloat16` multiply on inputs `a` and `b`, then performs a `nv_bfloat16` add of the result with `c`, rounding the result once in round-to-nearest-even mode, and clamps the result to range `[0.0, 1.0]`. NaN results are flushed to `+0.0`.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **c** – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The result of fused multiply-add operation on a, b, and c, with respect to saturation.

`__host__ __device__ __nv_bfloat16 __hmul(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` multiplication in round-to-nearest-even mode.

Performs `nv_bfloat16` multiplication of inputs a and b, in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The result of multiplying a and b.

`__host__ __device__ __nv_bfloat16 __hmul_rn(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` multiplication in round-to-nearest-even mode.

Performs `nv_bfloat16` multiplication of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add or sub into fma.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The result of multiplying a and b.

`__host__ __device__ __nv_bfloat16 __hmul_sat(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` multiplication in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs `nv_bfloat16` multiplication of inputs a and b, in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The result of multiplying a and b, with respect to saturation.

`__host__ __device__ __nv_bfloat16 __hneg(const __nv_bfloat16 a)`

Negates input `nv_bfloat16` number and returns the result.

Negates input `nv_bfloat16` number and returns the result.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

nv_bfloat16

- ▶ minus a

`__host__ __device__ __nv_bfloat16 __hsub(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 subtraction in round-to-nearest-even mode.

Subtracts nv_bfloat16 input b from input a in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - nv_bfloat16. Is only being read.
- ▶ **b** – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The result of subtracting b from a.

`__host__ __device__ __nv_bfloat16 __hsub_rn(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 subtraction in round-to-nearest-even mode.

Subtracts nv_bfloat16 input b from input a in round-to-nearest-even mode. Prevents floating-point contractions of mul+sub into fma.

Parameters

- ▶ **a** – [in] - nv_bfloat16. Is only being read.
- ▶ **b** – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The result of subtracting b from a.

`__host__ __device__ __nv_bfloat16 __hsub_sat(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 subtraction in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Subtracts nv_bfloat16 input b from input a in round-to-nearest-even mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** – [in] - nv_bfloat16. Is only being read.
- ▶ **b** – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- ▶ The result of subtraction of b from a, with respect to saturation.

`__device__ __nv_bfloat16 atomicAdd(__nv_bfloat16 *const address, const __nv_bfloat16 val)`

Adds val to the value stored at address in global or shared memory, and writes this value back to address.

This operation is performed in one atomic operation.

The location of address must be in global or shared memory. This operation has undefined behavior otherwise. This operation is natively supported by devices of compute capability 9.x and higher, older devices of compute capability 7.x and 8.x use emulation path.

Note: For more details for this function see the Atomic Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **address** – [in] - `__nv_bfloat16*`. An address in global or shared memory.
- ▶ **val** – [in] - `__nv_bfloat16`. The value to be added.

Returns

`__nv_bfloat16`

- ▶ The old value read from address.

`__host__ __device__ __nv_bfloat16 operator*(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` multiplication operation.

See also `__hmul(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ __nv_bfloat16 &operator*=(__nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` compound assignment with multiplication operation.

`__host__ __device__ __nv_bfloat16 operator+(const __nv_bfloat16 &h)`
 Implements `nv_bfloat16` unary plus operator, returns input value.

`__host__ __device__ __nv_bfloat16 operator+(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` addition operation.

See also `__hadd(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ __nv_bfloat16 operator++(__nv_bfloat16 &h, const int ignored)`
 Performs `nv_bfloat16` postfix increment operation.

`__host__ __device__ __nv_bfloat16 &operator++(__nv_bfloat16 &h)`
 Performs `nv_bfloat16` prefix increment operation.

`__host__ __device__ __nv_bfloat16 &operator+=(__nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` compound assignment with addition operation.

`__host__ __device__ __nv_bfloat16 operator-(const __nv_bfloat16 &h)`
 Implements `nv_bfloat16` unary minus operator.

See also `__hneg(__nv_bfloat16)`

`__host__ __device__ __nv_bfloat16 operator-(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` subtraction operation.

See also `__hsub(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ __nv_bfloat16 &operator--(__nv_bfloat16 &h)`
 Performs `nv_bfloat16` prefix decrement operation.

`__host__ __device__ __nv_bfloat16 operator--`(`__nv_bfloat16 &h`, const int ignored)

Performs `nv_bfloat16` postfix decrement operation.

`__host__ __device__ __nv_bfloat16 &operator-=`(`__nv_bfloat16 &lh`, const `__nv_bfloat16 &rh`)

Performs `nv_bfloat16` compound assignment with subtraction operation.

`__host__ __device__ __nv_bfloat16 operator/`(const `__nv_bfloat16 &lh`, const `__nv_bfloat16 &rh`)

Performs `nv_bfloat16` division operation.

See also `__hdiv(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ __nv_bfloat16 &operator/=`(`__nv_bfloat16 &lh`, const `__nv_bfloat16 &rh`)

Performs `nv_bfloat16` compound assignment with division operation.

3.3. Bfloat16 Comparison Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Functions

`__host__ __device__ bool __heq`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` if-equal comparison.

`__host__ __device__ bool __hequ`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` unordered if-equal comparison.

`__host__ __device__ bool __hge`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` greater-equal comparison.

`__host__ __device__ bool __hgeu`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` unordered greater-equal comparison.

`__host__ __device__ bool __hgt`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` greater-than comparison.

`__host__ __device__ bool __hgtu`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` unordered greater-than comparison.

`__host__ __device__ int __hisinf`(const `__nv_bfloat16 a`)

Checks if the input `nv_bfloat16` number is infinite.

`__host__ __device__ bool __hisnan`(const `__nv_bfloat16 a`)

Determine whether `nv_bfloat16` argument is a NaN.

`__host__ __device__ bool __hle`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` less-equal comparison.

`__host__ __device__ bool __hleu`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` unordered less-equal comparison.

`__host__ __device__ bool __hlt`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` less-than comparison.

`__host__ __device__ bool __hltu`(const `__nv_bfloat16 a`, const `__nv_bfloat16 b`)

Performs `nv_bfloat16` unordered less-than comparison.

- __host__ __device__ __nv_bfloat16 __hmax(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Calculates nv_bfloat16 maximum of two input values.
- __host__ __device__ __nv_bfloat16 __hmax_nan(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Calculates nv_bfloat16 maximum of two input values, NaNs pass through.
- __host__ __device__ __nv_bfloat16 __hmin(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Calculates nv_bfloat16 minimum of two input values.
- __host__ __device__ __nv_bfloat16 __hmin_nan(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Calculates nv_bfloat16 minimum of two input values, NaNs pass through.
- __host__ __device__ bool __hne(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Performs nv_bfloat16 not-equal comparison.
- __host__ __device__ bool __hneu(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Performs nv_bfloat16 unordered not-equal comparison.
- __host__ __device__ bool operator!=(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)**
 Performs nv_bfloat16 unordered compare not-equal operation.
- __host__ __device__ bool operator<(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)**
 Performs nv_bfloat16 ordered less-than compare operation.
- __host__ __device__ bool operator<=(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)**
 Performs nv_bfloat16 ordered less-or-equal compare operation.
- __host__ __device__ bool operator==(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)**
 Performs nv_bfloat16 ordered compare equal operation.
- __host__ __device__ bool operator>(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)**
 Performs nv_bfloat16 ordered greater-than compare operation.
- __host__ __device__ bool operator>=(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)**
 Performs nv_bfloat16 ordered greater-or-equal compare operation.

3.3.1. Functions

- __host__ __device__ bool __heq(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Performs nv_bfloat16 if-equal comparison.
 Performs nv_bfloat16 if-equal comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** - [in] - nv_bfloat16. Is only being read.
- ▶ **b** - [in] - nv_bfloat16. Is only being read.

Returns

bool

- ▶ The boolean result of if-equal comparison of a and b.

- __host__ __device__ bool __hequ(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Performs nv_bfloat16 unordered if-equal comparison.
 Performs nv_bfloat16 if-equal comparison of inputs a and b. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

bool

- ▶ The boolean result of unordered if-equal comparison of a and b.

`__host__ __device__ bool __hge(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 greater-equal comparison.

Performs nv_bfloat16 greater-equal comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

bool

- ▶ The boolean result of greater-equal comparison of a and b.

`__host__ __device__ bool __hgeu(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 unordered greater-equal comparison.

Performs nv_bfloat16 greater-equal comparison of inputs a and b. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

bool

- ▶ The boolean result of unordered greater-equal comparison of a and b.

`__host__ __device__ bool __hgt(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs nv_bfloat16 greater-than comparison.

Performs nv_bfloat16 greater-than comparison of inputs a and b. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat16. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat16. Is only being read.

Returns

bool

- ▶ The boolean result of greater-than comparison of a and b.

`__host__ __device__ bool __hgtu(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` unordered greater-than comparison.

Performs `nv_bfloat16` greater-than comparison of inputs `a` and `b`. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of unordered greater-than comparison of `a` and `b`.

`__host__ __device__ int __hisinf(const __nv_bfloat16 a)`

Checks if the input `nv_bfloat16` number is infinite.

Checks if the input `nv_bfloat16` number `a` is infinite.

Parameters

- a** – [in] - `nv_bfloat16`. Is only being read.

Returns

`int`

- ▶ -1 if `a` is equal to negative infinity,
- ▶ 1 if `a` is equal to positive infinity,
- ▶ 0 otherwise.

`__host__ __device__ bool __hisnan(const __nv_bfloat16 a)`

Determine whether `nv_bfloat16` argument is a NaN.

Determine whether `nv_bfloat16` value `a` is a NaN.

Parameters

- a** – [in] - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ true if argument is NaN.

`__host__ __device__ bool __hle(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` less-equal comparison.

Performs `nv_bfloat16` less-equal comparison of inputs `a` and `b`. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of less-equal comparison of `a` and `b`.

`__host__ __device__ bool __hleu(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` unordered less-equal comparison.

Performs `nv_bfloat16` less-equal comparison of inputs `a` and `b`. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of unordered less-equal comparison of `a` and `b`.

`__host__ __device__ bool __hlt(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` less-than comparison.

Performs `nv_bfloat16` less-than comparison of inputs `a` and `b`. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of less-than comparison of `a` and `b`.

`__host__ __device__ bool __hltu(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` unordered less-than comparison.

Performs `nv_bfloat16` less-than comparison of inputs `a` and `b`. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of unordered less-than comparison of `a` and `b`.

`__host__ __device__ __nv_bfloat16 __hmax(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Calculates `nv_bfloat16` maximum of two input values.

Calculates `nv_bfloat16` $\max(a, b)$ defined as $(a > b) ? a : b$.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** - [in] - nv_bfloat16. Is only being read.
- ▶ **b** - [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

`__host__ __device__ __nv_bfloat16 __hmax_nan(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Calculates nv_bfloat16 maximum of two input values, NaNs pass through.

Calculates nv_bfloat16 $\max(a, b)$ defined as $(a > b) ? a : b$.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** - [in] - nv_bfloat16. Is only being read.
- ▶ **b** - [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

`__host__ __device__ __nv_bfloat16 __hmin(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Calculates nv_bfloat16 minimum of two input values.

Calculates nv_bfloat16 $\min(a, b)$ defined as $(a < b) ? a : b$.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** - [in] - nv_bfloat16. Is only being read.
- ▶ **b** - [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

`__host__ __device__ __nv_bfloat16 __hmin_nan(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Calculates nv_bfloat16 minimum of two input values, NaNs pass through.

Calculates nv_bfloat16 $\min(a, b)$ defined as $(a < b) ? a : b$.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then $+0.0 > -0.0$

Parameters

- ▶ **a** - [in] - nv_bfloat16. Is only being read.

- ▶ **b** – **[in]** - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

`__host__ __device__ bool __hne(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` not-equal comparison.

Performs `nv_bfloat16` not-equal comparison of inputs `a` and `b`. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat16`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of not-equal comparison of `a` and `b`.

`__host__ __device__ bool __hneu(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Performs `nv_bfloat16` unordered not-equal comparison.

Performs `nv_bfloat16` not-equal comparison of inputs `a` and `b`. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat16`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat16`. Is only being read.

Returns

`bool`

- ▶ The boolean result of unordered not-equal comparison of `a` and `b`.

`__host__ __device__ bool operator!=(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`

Performs `nv_bfloat16` unordered compare not-equal operation.

See also `__hneu(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ bool operator<(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`

Performs `nv_bfloat16` ordered less-than compare operation.

See also `__hlt(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ bool operator<=(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`

Performs `nv_bfloat16` ordered less-or-equal compare operation.

See also `__hle(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ bool operator==(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`

Performs `nv_bfloat16` ordered compare equal operation.

See also `__heq(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ bool operator>(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` ordered greater-than compare operation.

See also `__hgt(__nv_bfloat16, __nv_bfloat16)`

`__host__ __device__ bool operator>=(const __nv_bfloat16 &lh, const __nv_bfloat16 &rh)`
 Performs `nv_bfloat16` ordered greater-or-equal compare operation.

See also `__hge(__nv_bfloat16, __nv_bfloat16)`

3.4. Bfloat16 Math Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Functions

`__device__ __nv_bfloat16 hceil(const __nv_bfloat16 h)`

Calculate ceiling of the input argument.

`__device__ __nv_bfloat16 hcos(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` cosine in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hexp(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` natural exponential function in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hexp10(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` decimal exponential function in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hexp2(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` binary exponential function in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hfloor(const __nv_bfloat16 h)`

Calculate the largest integer less than or equal to `h`.

`__device__ __nv_bfloat16 hlog(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` natural logarithm in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hlog10(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` decimal logarithm in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hlog2(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` binary logarithm in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hrcp(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` reciprocal in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hrint(const __nv_bfloat16 h)`

Round input to nearest integer value in `nv_bfloat16` floating-point number.

`__device__ __nv_bfloat16 hrsqrt(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` reciprocal square root in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hsin(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` sine in round-to-nearest-even mode.

`__device__ __nv_bfloat16 hsqrt(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` square root in round-to-nearest-even mode.

`__device__ __nv_bfloat16 htrunc(const __nv_bfloat16 h)`
 Truncate input argument to the integral part.

3.4.1. Functions

`__device__ __nv_bfloat16 hceil(const __nv_bfloat16 h)`
 Calculate ceiling of the input argument.
 Compute the smallest integer value not less than h.

Parameters

h – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

► The smallest integer value not less than h.

`__device__ __nv_bfloat16 hcos(const __nv_bfloat16 a)`
 Calculates nv_bfloat16 cosine in round-to-nearest-even mode.

Calculates nv_bfloat16 cosine of input a in round-to-nearest-even mode.

NOTE: this function’s implementation calls *cosf(float)* function and is exposed to compiler optimizations. Specifically, `--use_fast_math` flag changes *cosf(float)* into an intrinsic `__cosf(float)`, which has less accurate numeric behavior.

Parameters

a – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

► The cosine of a.

`__device__ __nv_bfloat16 hexp(const __nv_bfloat16 a)`
 Calculates nv_bfloat16 natural exponential function in round-to-nearest-even mode.

Calculates nv_bfloat16 natural exponential function of input a in round-to-nearest-even mode.

Parameters

a – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

► The natural exponential function on a.

`__device__ __nv_bfloat16 hexp10(const __nv_bfloat16 a)`
 Calculates nv_bfloat16 decimal exponential function in round-to-nearest-even mode.

Calculates nv_bfloat16 decimal exponential function of input a in round-to-nearest-even mode.

Parameters

a – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

► The decimal exponential function on a.

`__device__ __nv_bfloat16 hexp2(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` binary exponential function in round-to-nearest-even mode.

Calculates `nv_bfloat16` binary exponential function of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The binary exponential function on `a`.

`__device__ __nv_bfloat16 hfloor(const __nv_bfloat16 h)`

Calculate the largest integer less than or equal to `h`.

Calculate the largest integer value which is less than or equal to `h`.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The largest integer value which is less than or equal to `h`.

`__device__ __nv_bfloat16 hlog(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` natural logarithm in round-to-nearest-even mode.

Calculates `nv_bfloat16` natural logarithm of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The natural logarithm of `a`.

`__device__ __nv_bfloat16 hlog10(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` decimal logarithm in round-to-nearest-even mode.

Calculates `nv_bfloat16` decimal logarithm of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The decimal logarithm of `a`.

`__device__ __nv_bfloat16 hlog2(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` binary logarithm in round-to-nearest-even mode.

Calculates `nv_bfloat16` binary logarithm of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The binary logarithm of `a`.

`__device__ __nv_bfloat16 hrcp(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` reciprocal in round-to-nearest-even mode.

Calculates `nv_bfloat16` reciprocal of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The reciprocal of `a`.

`__device__ __nv_bfloat16 hrint(const __nv_bfloat16 h)`

Round input to nearest integer value in `nv_bfloat16` floating-point number.

Round `h` to the nearest integer value in `nv_bfloat16` floating-point format, with `bfloat16`way cases rounded to the nearest even integer value.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The nearest integer to `h`.

`__device__ __nv_bfloat16 hrsqrt(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` reciprocal square root in round-to-nearest-even mode.

Calculates `nv_bfloat16` reciprocal square root of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The reciprocal square root of `a`.

`__device__ __nv_bfloat16 hsin(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` sine in round-to-nearest-even mode.

Calculates `nv_bfloat16` sine of input `a` in round-to-nearest-even mode.

NOTE: this function's implementation calls `sinf(float)` function and is exposed to compiler optimizations. Specifically, `--use_fast_math` flag changes `sinf(float)` into an intrinsic `__sinf(float)`, which has less accurate numeric behavior.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat16`

► The sine of `a`.

`__device__ __nv_bfloat16 hsqrt(const __nv_bfloat16 a)`

Calculates `nv_bfloat16` square root in round-to-nearest-even mode.

Calculates `nv_bfloat16` square root of input `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat16`. Is only being read.

Returns

nv_bfloat16

- The square root of a.

`__device__ __nv_bfloat16 htrunc(const __nv_bfloat16 h)`

Truncate input argument to the integral part.

Round h to the nearest integer value that does not exceed h in magnitude.

Parameters

h – [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The truncated integer value.

3.5. Bfloat16 Precision Conversion and Data Movement

To use these functions, include the header file `cuda_bf16.h` in your program.

Functions

`__host__ __device__ float2 __bfloat162float2(const __nv_bfloat162 a)`

Converts both halves of nv_bfloat162 to float2 and returns the result.

`__host__ __device__ __nv_bfloat162 __bfloat162bfloat162(const __nv_bfloat162 a)`

Returns nv_bfloat162 with both halves equal to the input value.

`__host__ __device__ signed char __bfloat162char_rz(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed char in round-towards-zero mode.

`__host__ __device__ float __bfloat162float(const __nv_bfloat162 a)`

Converts nv_bfloat162 number to float.

`__device__ int __bfloat162int_rd(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed integer in round-down mode.

`__device__ int __bfloat162int_rn(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed integer in round-to-nearest-even mode.

`__device__ int __bfloat162int_ru(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed integer in round-up mode.

`__host__ __device__ int __bfloat162int_rz(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed integer in round-towards-zero mode.

`__device__ long long int __bfloat162ll_rd(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed 64-bit integer in round-down mode.

`__device__ long long int __bfloat162ll_rn(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed 64-bit integer in round-to-nearest-even mode.

`__device__ long long int __bfloat162ll_ru(const __nv_bfloat162 a)`

Convert a nv_bfloat162 to a signed 64-bit integer in round-up mode.

- __host__ __device__ long long int __bfloat162ll_rz(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to a signed 64-bit integer in round-towards-zero mode.
- __device__ short int __bfloat162short_rd(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to a signed short integer in round-down mode.
- __device__ short int __bfloat162short_rn(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to a signed short integer in round-to-nearest-even mode.
- __device__ short int __bfloat162short_ru(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to a signed short integer in round-up mode.
- __host__ __device__ short int __bfloat162short_rz(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to a signed short integer in round-towards-zero mode.
- __host__ __device__ unsigned char __bfloat162uchar_rz(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned char in round-towards-zero mode.
- __device__ unsigned int __bfloat162uint_rd(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned integer in round-down mode.
- __device__ unsigned int __bfloat162uint_rn(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned integer in round-to-nearest-even mode.
- __device__ unsigned int __bfloat162uint_ru(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned integer in round-up mode.
- __host__ __device__ unsigned int __bfloat162uint_rz(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned integer in round-towards-zero mode.
- __device__ unsigned long long int __bfloat162ull_rd(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned 64-bit integer in round-down mode.
- __device__ unsigned long long int __bfloat162ull_rn(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned 64-bit integer in round-to-nearest-even mode.
- __device__ unsigned long long int __bfloat162ull_ru(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned 64-bit integer in round-up mode.
- __host__ __device__ unsigned long long int __bfloat162ull_rz(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned 64-bit integer in round-towards-zero mode.
- __device__ unsigned short int __bfloat162ushort_rd(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned short integer in round-down mode.
- __device__ unsigned short int __bfloat162ushort_rn(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned short integer in round-to-nearest-even mode.
- __device__ unsigned short int __bfloat162ushort_ru(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned short integer in round-up mode.
- __host__ __device__ unsigned short int __bfloat162ushort_rz(const __nv_bfloat16 h)**
 Convert a nv_bfloat16 to an unsigned short integer in round-towards-zero mode.
- __host__ __device__ short int __bfloat16_as_short(const __nv_bfloat16 h)**
 Reinterprets bits in a nv_bfloat16 as a signed short integer.
- __host__ __device__ unsigned short int __bfloat16_as_ushort(const __nv_bfloat16 h)**
 Reinterprets bits in a nv_bfloat16 as an unsigned short integer.
- __host__ __device__ __nv_bfloat16 __double2bfloat16(const double a)**
 Converts double number to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat16 with converted value.

- __host__ __device__ __nv_bfloat162 __float22bfloat162_rn(const float2 a)**
 Converts both components of float2 number to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat162 with converted values.
- __host__ __device__ __nv_bfloat16 __float2bfloat16(const float a)**
 Converts float number to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat16 with converted value.
- __host__ __device__ __nv_bfloat162 __float2bfloat162_rn(const float a)**
 Converts input to nv_bfloat16 precision in round-to-nearest-even mode and populates both halves of nv_bfloat162 with converted value.
- __host__ __device__ __nv_bfloat16 __float2bfloat16_rd(const float a)**
 Converts float number to nv_bfloat16 precision in round-down mode and returns nv_bfloat16 with converted value.
- __host__ __device__ __nv_bfloat16 __float2bfloat16_rn(const float a)**
 Converts float number to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat16 with converted value.
- __host__ __device__ __nv_bfloat16 __float2bfloat16_ru(const float a)**
 Converts float number to nv_bfloat16 precision in round-up mode and returns nv_bfloat16 with converted value.
- __host__ __device__ __nv_bfloat16 __float2bfloat16_rz(const float a)**
 Converts float number to nv_bfloat16 precision in round-towards-zero mode and returns nv_bfloat16 with converted value.
- __host__ __device__ __nv_bfloat162 __floats2bfloat162_rn(const float a, const float b)**
 Converts both input floats to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat162 with converted values.
- __host__ __device__ __nv_bfloat162 __halves2bfloat162(const __nv_bfloat16 a, const __nv_bfloat16 b)**
 Combines two nv_bfloat16 numbers into one nv_bfloat162 number.
- __host__ __device__ __nv_bfloat16 __high2bfloat16(const __nv_bfloat162 a)**
 Returns high 16 bits of nv_bfloat162 input.
- __host__ __device__ __nv_bfloat162 __high2bfloat162(const __nv_bfloat162 a)**
 Extracts high 16 bits from nv_bfloat162 input.
- __host__ __device__ float __high2float(const __nv_bfloat162 a)**
 Converts high 16 bits of nv_bfloat162 to float and returns the result.
- __host__ __device__ __nv_bfloat162 __highs2bfloat162(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Extracts high 16 bits from each of the two nv_bfloat162 inputs and combines into one nv_bfloat162 number.
- __device__ __nv_bfloat16 __int2bfloat16_rd(const int i)**
 Convert a signed integer to a nv_bfloat16 in round-down mode.
- __host__ __device__ __nv_bfloat16 __int2bfloat16_rn(const int i)**
 Convert a signed integer to a nv_bfloat16 in round-to-nearest-even mode.
- __device__ __nv_bfloat16 __int2bfloat16_ru(const int i)**
 Convert a signed integer to a nv_bfloat16 in round-up mode.
- __device__ __nv_bfloat16 __int2bfloat16_rz(const int i)**
 Convert a signed integer to a nv_bfloat16 in round-towards-zero mode.

__device__ __nv_bfloat162 __ldca(const __nv_bfloat162 *const ptr)
 Generates a ld.global.ca load instruction.

__device__ __nv_bfloat16 __ldca(const __nv_bfloat16 *const ptr)
 Generates a ld.global.ca load instruction.

__device__ __nv_bfloat16 __ldcg(const __nv_bfloat16 *const ptr)
 Generates a ld.global.cg load instruction.

__device__ __nv_bfloat162 __ldcg(const __nv_bfloat162 *const ptr)
 Generates a ld.global.cg load instruction.

__device__ __nv_bfloat162 __ldcs(const __nv_bfloat162 *const ptr)
 Generates a ld.global.cs load instruction.

__device__ __nv_bfloat16 __ldcs(const __nv_bfloat16 *const ptr)
 Generates a ld.global.cs load instruction.

__device__ __nv_bfloat16 __ldcv(const __nv_bfloat16 *const ptr)
 Generates a ld.global.cv load instruction.

__device__ __nv_bfloat162 __ldcv(const __nv_bfloat162 *const ptr)
 Generates a ld.global.cv load instruction.

__device__ __nv_bfloat162 __ldg(const __nv_bfloat162 *const ptr)
 Generates a ld.global.nc load instruction.

__device__ __nv_bfloat16 __ldg(const __nv_bfloat16 *const ptr)
 Generates a ld.global.nc load instruction.

__device__ __nv_bfloat162 __ldlu(const __nv_bfloat162 *const ptr)
 Generates a ld.global.lu load instruction.

__device__ __nv_bfloat16 __ldlu(const __nv_bfloat16 *const ptr)
 Generates a ld.global.lu load instruction.

__device__ __nv_bfloat16 __ll2bfloat16_rd(const long long int i)
 Convert a signed 64-bit integer to a nv_bfloat16 in round-down mode.

__host__ __device__ __nv_bfloat16 __ll2bfloat16_rn(const long long int i)
 Convert a signed 64-bit integer to a nv_bfloat16 in round-to-nearest-even mode.

__device__ __nv_bfloat16 __ll2bfloat16_ru(const long long int i)
 Convert a signed 64-bit integer to a nv_bfloat16 in round-up mode.

__device__ __nv_bfloat16 __ll2bfloat16_rz(const long long int i)
 Convert a signed 64-bit integer to a nv_bfloat16 in round-towards-zero mode.

__host__ __device__ __nv_bfloat16 __low2bfloat16(const __nv_bfloat162 a)
 Returns low 16 bits of nv_bfloat162 input.

__host__ __device__ __nv_bfloat162 __low2bfloat162(const __nv_bfloat162 a)
 Extracts low 16 bits from nv_bfloat162 input.

__host__ __device__ float __low2float(const __nv_bfloat162 a)
 Converts low 16 bits of nv_bfloat162 to float and returns the result.

__host__ __device__ __nv_bfloat162 __lowhigh2highlow(const __nv_bfloat162 a)
 Swaps both halves of the nv_bfloat162 input.

__host__ __device__ __nv_bfloat162 __lows2bfloat162(const __nv_bfloat162 a, const __nv_bfloat162 b)
 Extracts low 16 bits from each of the two nv_bfloat162 inputs and combines into one nv_bfloat162 number.

__nv_bfloat162::__nv_bfloat162()=default

Constructor by default.

__host__ __device__ constexpr __nv_bfloat162::__nv_bfloat162(const __nv_bfloat16 &a, const __nv_bfloat16 &b)

Constructor from two __nv_bfloat16 variables.

__host__ __device__ __nv_bfloat162::__nv_bfloat162(__nv_bfloat162 &&src)

Move constructor, available for C++11 and later dialects.

__host__ __device__ __nv_bfloat162::__nv_bfloat162(const __nv_bfloat162_raw &h2r)

Constructor from __nv_bfloat162_raw .

__host__ __device__ __nv_bfloat162::__nv_bfloat162(const __nv_bfloat162 &src)

Copy constructor.

__host__ __device__ __nv_bfloat162::operator __nv_bfloat162_raw() const

Conversion operator to __nv_bfloat162_raw .

__host__ __device__ __nv_bfloat162 & __nv_bfloat162::operator=(const __nv_bfloat162 &src)

Copy assignment operator.

__host__ __device__ __nv_bfloat162 & __nv_bfloat162::operator=(const __nv_bfloat162_raw &h2r)

Assignment operator from __nv_bfloat162_raw .

__host__ __device__ __nv_bfloat162 & __nv_bfloat162::operator=(__nv_bfloat162 &&src)

Move assignment operator, available for C++11 and later dialects.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(const double f)

Construct __nv_bfloat16 from double input using default round-to-nearest-even rounding mode.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(const float f)

Construct __nv_bfloat16 from float input using default round-to-nearest-even rounding mode.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(long long val)

Construct __nv_bfloat16 from long long input using default round-to-nearest-even rounding mode.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(unsigned short val)

Construct __nv_bfloat16 from unsigned short integer input using default round-to-nearest-even rounding mode.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(unsigned int val)

Construct __nv_bfloat16 from unsigned int input using default round-to-nearest-even rounding mode.

__nv_bfloat16::__nv_bfloat16()=default

Constructor by default.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(const __half f)

Construct __nv_bfloat16 from __half input using default round-to-nearest-even rounding mode.

__host__ __device__ __nv_bfloat16::__nv_bfloat16(short val)

Construct __nv_bfloat16 from short integer input using default round-to-nearest-even rounding mode.

__host__ __device__ constexpr __nv_bfloat16::__nv_bfloat16(const __nv_bfloat16_raw &hr)

Constructor from __nv_bfloat16_raw .

- __host__ __device__ __nv_bfloat16::__nv_bfloat16(unsigned long long val)**
Construct __nv_bfloat16 from unsigned long long input using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16::__nv_bfloat16(int val)**
Construct __nv_bfloat16 from int input using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16::__nv_bfloat16(const unsigned long val)**
Construct __nv_bfloat16 from unsigned long input using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16::__nv_bfloat16(const long val)**
Construct __nv_bfloat16 from long input using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16::operator __nv_bfloat16_raw() const**
Type cast to __nv_bfloat16_raw operator.
- __host__ __device__ __nv_bfloat16::operator __nv_bfloat16_raw() const volatile**
Type cast to __nv_bfloat16_raw operator with volatile input.
- __host__ __device__ constexpr __nv_bfloat16::operator bool() const**
Conversion operator to bool data type.
- __host__ __device__ __nv_bfloat16::operator char() const**
Conversion operator to an implementation defined char data type.
- __host__ __device__ __nv_bfloat16::operator float() const**
Type cast to float operator.
- __host__ __device__ __nv_bfloat16::operator int() const**
Conversion operator to int data type.
- __host__ __device__ __nv_bfloat16::operator long() const**
Conversion operator to long data type.
- __host__ __device__ __nv_bfloat16::operator long long() const**
Conversion operator to long long data type.
- __host__ __device__ __nv_bfloat16::operator short() const**
Conversion operator to short data type.
- __host__ __device__ __nv_bfloat16::operator signed char() const**
Conversion operator to signed char data type.
- __host__ __device__ __nv_bfloat16::operator unsigned char() const**
Conversion operator to unsigned char data type.
- __host__ __device__ __nv_bfloat16::operator unsigned int() const**
Conversion operator to unsigned int data type.
- __host__ __device__ __nv_bfloat16::operator unsigned long() const**
Conversion operator to unsigned long data type.
- __host__ __device__ __nv_bfloat16::operator unsigned long long() const**
Conversion operator to unsigned long long data type.
- __host__ __device__ __nv_bfloat16::operator unsigned short() const**
Conversion operator to unsigned short data type.
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(const __nv_bfloat16_raw &hr)**
Assignment operator from __nv_bfloat16_raw.

- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(unsigned int val)**
 Type cast from unsigned int assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(int val)**
 Type cast from int assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(long long val)**
 Type cast from long long assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(unsigned long long val)**
 Type cast from unsigned long long assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(unsigned short val)**
 Type cast from unsigned short assignment operator, using default round-to-nearest-even rounding mode.
- __host__ __device__ volatile __nv_bfloat16 & __nv_bfloat16::operator=(const __nv_bfloat16_raw &hr) volatile**
 Assignment operator from __nv_bfloat16_raw to volatile __nv_bfloat16 .
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(const double f)**
 Type cast to __nv_bfloat16 assignment operator from double input using default round-to-nearest-even rounding mode.
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(const float f)**
 Type cast to __nv_bfloat16 assignment operator from float input using default round-to-nearest-even rounding mode.
- __host__ __device__ volatile __nv_bfloat16 & __nv_bfloat16::operator=(const volatile __nv_bfloat16_raw &hr) volatile**
 Assignment operator from volatile __nv_bfloat16_raw to volatile __nv_bfloat16 .
- __host__ __device__ __nv_bfloat16 & __nv_bfloat16::operator=(short val)**
 Type cast from short assignment operator, using default round-to-nearest-even rounding mode.
- __device__ __nv_bfloat162 __shfl_down_sync(const unsigned int mask, const __nv_bfloat162 var, const unsigned int delta, const int width=warpSize)**
 Exchange a variable between threads within a warp.
- __device__ __nv_bfloat16 __shfl_down_sync(const unsigned int mask, const __nv_bfloat16 var, const unsigned int delta, const int width=warpSize)**
 Exchange a variable between threads within a warp.
- __device__ __nv_bfloat162 __shfl_sync(const unsigned int mask, const __nv_bfloat162 var, const int srcLane, const int width=warpSize)**
 Exchange a variable between threads within a warp.
- __device__ __nv_bfloat16 __shfl_sync(const unsigned int mask, const __nv_bfloat16 var, const int srcLane, const int width=warpSize)**
 Exchange a variable between threads within a warp.
- __device__ __nv_bfloat16 __shfl_up_sync(const unsigned int mask, const __nv_bfloat16 var, const unsigned int delta, const int width=warpSize)**
 Exchange a variable between threads within a warp.
- __device__ __nv_bfloat162 __shfl_up_sync(const unsigned int mask, const __nv_bfloat162 var, const unsigned int delta, const int width=warpSize)**
 Exchange a variable between threads within a warp.

__device__ __nv_bfloat16 __shfl_xor_sync(const unsigned int mask, const __nv_bfloat16 var, const int laneMask, const int width=warpSize)

Exchange a variable between threads within a warp.

__device__ __nv_bfloat162 __shfl_xor_sync(const unsigned int mask, const __nv_bfloat162 var, const int laneMask, const int width=warpSize)

Exchange a variable between threads within a warp.

__device__ __nv_bfloat16 __short2bfloat16_rd(const short int i)

Convert a signed short integer to a nv_bfloat16 in round-down mode.

__host__ __device__ __nv_bfloat16 __short2bfloat16_rn(const short int i)

Convert a signed short integer to a nv_bfloat16 in round-to-nearest-even mode.

__device__ __nv_bfloat16 __short2bfloat16_ru(const short int i)

Convert a signed short integer to a nv_bfloat16 in round-up mode.

__device__ __nv_bfloat16 __short2bfloat16_rz(const short int i)

Convert a signed short integer to a nv_bfloat16 in round-towards-zero mode.

__host__ __device__ __nv_bfloat16 __short_as_bfloat16(const short int i)

Reinterprets bits in a signed short integer as a nv_bfloat16 .

__device__ void __stcg(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)

Generates a st.global.cg store instruction.

__device__ void __stcg(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)

Generates a st.global.cg store instruction.

__device__ void __stcs(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)

Generates a st.global.cs store instruction.

__device__ void __stcs(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)

Generates a st.global.cs store instruction.

__device__ void __stwb(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)

Generates a st.global.wb store instruction.

__device__ void __stwb(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)

Generates a st.global.wb store instruction.

__device__ void __stwt(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)

Generates a st.global.wt store instruction.

__device__ void __stwt(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)

Generates a st.global.wt store instruction.

__device__ __nv_bfloat16 __uint2bfloat16_rd(const unsigned int i)

Convert an unsigned integer to a nv_bfloat16 in round-down mode.

__host__ __device__ __nv_bfloat16 __uint2bfloat16_rn(const unsigned int i)

Convert an unsigned integer to a nv_bfloat16 in round-to-nearest-even mode.

__device__ __nv_bfloat16 __uint2bfloat16_ru(const unsigned int i)

Convert an unsigned integer to a nv_bfloat16 in round-up mode.

__device__ __nv_bfloat16 __uint2bfloat16_rz(const unsigned int i)

Convert an unsigned integer to a nv_bfloat16 in round-towards-zero mode.

__device__ __nv_bfloat16 __ull2bfloat16_rd(const unsigned long long int i)

Convert an unsigned 64-bit integer to a nv_bfloat16 in round-down mode.

__host__ __device__ __nv_bfloat16 __ull2bfloat16_rn(const unsigned long long int i)

Convert an unsigned 64-bit integer to a nv_bfloat16 in round-to-nearest-even mode.

- __device__ __nv_bfloat16 __ull2bfloat16_ru(const unsigned long long int i)**
 Convert an unsigned 64-bit integer to a nv_bfloat16 in round-up mode.
- __device__ __nv_bfloat16 __ull2bfloat16_rz(const unsigned long long int i)**
 Convert an unsigned 64-bit integer to a nv_bfloat16 in round-towards-zero mode.
- __device__ __nv_bfloat16 __ushort2bfloat16_rd(const unsigned short int i)**
 Convert an unsigned short integer to a nv_bfloat16 in round-down mode.
- __host__ __device__ __nv_bfloat16 __ushort2bfloat16_rn(const unsigned short int i)**
 Convert an unsigned short integer to a nv_bfloat16 in round-to-nearest-even mode.
- __device__ __nv_bfloat16 __ushort2bfloat16_ru(const unsigned short int i)**
 Convert an unsigned short integer to a nv_bfloat16 in round-up mode.
- __device__ __nv_bfloat16 __ushort2bfloat16_rz(const unsigned short int i)**
 Convert an unsigned short integer to a nv_bfloat16 in round-towards-zero mode.
- __host__ __device__ __nv_bfloat16 __ushort_as_bfloat16(const unsigned short int i)**
 Reinterprets bits in an unsigned short integer as a nv_bfloat16 .
- __host__ __device__ __nv_bfloat162 make_bfloat162(const __nv_bfloat16 x, const __nv_bfloat16 y)**
 Vector function, combines two nv_bfloat16 numbers into one nv_bfloat162 number.

3.5.1. Functions

- __host__ __device__ float2 __bfloat1622float2(const __nv_bfloat162 a)**
 Converts both halves of nv_bfloat162 to float2 and returns the result.
 Converts both halves of nv_bfloat162 input a to float and returns the result as a float2 packed value.

See also:

[__bfloat162float\(__nv_bfloat16\)](#) for further details.

Parameters

a - [in] - nv_bfloat162. Is only being read.

Returns

float2

- ▶ a converted to float2.

- __host__ __device__ __nv_bfloat162 __bfloat162bfloat162(const __nv_bfloat16 a)**
 Returns nv_bfloat162 with both halves equal to the input value.
 Returns nv_bfloat162 number with both halves equal to the input a nv_bfloat16 number.

Parameters

a - [in] - nv_bfloat16. Is only being read.

Returns

nv_bfloat162

- ▶ The vector which has both its halves equal to the input a.

`__host__ __device__ signed char __bfloat162char_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed char in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed char in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

signed char

- ▶ `h` converted to a signed char using round-towards-zero mode.
- ▶ `__bfloat162char_rz(±0)` returns 0.
- ▶ `__bfloat162char_rz(x), x > 127` returns `SCHAR_MAX = 0x7F`.
- ▶ `__bfloat162char_rz(x), x < -128` returns `SCHAR_MIN = 0x80`.
- ▶ `__bfloat162char_rz(NaN)` returns 0.

`__host__ __device__ float __bfloat162float(const __nv_bfloat16 a)`

Converts `nv_bfloat16` number to float.

Converts `nv_bfloat16` number `a` to float.

Parameters

a – [in] - float. Is only being read.

Returns

float

- ▶ `a` converted to float.
- ▶ `__bfloat162float(±0)` returns `±0`.
- ▶ `__bfloat162float(±∞)` returns `±∞`.
- ▶ `__bfloat162float(NaN)` returns NaN.

`__device__ int __bfloat162int_rd(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed integer in round-down mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

int

- ▶ `h` converted to a signed integer using round-down mode.
- ▶ `__bfloat162int_rd(±0)` returns 0.
- ▶ `__bfloat162int_rd(x), x > INT_MAX` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__bfloat162int_rd(x), x < INT_MIN` returns `INT_MIN = 0x80000000`.
- ▶ `__bfloat162int_rd(NaN)` returns 0.*

`__device__ int __bfloat162int_rn(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed integer in round-to-nearest-even mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

int

- ▶ `h` converted to a signed integer using round-to-nearest-even mode.
- ▶ `__bfloat162int_rn(±0)` returns 0.
- ▶ `__bfloat162int_rn(x), x > INT_MAX` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__bfloat162int_rn(x), x < INT_MIN` returns `INT_MIN = 0x80000000`.
- ▶ `__bfloat162int_rn(NaN)` returns 0.

`__device__ int __bfloat162int_ru(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed integer in round-up mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

int

- ▶ `h` converted to a signed integer using round-up mode.
- ▶ `__bfloat162int_ru(±0)` returns 0.
- ▶ `__bfloat162int_ru(x), x > INT_MAX` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__bfloat162int_ru(x), x < INT_MIN` returns `INT_MIN = 0x80000000`.
- ▶ `__bfloat162int_ru(NaN)` returns 0.

`__host__ __device__ int __bfloat162int_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed integer in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

int

- ▶ `h` converted to a signed integer using round-towards-zero mode.
- ▶ `__bfloat162int_rz(±0)` returns 0.
- ▶ `__bfloat162int_rz(x), x > INT_MAX` returns `INT_MAX = 0x7FFFFFFF`.
- ▶ `__bfloat162int_rz(x), x < INT_MIN` returns `INT_MIN = 0x80000000`.
- ▶ `__bfloat162int_rz(NaN)` returns 0.

`__device__ long long int __bfloat16211_rd(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed 64-bit integer in round-down mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed 64-bit integer in round-down mode. NaN inputs return a long long int with hex value of 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

long long int

- ▶ `h` converted to a signed 64-bit integer.

`__device__ long long int __bfloat16211_rn(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed 64-bit integer in round-to-nearest-even mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed 64-bit integer in round-to-nearest-even mode. NaN inputs return a long long int with hex value of 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

long long int

- ▶ `h` converted to a signed 64-bit integer.

`__device__ long long int __bfloat16211_ru(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed 64-bit integer in round-up mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed 64-bit integer in round-up mode. NaN inputs return a long long int with hex value of 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

long long int

- ▶ `h` converted to a signed 64-bit integer.

`__host__ __device__ long long int __bfloat16211_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed 64-bit integer in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed 64-bit integer in round-towards-zero mode. NaN inputs return a long long int with hex value of 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

long long int

- ▶ `h` converted to a signed 64-bit integer.

`__device__ short int __bfloat162short_rd(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to a signed short integer in round-down mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed short integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

short int

- ▶ `h` converted to a signed short integer using round-down mode.
- ▶ `__bfloat162short_rd(±0)` returns 0.
- ▶ `__bfloat162short_rd(x), x > 32767` returns `SHRT_MAX = 0x7FFF`.
- ▶ `__bfloat162short_rd(x), x < -32768` returns `SHRT_MIN = 0x8000`.
- ▶ `__bfloat162short_rd(NaN)` returns 0.

`__device__` short int **__bfloat162short_rn**(const `__nv_bfloat16` `h`)

Convert a `nv_bfloat16` to a signed short integer in round-to-nearest-even mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed short integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

short int

- ▶ `h` converted to a signed short integer using round-to-nearest-even mode.
- ▶ `__bfloat162short_rn(±0)` returns 0.
- ▶ `__bfloat162short_rn(x), x > 32767` returns `SHRT_MAX = 0x7FFF`.
- ▶ `__bfloat162short_rn(x), x < -32768` returns `SHRT_MIN = 0x8000`.
- ▶ `__bfloat162short_rn(NaN)` returns 0.

`__device__` short int **__bfloat162short_ru**(const `__nv_bfloat16` `h`)

Convert a `nv_bfloat16` to a signed short integer in round-up mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed short integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

short int

- ▶ `h` converted to a signed short integer using round-up mode.
- ▶ `__bfloat162short_ru(±0)` returns 0.
- ▶ `__bfloat162short_ru(x), x > 32767` returns `SHRT_MAX = 0x7FFF`.
- ▶ `__bfloat162short_ru(x), x < -32768` returns `SHRT_MIN = 0x8000`.
- ▶ `__bfloat162short_ru(NaN)` returns 0.

`__host__ __device__` short int **__bfloat162short_rz**(const `__nv_bfloat16` `h`)

Convert a `nv_bfloat16` to a signed short integer in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to a signed short integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

short int

- ▶ `h` converted to a signed short integer using round-towards-zero mode.
- ▶ `__bfloat162short_rz(±0)` returns 0.
- ▶ `__bfloat162short_rz(x), x > 32767` returns `SHRT_MAX = 0x7FFF`.
- ▶ `__bfloat162short_rz(x), x < -32768` returns `SHRT_MIN = 0x8000`.
- ▶ `__bfloat162short_rz(NaN)` returns 0.

`__host__ __device__ unsigned char __bfloat162uchar_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned char in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned char in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned char

- ▶ `h` converted to an unsigned char using round-towards-zero mode.
- ▶ `__bfloat162uchar_rz(±0)` returns 0.
- ▶ `__bfloat162uchar_rz(x), x > 255` returns `UCHAR_MAX = 0xFF`.
- ▶ `__bfloat162uchar_rz(x), x < 0.0` returns 0.
- ▶ `__bfloat162uchar_rz(NaN)` returns 0.

`__device__ unsigned int __bfloat162uint_rd(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned integer in round-down mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned int

- ▶ `h` converted to an unsigned integer.

`__device__ unsigned int __bfloat162uint_rn(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned integer in round-to-nearest-even mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned int

- ▶ `h` converted to an unsigned integer.

`__device__ unsigned int __bfloat162uint_ru(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned integer in round-up mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned int

- ▶ `h` converted to an unsigned integer.

`__host__ __device__ unsigned int __bfloat162uint_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned integer in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned int

- ▶ `h` converted to an unsigned integer.

`__device__ unsigned long long int __bfloat162ull_rd(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned 64-bit integer in round-down mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned 64-bit integer in round-down mode. NaN inputs return 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned long long int

- ▶ `h` converted to an unsigned 64-bit integer.

`__device__ unsigned long long int __bfloat162ull_rn(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned 64-bit integer in round-to-nearest-even mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned 64-bit integer in round-to-nearest-even mode. NaN inputs return 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned long long int

- ▶ `h` converted to an unsigned 64-bit integer.

`__device__ unsigned long long int __bfloat162ull_ru(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned 64-bit integer in round-up mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned 64-bit integer in round-up mode. NaN inputs return 0x8000000000000000.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned long long int

- ▶ h converted to an unsigned 64-bit integer.

`__host__ __device__ unsigned long long int __bfloat162u11_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned 64-bit integer in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned 64-bit integer in round-towards-zero mode. NaN inputs return `0x8000000000000000`.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned long long int

- ▶ h converted to an unsigned 64-bit integer.

`__device__ unsigned short int __bfloat162ushort_rd(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned short integer in round-down mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned short integer in round-down mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned short int

- ▶ h converted to an unsigned short integer.

`__device__ unsigned short int __bfloat162ushort_rn(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned short integer in round-to-nearest-even mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned short integer in round-to-nearest-even mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned short int

- ▶ h converted to an unsigned short integer.

`__device__ unsigned short int __bfloat162ushort_ru(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned short integer in round-up mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned short integer in round-up mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned short int

- ▶ h converted to an unsigned short integer.

`__host__ __device__ unsigned short int __bfloat162ushort_rz(const __nv_bfloat16 h)`

Convert a `nv_bfloat16` to an unsigned short integer in round-towards-zero mode.

Convert the `nv_bfloat16` floating-point value `h` to an unsigned short integer in round-towards-zero mode. NaN inputs are converted to 0.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned short int

- ▶ `h` converted to an unsigned short integer.

`__host__ __device__ short int __bfloat16_as_short(const __nv_bfloat16 h)`

Reinterprets bits in a `nv_bfloat16` as a signed short integer.

Reinterprets the bits in the `nv_bfloat16` floating-point number `h` as a signed short integer.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

short int

- ▶ The reinterpreted value.

`__host__ __device__ unsigned short int __bfloat16_as_ushort(const __nv_bfloat16 h)`

Reinterprets bits in a `nv_bfloat16` as an unsigned short integer.

Reinterprets the bits in the `nv_bfloat16` floating-point `h` as an unsigned short number.

Parameters

h – [in] - `nv_bfloat16`. Is only being read.

Returns

unsigned short int

- ▶ The reinterpreted value.

`__host__ __device__ __nv_bfloat16 __double2bfloat16(const double a)`

Converts double number to `nv_bfloat16` precision in round-to-nearest-even mode and returns `nv_bfloat16` with converted value.

Converts double number `a` to `nv_bfloat16` precision in round-to-nearest-even mode.

Parameters

a – [in] - double. Is only being read.

Returns

`nv_bfloat16`

- ▶ `a` converted to `nv_bfloat16` using round-to-nearest-even mode.
- ▶ `__double2bfloat16(±0)` returns `±0`.
- ▶ `__double2bfloat16(±∞)` returns `±∞`.
- ▶ `__double2bfloat16(NaN)` returns NaN.

`__host__ __device__ __nv_bfloat162 __float22bfloat162_rn(const float2 a)`

Converts both components of `float2` number to `nv_bfloat16` precision in round-to-nearest-even mode and returns `nv_bfloat162` with converted values.

Converts both components of float2 to nv_bfloat16 precision in round-to-nearest-even mode and combines the results into one nv_bfloat162 number. Low 16 bits of the return value correspond to a.x and high 16 bits of the return value correspond to a.y.

See also:

[__float2bfloat16_rn\(float\)](#) for further details.

Parameters

a – [in] - float2. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 which has corresponding halves equal to the converted float2 components.

`__host__ __device__ __nv_bfloat16 __float2bfloat16(const float a)`

Converts float number to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat16 with converted value.

Converts float number a to nv_bfloat16 precision in round-to-nearest-even mode.

See also:

[__float2bfloat16_rn\(float\)](#) for further details.

Parameters

a – [in] - float. Is only being read.

Returns

nv_bfloat16

- ▶ a converted to nv_bfloat16 using round-to-nearest-even mode.

`__host__ __device__ __nv_bfloat162 __float2bfloat162_rn(const float a)`

Converts input to nv_bfloat16 precision in round-to-nearest-even mode and populates both halves of nv_bfloat162 with converted value.

Converts input a to nv_bfloat16 precision in round-to-nearest-even mode and populates both halves of nv_bfloat162 with converted value.

See also:

[__float2bfloat16_rn\(float\)](#) for further details.

Parameters

a – [in] - float. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 value with both halves equal to the converted nv_bfloat16 precision number.

`__host__ __device__ __nv_bfloat16 __float2bfloat16_rd(const float a)`

Converts float number to nv_bfloat16 precision in round-down mode and returns nv_bfloat16 with converted value.

Converts float number a to nv_bfloat16 precision in round-down mode.

Parameters

a – [in] - float. Is only being read.

Returns

nv_bfloat16

- ▶ a converted to nv_bfloat16 using round-down mode.
- ▶ __float2bfloat16_rd(± 0) returns ± 0 .
- ▶ __float2bfloat16_rd($\pm \infty$) returns $\pm \infty$.
- ▶ __float2bfloat16_rd(NaN) returns NaN.

__host__ __device__ *__nv_bfloat16* **__float2bfloat16_rn**(const float a)

Converts float number to nv_bfloat16 precision in round-to-nearest-even mode and returns nv_bfloat16 with converted value.

Converts float number a to nv_bfloat16 precision in round-to-nearest-even mode.

Parameters

a – [in] - float. Is only being read.

Returns

nv_bfloat16

- ▶ a converted to nv_bfloat16 using round-to-nearest-even mode.
- ▶ __float2bfloat16_rn(± 0) returns ± 0 .
- ▶ __float2bfloat16_rn($\pm \infty$) returns $\pm \infty$.
- ▶ __float2bfloat16_rn(NaN) returns NaN.

__host__ __device__ *__nv_bfloat16* **__float2bfloat16_ru**(const float a)

Converts float number to nv_bfloat16 precision in round-up mode and returns nv_bfloat16 with converted value.

Converts float number a to nv_bfloat16 precision in round-up mode.

Parameters

a – [in] - float. Is only being read.

Returns

nv_bfloat16

- ▶ a converted to nv_bfloat16 using round-up mode.
- ▶ __float2bfloat16_ru(± 0) returns ± 0 .
- ▶ __float2bfloat16_ru($\pm \infty$) returns $\pm \infty$.
- ▶ __float2bfloat16_ru(NaN) returns NaN.

__host__ __device__ *__nv_bfloat16* **__float2bfloat16_rz**(const float a)

Converts float number to nv_bfloat16 precision in round-towards-zero mode and returns nv_bfloat16 with converted value.

Converts float number a to nv_bfloat16 precision in round-towards-zero mode.

Parameters

a – [in] - float. Is only being read.

Returns

nv_bfloat16

- ▶ a converted to `nv_bfloat16` using round-towards-zero mode.
- ▶ `__float2bfloat16_rz(±0)` returns ± 0 .
- ▶ `__float2bfloat16_rz(±∞)` returns $\pm \infty$.
- ▶ `__float2bfloat16_rz(NaN)` returns NaN.

`__host__ __device__ __nv_bfloat162 __floats2bfloat162_rn(const float a, const float b)`

Converts both input floats to `nv_bfloat16` precision in round-to-nearest-even mode and returns `nv_bfloat162` with converted values.

Converts both input floats to `nv_bfloat16` precision in round-to-nearest-even mode and combines the results into one `nv_bfloat162` number. Low 16 bits of the return value correspond to the input a, high 16 bits correspond to the input b.

See also:

[`__float2bfloat16_rn\(float\)`](#) for further details.

Parameters

- ▶ **a** - **[in]** - float. Is only being read.
- ▶ **b** - **[in]** - float. Is only being read.

Returns

`nv_bfloat162`

- ▶ The `nv_bfloat162` value with corresponding halves equal to the converted input floats.

`__host__ __device__ __nv_bfloat162 __halves2bfloat162(const __nv_bfloat16 a, const __nv_bfloat16 b)`

Combines two `nv_bfloat16` numbers into one `nv_bfloat162` number.

Combines two input `nv_bfloat16` number a and b into one `nv_bfloat162` number. Input a is stored in low 16 bits of the return value, input b is stored in high 16 bits of the return value.

Parameters

- ▶ **a** - **[in]** - `nv_bfloat16`. Is only being read.
- ▶ **b** - **[in]** - `nv_bfloat16`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The `nv_bfloat162` with one `nv_bfloat16` equal to a and the other to b.

`__host__ __device__ __nv_bfloat16 __high2bfloat16(const __nv_bfloat162 a)`

Returns high 16 bits of `nv_bfloat162` input.

Returns high 16 bits of `nv_bfloat162` input a.

Parameters

a - **[in]** - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat16`

- ▶ The high 16 bits of the input.

`__host__ __device__ __nv_bfloat162 __high2bfloat162(const __nv_bfloat162 a)`

Extracts high 16 bits from `nv_bfloat162` input.

Extracts high 16 bits from `nv_bfloat162` input `a` and returns a new `nv_bfloat162` number which has both halves equal to the extracted bits.

Parameters

a – **[in]** - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The `nv_bfloat162` with both halves equal to the high 16 bits of the input.

`__host__ __device__ float __high2float(const __nv_bfloat162 a)`

Converts high 16 bits of `nv_bfloat162` to `float` and returns the result.

Converts high 16 bits of `nv_bfloat162` input `a` to 32-bit floating-point number and returns the result.

See also:

[`__bfloat162float\(__nv_bfloat16\)`](#) for further details.

Parameters

a – **[in]** - `nv_bfloat162`. Is only being read.

Returns

`float`

- ▶ The high 16 bits of `a` converted to `float`.

`__host__ __device__ __nv_bfloat162 __highs2bfloat162(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Extracts high 16 bits from each of the two `nv_bfloat162` inputs and combines into one `nv_bfloat162` number.

Extracts high 16 bits from each of the two `nv_bfloat162` inputs and combines into one `nv_bfloat162` number. High 16 bits from input `a` is stored in low 16 bits of the return value, high 16 bits from input `b` is stored in high 16 bits of the return value.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The high 16 bits of `a` and of `b`.

`__device__ __nv_bfloat16 __int2bfloat16_rd(const int i)`

Convert a signed integer to a `nv_bfloat16` in round-down mode.

Convert the signed integer value `i` to a `nv_bfloat16` floating-point value in round-down mode.

Parameters

i – **[in]** - `int`. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 __int2bfloat16_rn(const int i)`

Convert a signed integer to a `nv_bfloat16` in round-to-nearest-even mode.

Convert the signed integer value `i` to a `nv_bfloat16` floating-point value in round-to-nearest-even mode.

Parameters

`i` – [in] - int. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __int2bfloat16_ru(const int i)`

Convert a signed integer to a `nv_bfloat16` in round-up mode.

Convert the signed integer value `i` to a `nv_bfloat16` floating-point value in round-up mode.

Parameters

`i` – [in] - int. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __int2bfloat16_rz(const int i)`

Convert a signed integer to a `nv_bfloat16` in round-towards-zero mode.

Convert the signed integer value `i` to a `nv_bfloat16` floating-point value in round-towards-zero mode.

Parameters

`i` – [in] - int. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat162 __ldca(const __nv_bfloat162 *const ptr)`

Generates a `ld.global.ca` load instruction.

Parameters

`ptr` – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ldca(const __nv_bfloat16 *const ptr)`

Generates a `ld.global.ca` load instruction.

Parameters

`ptr` – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ldcg(const __nv_bfloat16 *const ptr)`

Generates a `ld.global.cg` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat162 __ldcg(const __nv_bfloat162 *const ptr)`

Generates a `ld.global.cg` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat162 __ldcs(const __nv_bfloat162 *const ptr)`

Generates a `ld.global.cs` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ldcs(const __nv_bfloat16 *const ptr)`

Generates a `ld.global.cs` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ldcv(const __nv_bfloat16 *const ptr)`

Generates a `ld.global.cv` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat162 __ldcv(const __nv_bfloat162 *const ptr)`

Generates a `ld.global.cv` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat162 __ldg(const __nv_bfloat162 *const ptr)`

Generates a `ld.global.nc` load instruction.

Parameters

`ptr` - [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ldg(const __nv_bfloat16 *const ptr)`

Generates a `ld.global.nc` load instruction.

Parameters

`ptr` – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat162 __ldlu(const __nv_bfloat162 *const ptr)`

Generates a `ld.global.lu` load instruction.

Parameters

`ptr` – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ldlu(const __nv_bfloat16 *const ptr)`

Generates a `ld.global.lu` load instruction.

Parameters

`ptr` – [in] - memory location

Returns

The value pointed by `ptr`

`__device__ __nv_bfloat16 __ll2bfloat16_rd(const long long int i)`

Convert a signed 64-bit integer to a `nv_bfloat16` in round-down mode.

Convert the signed 64-bit integer value `i` to a `nv_bfloat16` floating-point value in round-down mode.

Parameters

`i` – [in] - long long int. Is only being read.

Returns

`nv_bfloat16`

► `i` converted to `nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 __ll2bfloat16_rn(const long long int i)`

Convert a signed 64-bit integer to a `nv_bfloat16` in round-to-nearest-even mode.

Convert the signed 64-bit integer value `i` to a `nv_bfloat16` floating-point value in round-to-nearest-even mode.

Parameters

`i` – [in] - long long int. Is only being read.

Returns

`nv_bfloat16`

► `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __ll2bfloat16_ru(const long long int i)`

Convert a signed 64-bit integer to a `nv_bfloat16` in round-up mode.

Convert the signed 64-bit integer value `i` to a `nv_bfloat16` floating-point value in round-up mode.

Parameters

`i` – [in] - long long int. Is only being read.

Returns

nv_bfloat16

- i converted to nv_bfloat16.

`__device__ __nv_bfloat16 __112bfloat16_rz(const long long int i)`

Convert a signed 64-bit integer to a nv_bfloat16 in round-towards-zero mode.

Convert the signed 64-bit integer value `i` to a nv_bfloat16 floating-point value in round-towards-zero mode.

Parameters

i – [in] - long long int. Is only being read.

Returns

nv_bfloat16

- i converted to nv_bfloat16.

`__host__ __device__ __nv_bfloat16 __low2bfloat16(const __nv_bfloat162 a)`

Returns low 16 bits of nv_bfloat162 input.

Returns low 16 bits of nv_bfloat162 input `a`.

Parameters

a – [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat16

- Returns nv_bfloat16 which contains low 16 bits of the input `a`.

`__host__ __device__ __nv_bfloat162 __low2bfloat162(const __nv_bfloat162 a)`

Extracts low 16 bits from nv_bfloat162 input.

Extracts low 16 bits from nv_bfloat162 input `a` and returns a new nv_bfloat162 number which has both halves equal to the extracted bits.

Parameters

a – [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The nv_bfloat162 with both halves equal to the low 16 bits of the input.

`__host__ __device__ float __low2float(const __nv_bfloat162 a)`

Converts low 16 bits of nv_bfloat162 to float and returns the result.

Converts low 16 bits of nv_bfloat162 input `a` to 32-bit floating-point number and returns the result.

See also:

[__bfloat162float\(__nv_bfloat16\)](#) for further details.

Parameters

a – [in] - nv_bfloat162. Is only being read.

Returns

float

- The low 16 bits of `a` converted to float.

`__host__ __device__ __nv_bfloat162 __lowhigh2highlow(const __nv_bfloat162 a)`

Swaps both halves of the `nv_bfloat162` input.

Swaps both halves of the `nv_bfloat162` input and returns a new `nv_bfloat162` number with swapped halves.

Parameters

▶ **a** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

▶ **a** with its halves being swapped.

`__host__ __device__ __nv_bfloat162 __lows2bfloat162(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Extracts low 16 bits from each of the two `nv_bfloat162` inputs and combines into one `nv_bfloat162` number.

Extracts low 16 bits from each of the two `nv_bfloat162` inputs and combines into one `nv_bfloat162` number. Low 16 bits from input `a` is stored in low 16 bits of the return value, low 16 bits from input `b` is stored in high 16 bits of the return value.

Parameters

▶ **a** – [in] - `nv_bfloat162`. Is only being read.

▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

▶ The low 16 bits of `a` and of `b`.

`__device__ __nv_bfloat162 __shfl_down_sync(const unsigned int mask, const __nv_bfloat162 var, const unsigned int delta, const int width = warpSize)`

Exchange a variable between threads within a warp.

Copy from a thread with higher ID relative to the caller.

Calculates a source thread ID by adding `delta` to the caller's thread ID. The value of `var` held by the resulting thread ID is returned: this has the effect of shifting `var` down the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. As for `__shfl_up_sync()`, the ID number of the source thread will not wrap around the value of `width` and so the upper `delta` threads will remain unchanged. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

▶ **mask** – [in] - unsigned int. Is only being read.

▶ Indicates the threads participating in the call.

- ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
- ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **delta** – **[in]** - unsigned int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 4-byte word referenced by `var` from the source thread ID as `nv_bfloat162`.

`__device__ __nv_bfloat16 __shfl_down_sync`(const unsigned int mask, const `__nv_bfloat16` var, const unsigned int delta, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread with higher ID relative to the caller.

Calculates a source thread ID by adding `delta` to the caller's thread ID. The value of `var` held by the resulting thread ID is returned: this has the effect of shifting `var` down the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. As for `__shfl_up_sync()`, the ID number of the source thread will not wrap around the value of `width` and so the upper `delta` threads will remain unchanged. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – **[in]** - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – **[in]** - `nv_bfloat16`. Is only being read.
- ▶ **delta** – **[in]** - unsigned int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `nv_bfloat16`.

`__device__ __nv_bfloat162 __shf1_sync` (const unsigned int mask, const `__nv_bfloat162` var, const int srcLane, const int width = warpSize)

Exchange a variable between threads within a warp.

Direct copy from indexed thread.

Returns the value of var held by the thread whose ID is given by srcLane. If width is less than warpSize then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. If srcLane is outside the range [0:width-1], the value returned corresponds to the value of var held by the srcLane modulo width (i.e. within the same subsection). width must have a value which is a power of 2; results are undefined if width is not a power of 2, or is a number greater than warpSize. Threads may only read data from another thread which is actively participating in the `__shf1_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the mask and all non-exited threads named in mask must execute the same intrinsic with the same mask, or the result is undefined.
- ▶ **var** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **srcLane** – [in] - int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as `nv_bfloat162`.

`__device__ __nv_bfloat16 __shf1_sync` (const unsigned int mask, const `__nv_bfloat16` var, const int srcLane, const int width = warpSize)

Exchange a variable between threads within a warp.

Direct copy from indexed thread.

Returns the value of var held by the thread whose ID is given by srcLane. If width is less than warpSize then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. If srcLane is outside the range [0:width-1], the value returned corresponds to the value of var held by the srcLane modulo width (i.e. within the same subsection). width must have a value which is a power of 2; results are undefined if width is not a power of 2, or is a number greater than warpSize. Threads may only read data from another thread which is actively participating in the `__shf1_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – **[in]** - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the **mask** and all non-exited threads named in **mask** must execute the same intrinsic with the same **mask**, or the result is undefined.
- ▶ **var** – **[in]** - `nv_bfloat16`. Is only being read.
- ▶ **srcLane** – **[in]** - int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 2-byte word referenced by **var** from the source thread ID as `nv_bfloat16`.

```
__device__ __nv_bfloat16 __shfl_up_sync(const unsigned int mask, const __nv_bfloat16 var, const unsigned int delta, const int width = warpSize)
```

Exchange a variable between threads within a warp.

Copy from a thread with lower ID relative to the caller.

Calculates a source thread ID by subtracting **delta** from the caller's lane ID. The value of **var** held by the resulting lane ID is returned: in effect, **var** is shifted up the warp by **delta** threads. If **width** is less than **warpSize** then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. The source thread index will not wrap around the value of **width**, so effectively the lower **delta** threads will be unchanged. **width** must have a value which is a power of 2; results are undefined if **width** is not a power of 2, or is a number greater than **warpSize**. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – **[in]** - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.

- ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – **[in]** - `nv_bfloat16`. Is only being read.
- ▶ **delta** – **[in]** - unsigned int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `nv_bfloat16`.

`__device__ __nv_bfloat162 __shfl_up_sync` (const unsigned int mask, const `__nv_bfloat162` var, const unsigned int delta, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread with lower ID relative to the caller.

Calculates a source thread ID by subtracting `delta` from the caller's lane ID. The value of `var` held by the resulting lane ID is returned: in effect, `var` is shifted up the warp by `delta` threads. If `width` is less than `warpSize` then each subsection of the warp behaves as a separate entity with a starting logical thread ID of 0. The source thread index will not wrap around the value of `width`, so effectively the lower `delta` threads will be unchanged. `width` must have a value which is a power of 2; results are undefined if `width` is not a power of 2, or is a number greater than `warpSize`. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – **[in]** - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **delta** – **[in]** - unsigned int. Is only being read.
- ▶ **width** – **[in]** - int. Is only being read.

Returns

Returns the 4-byte word referenced by `var` from the source thread ID as `nv_bfloat162`.

`__device__ __nv_bfloat16 __shfl_xor_sync` (const unsigned int mask, const `__nv_bfloat16` var, const int laneMask, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread based on bitwise XOR of own thread ID.

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with `laneMask`: the value of `var` held by the resulting thread ID is returned. If `width` is less than `warpSize` then each group of `width` consecutive threads are able to access elements from earlier groups of threads, however if they attempt to access elements from later groups of threads their own value of `var` will be returned. This mode implements a butterfly addressing pattern such as is used in tree reduction and broadcast. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread's lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the `mask` and all non-exited threads named in `mask` must execute the same intrinsic with the same `mask`, or the result is undefined.
- ▶ **var** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **laneMask** – [in] - int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 2-byte word referenced by `var` from the source thread ID as `nv_bfloat16`.

`__device__ __nv_bfloat162 __shfl_xor_sync` (const unsigned int mask, const `__nv_bfloat162` var, const int laneMask, const int width = warpSize)

Exchange a variable between threads within a warp.

Copy from a thread based on bitwise XOR of own thread ID.

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with `laneMask`: the value of `var` held by the resulting thread ID is returned. If `width` is less than `warpSize` then each group of `width` consecutive threads are able to access elements from earlier groups of threads, however if they attempt to access elements from later groups of threads their own value of `var` will be returned. This mode implements a butterfly addressing pattern such as is used in tree reduction and broadcast. Threads may only read data from another thread which is actively participating in the `__shfl_*sync()` command. If the target thread is inactive, the retrieved value is undefined.

Note: For more details for this function see the Warp Shuffle Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **mask** – [in] - unsigned int. Is only being read.
 - ▶ Indicates the threads participating in the call.
 - ▶ A bit, representing the thread’s lane id, must be set for each participating thread to ensure they are properly converged before the intrinsic is executed by the hardware.
 - ▶ Each calling thread must have its own bit set in the **mask** and all non-exited threads named in **mask** must execute the same intrinsic with the same **mask**, or the result is undefined.
- ▶ **var** – [in] - nv_bfloat162. Is only being read.
- ▶ **laneMask** – [in] - int. Is only being read.
- ▶ **width** – [in] - int. Is only being read.

Returns

Returns the 4-byte word referenced by **var** from the source thread ID as nv_bfloat162.

`__device__ __nv_bfloat16 __short2bfloat16_rd(const short int i)`

Convert a signed short integer to a nv_bfloat16 in round-down mode.

Convert the signed short integer value **i** to a nv_bfloat16 floating-point value in round-down mode.

Parameters

i – [in] - short int. Is only being read.

Returns

nv_bfloat16

- ▶ **i** converted to nv_bfloat16.

`__host__ __device__ __nv_bfloat16 __short2bfloat16_rn(const short int i)`

Convert a signed short integer to a nv_bfloat16 in round-to-nearest-even mode.

Convert the signed short integer value **i** to a nv_bfloat16 floating-point value in round-to-nearest-even mode.

Parameters

i – [in] - short int. Is only being read.

Returns

nv_bfloat16

- ▶ **i** converted to nv_bfloat16.

`__device__ __nv_bfloat16 __short2bfloat16_ru(const short int i)`

Convert a signed short integer to a nv_bfloat16 in round-up mode.

Convert the signed short integer value **i** to a nv_bfloat16 floating-point value in round-up mode.

Parameters

i – **[in]** - short int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__device__ __nv_bfloat16 __short2bfloat16_rz(const short int i)`

Convert a signed short integer to a nv_bfloat16 in round-towards-zero mode.

Convert the signed short integer value `i` to a nv_bfloat16 floating-point value in round-towards-zero mode.

Parameters

i – **[in]** - short int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__host__ __device__ __nv_bfloat16 __short_as_bfloat16(const short int i)`

Reinterprets bits in a signed short integer as a nv_bfloat16.

Reinterprets the bits in the signed short integer `i` as a nv_bfloat16 floating-point number.

Parameters

i – **[in]** - short int. Is only being read.

Returns

nv_bfloat16

- ▶ The reinterpreted value.

`__device__ void __stcg(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)`

Generates a `st.global.cg` store instruction.

Parameters

- ▶ **ptr** – **[out]** - memory location
- ▶ **value** – **[in]** - the value to be stored

`__device__ void __stcg(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)`

Generates a `st.global.cg` store instruction.

Parameters

- ▶ **ptr** – **[out]** - memory location
- ▶ **value** – **[in]** - the value to be stored

`__device__ void __stcs(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)`

Generates a `st.global.cs` store instruction.

Parameters

- ▶ **ptr** – **[out]** - memory location
- ▶ **value** – **[in]** - the value to be stored

`__device__ void __stcs(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)`

Generates a `st.global.cs` store instruction.

Parameters

- ▶ **ptr** – [out] - memory location
- ▶ **value** – [in] - the value to be stored

`__device__ void __stwb(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)`

Generates a `st.global.wb` store instruction.

Parameters

- ▶ **ptr** – [out] - memory location
- ▶ **value** – [in] - the value to be stored

`__device__ void __stwb(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)`

Generates a `st.global.wb` store instruction.

Parameters

- ▶ **ptr** – [out] - memory location
- ▶ **value** – [in] - the value to be stored

`__device__ void __stwt(__nv_bfloat162 *const ptr, const __nv_bfloat162 value)`

Generates a `st.global.wt` store instruction.

Parameters

- ▶ **ptr** – [out] - memory location
- ▶ **value** – [in] - the value to be stored

`__device__ void __stwt(__nv_bfloat16 *const ptr, const __nv_bfloat16 value)`

Generates a `st.global.wt` store instruction.

Parameters

- ▶ **ptr** – [out] - memory location
- ▶ **value** – [in] - the value to be stored

`__device__ __nv_bfloat16 __uint2bfloat16_rd(const unsigned int i)`

Convert an unsigned integer to a `nv_bfloat16` in round-down mode.

Convert the unsigned integer value `i` to a `nv_bfloat16` floating-point value in round-down mode.

Parameters

- i** – [in] - unsigned int. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 __uint2bfloat16_rn`(const unsigned int i)

Convert an unsigned integer to a `nv_bfloat16` in round-to-nearest-even mode.

Convert the unsigned integer value `i` to a `nv_bfloat16` floating-point value in round-to-nearest-even mode.

Parameters

`i` - [in] - unsigned int. Is only being read.

Returns

`nv_bfloat16`

► `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __uint2bfloat16_ru`(const unsigned int i)

Convert an unsigned integer to a `nv_bfloat16` in round-up mode.

Convert the unsigned integer value `i` to a `nv_bfloat16` floating-point value in round-up mode.

Parameters

`i` - [in] - unsigned int. Is only being read.

Returns

`nv_bfloat16`

► `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __uint2bfloat16_rz`(const unsigned int i)

Convert an unsigned integer to a `nv_bfloat16` in round-towards-zero mode.

Convert the unsigned integer value `i` to a `nv_bfloat16` floating-point value in round-towards-zero mode.

Parameters

`i` - [in] - unsigned int. Is only being read.

Returns

`nv_bfloat16`

► `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __u112bfloat16_rd`(const unsigned long long int i)

Convert an unsigned 64-bit integer to a `nv_bfloat16` in round-down mode.

Convert the unsigned 64-bit integer value `i` to a `nv_bfloat16` floating-point value in round-down mode.

Parameters

`i` - [in] - unsigned long long int. Is only being read.

Returns

`nv_bfloat16`

► `i` converted to `nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 __u112bfloat16_rn`(const unsigned long long int i)

Convert an unsigned 64-bit integer to a `nv_bfloat16` in round-to-nearest-even mode.

Convert the unsigned 64-bit integer value `i` to a `nv_bfloat16` floating-point value in round-to-nearest-even mode.

Parameters

`i` - [in] - unsigned long long int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__device__ __nv_bfloat16 __u112bfloat16_ru`(const unsigned long long int i)

Convert an unsigned 64-bit integer to a nv_bfloat16 in round-up mode.

Convert the unsigned 64-bit integer value *i* to a nv_bfloat16 floating-point value in round-up mode.

Parameters

i – [in] - unsigned long long int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__device__ __nv_bfloat16 __u112bfloat16_rz`(const unsigned long long int i)

Convert an unsigned 64-bit integer to a nv_bfloat16 in round-towards-zero mode.

Convert the unsigned 64-bit integer value *i* to a nv_bfloat16 floating-point value in round-towards-zero mode.

Parameters

i – [in] - unsigned long long int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__device__ __nv_bfloat16 __ushort2bfloat16_rd`(const unsigned short int i)

Convert an unsigned short integer to a nv_bfloat16 in round-down mode.

Convert the unsigned short integer value *i* to a nv_bfloat16 floating-point value in round-down mode.

Parameters

i – [in] - unsigned short int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__host__ __device__ __nv_bfloat16 __ushort2bfloat16_rn`(const unsigned short int i)

Convert an unsigned short integer to a nv_bfloat16 in round-to-nearest-even mode.

Convert the unsigned short integer value *i* to a nv_bfloat16 floating-point value in round-to-nearest-even mode.

Parameters

i – [in] - unsigned short int. Is only being read.

Returns

nv_bfloat16

- ▶ i converted to nv_bfloat16.

`__device__ __nv_bfloat16 __ushort2bfloat16_ru`(const unsigned short int i)

Convert an unsigned short integer to a `nv_bfloat16` in round-up mode.

Convert the unsigned short integer value `i` to a `nv_bfloat16` floating-point value in round-up mode.

Parameters

i – [in] - unsigned short int. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__device__ __nv_bfloat16 __ushort2bfloat16_rz`(const unsigned short int i)

Convert an unsigned short integer to a `nv_bfloat16` in round-towards-zero mode.

Convert the unsigned short integer value `i` to a `nv_bfloat16` floating-point value in round-towards-zero mode.

Parameters

i – [in] - unsigned short int. Is only being read.

Returns

`nv_bfloat16`

- ▶ `i` converted to `nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 __ushort_as_bfloat16`(const unsigned short int i)

Reinterprets bits in an unsigned short integer as a `nv_bfloat16`.

Reinterprets the bits in the unsigned short integer `i` as a `nv_bfloat16` floating-point number.

Parameters

i – [in] - unsigned short int. Is only being read.

Returns

`nv_bfloat16`

- ▶ The reinterpreted value.

`__host__ __device__ __nv_bfloat162 make_bfloat162`(const `__nv_bfloat16` x, const `__nv_bfloat16` y)

Vector function, combines two `nv_bfloat16` numbers into one `nv_bfloat162` number.

Combines two input `nv_bfloat16` number `x` and `y` into one `nv_bfloat162` number. Input `x` is stored in low 16 bits of the return value, input `y` is stored in high 16 bits of the return value.

Parameters

- ▶ **x** – [in] - `nv_bfloat16`. Is only being read.
- ▶ **y** – [in] - `nv_bfloat16`. Is only being read.

Returns

`__nv_bfloat162`

- ▶ The `__nv_bfloat162` vector with one half equal to `x` and the other to `y`.

3.6. Bfloat162 Arithmetic Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Functions

__host__ __device__ __nv_bfloat162 __h2div(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector division in round-to-nearest-even mode.

__host__ __device__ __nv_bfloat162 __habs2(const __nv_bfloat162 a)

Calculates the absolute value of both halves of the input `nv_bfloat162` number and returns the result.

__host__ __device__ __nv_bfloat162 __hadd2(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector addition in round-to-nearest-even mode.

__host__ __device__ __nv_bfloat162 __hadd2_rn(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector addition in round-to-nearest-even mode.

__host__ __device__ __nv_bfloat162 __hadd2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector addition in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.

__device__ __nv_bfloat162 __hcmadd(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)

Performs fast complex multiply-accumulate.

__device__ __nv_bfloat162 __hfma2(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)

Performs `nv_bfloat162` vector fused multiply-add in round-to-nearest-even mode.

__device__ __nv_bfloat162 __hfma2_relu(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)

Performs `nv_bfloat162` vector fused multiply-add in round-to-nearest-even mode with relu saturation.

__device__ __nv_bfloat162 __hfma2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)

Performs `nv_bfloat162` vector fused multiply-add in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.

__host__ __device__ __nv_bfloat162 __hmul2(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode.

__host__ __device__ __nv_bfloat162 __hmul2_rn(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode.

__host__ __device__ __nv_bfloat162 __hmul2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.

__host__ __device__ __nv_bfloat162 __hneg2(const __nv_bfloat162 a)

Negates both halves of the input `nv_bfloat162` number and returns the result.

__host__ __device__ __nv_bfloat162 __hsub2(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector subtraction in round-to-nearest-even mode.

- __host__ __device__ __nv_bfloat162 __hsub2_rn(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector subtraction in round-to-nearest-even mode.
- __host__ __device__ __nv_bfloat162 __hsub2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector subtraction in round-to-nearest-even mode, with saturation to `[0.0, 1.0]`.
- __device__ __nv_bfloat162 atomicAdd(__nv_bfloat162 *const address, const __nv_bfloat162 val)**
 Vector add `val` to the value stored at `address` in global or shared memory, and writes this value back to `address`.
- __host__ __device__ __nv_bfloat162 operator*(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` multiplication operation.
- __host__ __device__ __nv_bfloat162 & operator*=(__nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` compound assignment with multiplication operation.
- __host__ __device__ __nv_bfloat162 operator+(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` addition operation.
- __host__ __device__ __nv_bfloat162 operator+(const __nv_bfloat162 &h)**
 Implements packed `nv_bfloat16` unary plus operator, returns input value.
- __host__ __device__ __nv_bfloat162 operator++(__nv_bfloat162 &h, const int ignored)**
 Performs packed `nv_bfloat16` postfix increment operation.
- __host__ __device__ __nv_bfloat162 & operator++(__nv_bfloat162 &h)**
 Performs packed `nv_bfloat16` prefix increment operation.
- __host__ __device__ __nv_bfloat162 & operator+=(__nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` compound assignment with addition operation.
- __host__ __device__ __nv_bfloat162 operator-(const __nv_bfloat162 &h)**
 Implements packed `nv_bfloat16` unary minus operator.
- __host__ __device__ __nv_bfloat162 operator-(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` subtraction operation.
- __host__ __device__ __nv_bfloat162 operator--(__nv_bfloat162 &h, const int ignored)**
 Performs packed `nv_bfloat16` postfix decrement operation.
- __host__ __device__ __nv_bfloat162 & operator--(__nv_bfloat162 &h)**
 Performs packed `nv_bfloat16` prefix decrement operation.
- __host__ __device__ __nv_bfloat162 & operator-=(__nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` compound assignment with subtraction operation.
- __host__ __device__ __nv_bfloat162 operator/(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` division operation.
- __host__ __device__ __nv_bfloat162 & operator/=(__nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed `nv_bfloat16` compound assignment with division operation.

3.6.1. Functions

`__host__ __device__ __nv_bfloat162 __h2div(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector division in round-to-nearest-even mode.

Divides `nv_bfloat162` input vector `a` by input vector `b` in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The elementwise division of `a` with `b`.

`__host__ __device__ __nv_bfloat162 __habs2(const __nv_bfloat162 a)`

Calculates the absolute value of both halves of the input `nv_bfloat162` number and returns the result.

Calculates the absolute value of both halves of the input `nv_bfloat162` number and returns the result.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`bfloat2`

- ▶ Returns `a` with the absolute value of both halves.

`__host__ __device__ __nv_bfloat162 __hadd2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector addition in round-to-nearest-even mode.

Performs `nv_bfloat162` vector add of inputs `a` and `b`, in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The sum of vectors `a` and `b`.

`__host__ __device__ __nv_bfloat162 __hadd2_rn(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector addition in round-to-nearest-even mode.

Performs `nv_bfloat162` vector add of inputs `a` and `b`, in round-to-nearest-even mode. Prevents floating-point contractions of `mul+add` into `fma`.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

nv_bfloat162

- ▶ The sum of vectors a and b.

`__host__ __device__ __nv_bfloat162 __hadd2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector addition in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs nv_bfloat162 vector add of inputs a and b, in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The sum of a and b, with respect to saturation.

`__device__ __nv_bfloat162 __hcmadd(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)`

Performs fast complex multiply-accumulate.

Interprets vector nv_bfloat162 input pairs a, b, and c as complex numbers in nv_bfloat16 precision and performs complex multiply-accumulate operation: $a*b + c$

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.
- ▶ **c** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The result of complex multiply-accumulate operation on complex numbers a, b, and c

`__device__ __nv_bfloat162 __hfma2(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)`

Performs nv_bfloat162 vector fused multiply-add in round-to-nearest-even mode.

Performs nv_bfloat162 vector multiply on inputs a and b, then performs a nv_bfloat162 vector add of the result with c, rounding the result once in round-to-nearest-even mode.

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.
- ▶ **c** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The result of elementwise fused multiply-add operation on vectors a, b, and c.

`__device__ __nv_bfloat162 __hfma2_relu(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)`

Performs `nv_bfloat162` vector fused multiply-add in round-to-nearest-even mode with relu saturation.

Performs `nv_bfloat162` vector multiply on inputs a and b, then performs a `nv_bfloat162` vector add of the result with c, rounding the result once in round-to-nearest-even mode. Then negative result is clamped to 0. NaN result is converted to canonical NaN.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **c** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The result of elementwise fused multiply-add operation on vectors a, b, and c with relu saturation.

`__device__ __nv_bfloat162 __hfma2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)`

Performs `nv_bfloat162` vector fused multiply-add in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs `nv_bfloat162` vector multiply on inputs a and b, then performs a `nv_bfloat162` vector add of the result with c, rounding the result once in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **c** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The result of elementwise fused multiply-add operation on vectors a, b, and c, with respect to saturation.

`__host__ __device__ __nv_bfloat162 __hmu12(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode.

Performs `nv_bfloat162` vector multiplication of inputs a and b, in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The result of elementwise multiplying the vectors a and b.

`__host__ __device__ __nv_bfloat162 __hmul2_rn(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode.

Performs `nv_bfloat162` vector multiplication of inputs a and b, in round-to-nearest-even mode. Prevents floating-point contractions of mul+add or sub into fma.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The result of elementwise multiplying the vectors a and b.

`__host__ __device__ __nv_bfloat162 __hmul2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Performs `nv_bfloat162` vector multiplication of inputs a and b, in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The result of elementwise multiplication of vectors a and b, with respect to saturation.

`__host__ __device__ __nv_bfloat162 __hneg2(const __nv_bfloat162 a)`

Negates both halves of the input `nv_bfloat162` number and returns the result.

Negates both halves of the input `nv_bfloat162` number a and returns the result.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ Returns a with both halves negated.

`__host__ __device__ __nv_bfloat162 __hsub2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector subtraction in round-to-nearest-even mode.

Subtracts `nv_bfloat162` input vector b from input vector a in round-to-nearest-even mode.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

nv_bfloat162

- ▶ The subtraction of vector b from a.

`__host__ __device__ __nv_bfloat162 __hsub2_rn(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector subtraction in round-to-nearest-even mode.

Subtracts nv_bfloat162 input vector b from input vector a in round-to-nearest-even mode. Prevents floating-point contractions of mul+sub into fma.

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The subtraction of vector b from a.

`__host__ __device__ __nv_bfloat162 __hsub2_sat(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector subtraction in round-to-nearest-even mode, with saturation to [0.0, 1.0].

Subtracts nv_bfloat162 input vector b from input vector a in round-to-nearest-even mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The subtraction of vector b from a, with respect to saturation.

`__device__ __nv_bfloat162 atomicAdd(__nv_bfloat162 *const address, const __nv_bfloat162 val)`

Vector add val to the value stored at address in global or shared memory, and writes this value back to address.

The atomicity of the add operation is guaranteed separately for each of the two nv_bfloat16 elements; the entire __nv_bfloat162 is not guaranteed to be atomic as a single 32-bit access.

The location of address must be in global or shared memory. This operation has undefined behavior otherwise. This operation is natively supported by devices of compute capability 9.x and higher, older devices use emulation path.

Note: For more details for this function see the Atomic Functions section in the CUDA C++ Programming Guide.

Parameters

- ▶ **address** - [in] - __nv_bfloat162*. An address in global or shared memory.
- ▶ **val** - [in] - __nv_bfloat162. The value to be added.

Returns

__nv_bfloat162

- The old value read from address.

*__host__ __device__ __nv_bfloat162 operator**(const *__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* multiplication operation.

See also *__hmul2(__nv_bfloat162, __nv_bfloat162)*

__host__ __device__ __nv_bfloat162 &operator=*(*__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* compound assignment with multiplication operation.

__host__ __device__ __nv_bfloat162 operator+(const *__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* addition operation.

See also *__hadd2(__nv_bfloat162, __nv_bfloat162)*

__host__ __device__ __nv_bfloat162 operator+(const *__nv_bfloat162* &h)

Implements packed *nv_bfloat16* unary plus operator, returns input value.

__host__ __device__ __nv_bfloat162 operator++(*__nv_bfloat162* &h, const int ignored)

Performs packed *nv_bfloat16* postfix increment operation.

__host__ __device__ __nv_bfloat162 &operator++(*__nv_bfloat162* &h)

Performs packed *nv_bfloat16* prefix increment operation.

__host__ __device__ __nv_bfloat162 &operator+=(*__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* compound assignment with addition operation.

__host__ __device__ __nv_bfloat162 operator-(const *__nv_bfloat162* &h)

Implements packed *nv_bfloat16* unary minus operator.

See also *__hneg2(__nv_bfloat162)*

__host__ __device__ __nv_bfloat162 operator-(const *__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* subtraction operation.

See also *__hsub2(__nv_bfloat162, __nv_bfloat162)*

__host__ __device__ __nv_bfloat162 operator--(*__nv_bfloat162* &h, const int ignored)

Performs packed *nv_bfloat16* postfix decrement operation.

__host__ __device__ __nv_bfloat162 &operator--(*__nv_bfloat162* &h)

Performs packed *nv_bfloat16* prefix decrement operation.

__host__ __device__ __nv_bfloat162 &operator-=(*__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* compound assignment with subtraction operation.

__host__ __device__ __nv_bfloat162 operator/(const *__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* division operation.

See also *__h2div(__nv_bfloat162, __nv_bfloat162)*

__host__ __device__ __nv_bfloat162 &operator/=(*__nv_bfloat162* &lh, const *__nv_bfloat162* &rh)

Performs packed *nv_bfloat16* compound assignment with division operation.

3.7. Bfloat162 Comparison Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Functions

- __host__ __device__ bool `__hbeq2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector if-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbequ2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector unordered if-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbge2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector greater-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbgeu2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector unordered greater-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbgt2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector greater-than comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbgtu2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector unordered greater-than comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hble2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector less-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbleu2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector unordered less-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hblt2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector less-than comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbltu2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector unordered less-than comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbne2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector not-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ bool `__hbneu2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector unordered not-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.
- __host__ __device__ __nv_bfloat162 `__heq2`(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs `nv_bfloat162` vector if-equal comparison.

- __host__ __device__ unsigned int __heq2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector if-equal comparison.
- __host__ __device__ __nv_bfloat162 __hequ2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered if-equal comparison.
- __host__ __device__ unsigned int __hequ2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered if-equal comparison.
- __host__ __device__ __nv_bfloat162 __hge2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector greater-equal comparison.
- __host__ __device__ unsigned int __hge2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector greater-equal comparison.
- __host__ __device__ __nv_bfloat162 __hgeu2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered greater-equal comparison.
- __host__ __device__ unsigned int __hgeu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered greater-equal comparison.
- __host__ __device__ __nv_bfloat162 __hgt2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector greater-than comparison.
- __host__ __device__ unsigned int __hgt2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector greater-than comparison.
- __host__ __device__ __nv_bfloat162 __hgtu2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered greater-than comparison.
- __host__ __device__ unsigned int __hgtu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered greater-than comparison.
- __host__ __device__ __nv_bfloat162 __hisnan2(const __nv_bfloat162 a)**
 Determine whether nv_bfloat162 argument is a NaN.
- __host__ __device__ __nv_bfloat162 __hle2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector less-equal comparison.
- __host__ __device__ unsigned int __hle2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector less-equal comparison.
- __host__ __device__ __nv_bfloat162 __hleu2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered less-equal comparison.
- __host__ __device__ unsigned int __hleu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered less-equal comparison.
- __host__ __device__ __nv_bfloat162 __hlt2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector less-than comparison.
- __host__ __device__ unsigned int __hlt2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector less-than comparison.
- __host__ __device__ __nv_bfloat162 __hltu2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered less-than comparison.
- __host__ __device__ unsigned int __hltu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered less-than comparison.
- __host__ __device__ __nv_bfloat162 __hmax2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Calculates nv_bfloat162 vector maximum of two inputs.

- __host__ __device__ __nv_bfloat162 __hmax2_nan(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Calculates nv_bfloat162 vector maximum of two inputs, NaNs pass through.
- __host__ __device__ __nv_bfloat162 __hmin2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Calculates nv_bfloat162 vector minimum of two inputs.
- __host__ __device__ __nv_bfloat162 __hmin2_nan(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Calculates nv_bfloat162 vector minimum of two inputs, NaNs pass through.
- __host__ __device__ __nv_bfloat162 __hne2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector not-equal comparison.
- __host__ __device__ unsigned int __hne2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector not-equal comparison.
- __host__ __device__ __nv_bfloat162 __hneu2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered not-equal comparison.
- __host__ __device__ unsigned int __hneu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector unordered not-equal comparison.
- __host__ __device__ bool operator!=(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed nv_bfloat16 unordered compare not-equal operation.
- __host__ __device__ bool operator<(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed nv_bfloat16 ordered less-than compare operation.
- __host__ __device__ bool operator<=(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed nv_bfloat16 ordered less-or-equal compare operation.
- __host__ __device__ bool operator==(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed nv_bfloat16 ordered compare equal operation.
- __host__ __device__ bool operator>(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed nv_bfloat16 ordered greater-than compare operation.
- __host__ __device__ bool operator>=(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)**
 Performs packed nv_bfloat16 ordered greater-or-equal compare operation.

3.7.1. Functions

- __host__ __device__ bool __hbeq2(const __nv_bfloat162 a, const __nv_bfloat162 b)**
 Performs nv_bfloat162 vector if-equal comparison and returns boolean true if both nv_bfloat16 results are true, boolean false otherwise.
- Performs nv_bfloat162 vector if-equal comparison of inputs a and b. The bool result is set to true only if both nv_bfloat16 if-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - nv_bfloat162. Is only being read.
- ▶ **b** – [in] - nv_bfloat162. Is only being read.

Returns

bool

- ▶ true if both nv_bfloat16 results of if-equal comparison of vectors a and b are true;

- ▶ false otherwise.

`__host__ __device__ bool __hbequ2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered if-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector if-equal comparison of inputs `a` and `b`. The bool result is set to true only if both `nv_bfloat16` if-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

bool

- ▶ true if both `nv_bfloat16` results of unordered if-equal comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbge2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector greater-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector greater-equal comparison of inputs `a` and `b`. The bool result is set to true only if both `nv_bfloat16` greater-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

bool

- ▶ true if both `nv_bfloat16` results of greater-equal comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbgeu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered greater-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector greater-equal comparison of inputs `a` and `b`. The bool result is set to true only if both `nv_bfloat16` greater-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

bool

- ▶ true if both `nv_bfloat16` results of unordered greater-equal comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbgt2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector greater-than comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector greater-than comparison of inputs `a` and `b`. The bool result is set to true only if both `nv_bfloat16` greater-than comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

bool

- ▶ true if both `nv_bfloat16` results of greater-than comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbgtu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered greater-than comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector greater-than comparison of inputs `a` and `b`. The bool result is set to true only if both `nv_bfloat16` greater-than comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

bool

- ▶ true if both `nv_bfloat16` results of unordered greater-than comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1e2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector less-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector less-equal comparison of inputs `a` and `b`. The bool result is set to true only if both `nv_bfloat16` less-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

bool

- ▶ true if both nv_bfloat16 results of less-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1eu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector unordered less-equal comparison and returns boolean true if both nv_bfloat16 results are true, boolean false otherwise.

Performs nv_bfloat162 vector less-equal comparison of inputs a and b. The bool result is set to true only if both nv_bfloat16 less-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

bool

- ▶ true if both nv_bfloat16 results of unordered less-equal comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1t2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector less-than comparison and returns boolean true if both nv_bfloat16 results are true, boolean false otherwise.

Performs nv_bfloat162 vector less-than comparison of inputs a and b. The bool result is set to true only if both nv_bfloat16 less-than comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

bool

- ▶ true if both nv_bfloat16 results of less-than comparison of vectors a and b are true;
- ▶ false otherwise.

`__host__ __device__ bool __hb1tu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector unordered less-than comparison and returns boolean true if both nv_bfloat16 results are true, boolean false otherwise.

Performs `nv_bfloat162` vector less-than comparison of inputs `a` and `b`. The `bool` result is set to true only if both `nv_bfloat16` less-than comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

`bool`

- ▶ true if both `nv_bfloat16` results of unordered less-than comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ bool __hbne2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector not-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector not-equal comparison of inputs `a` and `b`. The `bool` result is set to true only if both `nv_bfloat16` not-equal comparisons evaluate to true, or false otherwise. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

`bool`

- ▶ true if both `nv_bfloat16` results of not-equal comparison of vectors `a` and `b` are true,
- ▶ false otherwise.

`__host__ __device__ bool __hbneu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered not-equal comparison and returns boolean true if both `nv_bfloat16` results are true, boolean false otherwise.

Performs `nv_bfloat162` vector not-equal comparison of inputs `a` and `b`. The `bool` result is set to true only if both `nv_bfloat16` not-equal comparisons evaluate to true, or false otherwise. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - `nv_bfloat162`. Is only being read.
- ▶ **b** – **[in]** - `nv_bfloat162`. Is only being read.

Returns

`bool`

- ▶ true if both `nv_bfloat16` results of unordered not-equal comparison of vectors `a` and `b` are true;
- ▶ false otherwise.

`__host__ __device__ __nv_bfloat162 __heq2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector if-equal comparison.

Performs `nv_bfloat162` vector if-equal comparison of inputs `a` and `b`. The corresponding `nv_bfloat16` results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The vector result of if-equal comparison of vectors `a` and `b`.

`__host__ __device__ unsigned int __heq2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector if-equal comparison.

Performs `nv_bfloat162` vector if-equal comparison of inputs `a` and `b`. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of if-equal comparison of vectors `a` and `b`.

`__host__ __device__ __nv_bfloat162 __hequ2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered if-equal comparison.

Performs `nv_bfloat162` vector if-equal comparison of inputs `a` and `b`. The corresponding `nv_bfloat16` results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The vector result of unordered if-equal comparison of vectors `a` and `b`.

`__host__ __device__ unsigned int __hequ2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered if-equal comparison.

Performs `nv_bfloat162` vector if-equal comparison of inputs `a` and `b`. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.

- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered if-equal comparison of vectors a and b.

`__host__ __device__ __nv_bfloat162 __hge2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector greater-equal comparison.

Performs nv_bfloat162 vector greater-equal comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The vector result of greater-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hge2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector greater-equal comparison.

Performs nv_bfloat162 vector greater-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of greater-equal comparison of vectors a and b.

`__host__ __device__ __nv_bfloat162 __hgeu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector unordered greater-equal comparison.

Performs nv_bfloat162 vector greater-equal comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 vector result of unordered greater-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hgeu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered greater-equal comparison.

Performs `nv_bfloat162` vector greater-equal comparison of inputs `a` and `b`. The corresponding unsigned bits are set to `0xFFFF` for true, or `0x0` for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered greater-equal comparison of vectors `a` and `b`.

`__host__ __device__ __nv_bfloat162 __hgt2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector greater-than comparison.

Performs `nv_bfloat162` vector greater-than comparison of inputs `a` and `b`. The corresponding `nv_bfloat16` results are set to `1.0` for true, or `0.0` for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The vector result of greater-than comparison of vectors `a` and `b`.

`__host__ __device__ unsigned int __hgt2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector greater-than comparison.

Performs `nv_bfloat162` vector greater-than comparison of inputs `a` and `b`. The corresponding unsigned bits are set to `0xFFFF` for true, or `0x0` for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of greater-than comparison of vectors `a` and `b`.

`__host__ __device__ __nv_bfloat162 __hgtu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered greater-than comparison.

Performs `nv_bfloat162` vector greater-than comparison of inputs `a` and `b`. The corresponding `nv_bfloat16` results are set to `1.0` for true, or `0.0` for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.

- ▶ **b** – [**in**] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 vector result of unordered greater-than comparison of vectors a and b.

__host__ __device__ unsigned int **__hgtu2_mask**(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs nv_bfloat162 vector unordered greater-than comparison.

Performs nv_bfloat162 vector greater-than comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [**in**] - nv_bfloat162. Is only being read.
- ▶ **b** – [**in**] - nv_bfloat162. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered greater-than comparison of vectors a and b.

__host__ __device__ __nv_bfloat162 **__hisnan2**(const __nv_bfloat162 a)

Determine whether nv_bfloat162 argument is a NaN.

Determine whether each nv_bfloat16 of input nv_bfloat162 number a is a NaN.

Parameters

a – [**in**] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 with the corresponding nv_bfloat16 results set to 1.0 for NaN, 0.0 otherwise.

__host__ __device__ __nv_bfloat162 **__hle2**(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs nv_bfloat162 vector less-equal comparison.

Performs nv_bfloat162 vector less-equal comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [**in**] - nv_bfloat162. Is only being read.
- ▶ **b** – [**in**] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 result of less-equal comparison of vectors a and b.

__host__ __device__ unsigned int **__hle2_mask**(const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs nv_bfloat162 vector less-equal comparison.

Performs nv_bfloat162 vector less-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - nv_bfloat162. Is only being read.
- ▶ **b** – [in] - nv_bfloat162. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of less-equal comparison of vectors a and b.

`__host__ __device__ __nv_bfloat162 __hleu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector unordered less-equal comparison.

Performs nv_bfloat162 vector less-equal comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - nv_bfloat162. Is only being read.
- ▶ **b** – [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The vector result of unordered less-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hleu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector unordered less-equal comparison.

Performs nv_bfloat162 vector less-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - nv_bfloat162. Is only being read.
- ▶ **b** – [in] - nv_bfloat162. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered less-equal comparison of vectors a and b.

`__host__ __device__ __nv_bfloat162 __hlt2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector less-than comparison.

Performs nv_bfloat162 vector less-than comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - nv_bfloat162. Is only being read.
- ▶ **b** – [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The nv_bfloat162 vector result of less-than comparison of vectors a and b.

`__host__ __device__ unsigned int __h1t2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector less-than comparison.

Performs `nv_bfloat162` vector less-than comparison of inputs `a` and `b`. The corresponding unsigned bits are set to `0xFFFF` for true, or `0x0` for false. NaN inputs generate false results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of less-than comparison of vectors `a` and `b`.

`__host__ __device__ __nv_bfloat162 __h1tu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered less-than comparison.

Performs `nv_bfloat162` vector less-than comparison of inputs `a` and `b`. The corresponding `nv_bfloat16` results are set to `1.0` for true, or `0.0` for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The vector result of unordered less-than comparison of vectors `a` and `b`.

`__host__ __device__ unsigned int __h1tu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs `nv_bfloat162` vector unordered less-than comparison.

Performs `nv_bfloat162` vector less-than comparison of inputs `a` and `b`. The corresponding unsigned bits are set to `0xFFFF` for true, or `0x0` for false. NaN inputs generate true results.

Parameters

- ▶ **a** – [in] - `nv_bfloat162`. Is only being read.
- ▶ **b** – [in] - `nv_bfloat162`. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of unordered less-than comparison of vectors `a` and `b`.

`__host__ __device__ __nv_bfloat162 __hmax2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Calculates `nv_bfloat162` vector maximum of two inputs.

Calculates `nv_bfloat162` vector `max(a, b)`. Elementwise `nv_bfloat16` operation is defined as `(a > b) ? a : b`.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are `0.0`, then `+0.0 > -0.0`

- ▶ The result of elementwise maximum of vectors a and b

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

`__host__ __device__ __nv_bfloat162 __hmax2_nan(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Calculates nv_bfloat162 vector maximum of two inputs, NaNs pass through.

Calculates nv_bfloat162 vector max(a, b). Elementwise nv_bfloat16 operation is defined as (a > b) ? a : b.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then +0.0 > -0.0
- ▶ The result of elementwise maximum of vectors a and b, with NaNs pass through

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

`__host__ __device__ __nv_bfloat162 __hmin2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Calculates nv_bfloat162 vector minimum of two inputs.

Calculates nv_bfloat162 vector min(a, b). Elementwise nv_bfloat16 operation is defined as (a < b) ? a : b.

- ▶ If either of inputs is NaN, the other input is returned.
- ▶ If both inputs are NaNs, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then +0.0 > -0.0
- ▶ The result of elementwise minimum of vectors a and b

Parameters

- ▶ **a** - [in] - nv_bfloat162. Is only being read.
- ▶ **b** - [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

`__host__ __device__ __nv_bfloat162 __hmin2_nan(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Calculates nv_bfloat162 vector minimum of two inputs, NaNs pass through.

Calculates nv_bfloat162 vector min(a, b). Elementwise nv_bfloat16 operation is defined as (a < b) ? a : b.

- ▶ If either of inputs is NaN, then canonical NaN is returned.
- ▶ If values of both inputs are 0.0, then +0.0 > -0.0
- ▶ The result of elementwise minimum of vectors a and b, with NaNs pass through

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

`__host__ __device__ __nv_bfloat162 __hne2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector not-equal comparison.

Performs nv_bfloat162 vector not-equal comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The vector result of not-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hne2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector not-equal comparison.

Performs nv_bfloat162 vector not-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate false results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

unsigned int

- ▶ The vector mask result of not-equal comparison of vectors a and b.

`__host__ __device__ __nv_bfloat162 __hneu2(const __nv_bfloat162 a, const __nv_bfloat162 b)`

Performs nv_bfloat162 vector unordered not-equal comparison.

Performs nv_bfloat162 vector not-equal comparison of inputs a and b. The corresponding nv_bfloat16 results are set to 1.0 for true, or 0.0 for false. NaN inputs generate true results.

Parameters

- ▶ **a** – **[in]** - nv_bfloat162. Is only being read.
- ▶ **b** – **[in]** - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The vector result of unordered not-equal comparison of vectors a and b.

`__host__ __device__ unsigned int __hneu2_mask(const __nv_bfloat162 a, const __nv_bfloat162 b)`
 Performs nv_bfloat162 vector unordered not-equal comparison.

Performs nv_bfloat162 vector not-equal comparison of inputs a and b. The corresponding unsigned bits are set to 0xFFFF for true, or 0x0 for false. NaN inputs generate true results.

Parameters

- **a** - [in] - nv_bfloat162. Is only being read.
- **b** - [in] - nv_bfloat162. Is only being read.

Returns

unsigned int

- The vector mask result of unordered not-equal comparison of vectors a and b.

`__host__ __device__ bool operator!=(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)`
 Performs packed nv_bfloat16 unordered compare not-equal operation.

See also `__hbneu2(__nv_bfloat162, __nv_bfloat162)`

`__host__ __device__ bool operator<(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)`
 Performs packed nv_bfloat16 ordered less-than compare operation.

See also `__hblt2(__nv_bfloat162, __nv_bfloat162)`

`__host__ __device__ bool operator<=(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)`
 Performs packed nv_bfloat16 ordered less-or-equal compare operation.

See also `__hble2(__nv_bfloat162, __nv_bfloat162)`

`__host__ __device__ bool operator==(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)`
 Performs packed nv_bfloat16 ordered compare equal operation.

See also `__hbeq2(__nv_bfloat162, __nv_bfloat162)`

`__host__ __device__ bool operator>(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)`
 Performs packed nv_bfloat16 ordered greater-than compare operation.

See also `__hbgt2(__nv_bfloat162, __nv_bfloat162)`

`__host__ __device__ bool operator>=(const __nv_bfloat162 &lh, const __nv_bfloat162 &rh)`
 Performs packed nv_bfloat16 ordered greater-or-equal compare operation.

See also `__hbge2(__nv_bfloat162, __nv_bfloat162)`

3.8. Bfloat162 Math Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Functions

__device__ __nv_bfloat162 h2ceil(const __nv_bfloat162 h)

Calculate `nv_bfloat162` vector ceiling of the input argument.

__device__ __nv_bfloat162 h2cos(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector cosine in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2exp(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector exponential function in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2exp10(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector decimal exponential function in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2exp2(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector binary exponential function in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2floor(const __nv_bfloat162 h)

Calculate the largest integer less than or equal to `h`.

__device__ __nv_bfloat162 h2log(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector natural logarithm in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2log10(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector decimal logarithm in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2log2(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector binary logarithm in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2rcp(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector reciprocal in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2rint(const __nv_bfloat162 h)

Round input to nearest integer value in `nv_bfloat16` floating-point number.

__device__ __nv_bfloat162 h2rsqrt(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector reciprocal square root in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2sin(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector sine in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2sqrt(const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector square root in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2trunc(const __nv_bfloat162 h)

Truncate `nv_bfloat162` vector input argument to the integral part.

3.8.1. Functions

`__device__ __nv_bfloat162 h2ceil(const __nv_bfloat162 h)`

Calculate `nv_bfloat162` vector ceiling of the input argument.

For each component of vector `h` compute the smallest integer value not less than `h`.

Parameters

`h` – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The vector of smallest integers not less than `h`.

`__device__ __nv_bfloat162 h2cos(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector cosine in round-to-nearest-even mode.

Calculates `nv_bfloat162` cosine of input vector `a` in round-to-nearest-even mode.

NOTE: this function's implementation calls `cosf(float)` function and is exposed to compiler optimizations. Specifically, `--use_fast_math` flag changes `cosf(float)` into an intrinsic `__cosf(float)`, which has less accurate numeric behavior.

Parameters

`a` – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The elementwise cosine on vector `a`.

`__device__ __nv_bfloat162 h2exp(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector exponential function in round-to-nearest-even mode.

Calculates `nv_bfloat162` exponential function of input vector `a` in round-to-nearest-even mode.

Parameters

`a` – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The elementwise exponential function on vector `a`.

`__device__ __nv_bfloat162 h2exp10(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector decimal exponential function in round-to-nearest-even mode.

Calculates `nv_bfloat162` decimal exponential function of input vector `a` in round-to-nearest-even mode.

Parameters

`a` – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- ▶ The elementwise decimal exponential function on vector `a`.

`__device__ __nv_bfloat162 h2exp2(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector binary exponential function in round-to-nearest-even mode.

Calculates `nv_bfloat162` binary exponential function of input vector `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

► The elementwise binary exponential function on vector `a`.

`__device__ __nv_bfloat162 h2floor(const __nv_bfloat162 h)`

Calculate the largest integer less than or equal to `h`.

For each component of vector `h` calculate the largest integer value which is less than or equal to `h`.

Parameters

h – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

► The vector of largest integers which is less than or equal to `h`.

`__device__ __nv_bfloat162 h2log(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector natural logarithm in round-to-nearest-even mode.

Calculates `nv_bfloat162` natural logarithm of input vector `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

► The elementwise natural logarithm on vector `a`.

`__device__ __nv_bfloat162 h2log10(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector decimal logarithm in round-to-nearest-even mode.

Calculates `nv_bfloat162` decimal logarithm of input vector `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

► The elementwise decimal logarithm on vector `a`.

`__device__ __nv_bfloat162 h2log2(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector binary logarithm in round-to-nearest-even mode.

Calculates `nv_bfloat162` binary logarithm of input vector `a` in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- The elementwise binary logarithm on vector a.

`__device__ __nv_bfloat162 h2rcp(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector reciprocal in round-to-nearest-even mode.

Calculates `nv_bfloat162` reciprocal of input vector a in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- The elementwise reciprocal on vector a.

`__device__ __nv_bfloat162 h2rint(const __nv_bfloat162 h)`

Round input to nearest integer value in `nv_bfloat16` floating-point number.

Round each component of `nv_bfloat162` vector h to the nearest integer value in `nv_bfloat16` floating-point format, with `bfloat16`way cases rounded to the nearest even integer value.

Parameters

h – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- The vector of rounded integer values.

`__device__ __nv_bfloat162 h2rsqrt(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector reciprocal square root in round-to-nearest-even mode.

Calculates `nv_bfloat162` reciprocal square root of input vector a in round-to-nearest-even mode.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- The elementwise reciprocal square root on vector a.

`__device__ __nv_bfloat162 h2sin(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector sine in round-to-nearest-even mode.

Calculates `nv_bfloat162` sine of input vector a in round-to-nearest-even mode.

NOTE: this function's implementation calls `sinf(float)` function and is exposed to compiler optimizations. Specifically, `--use_fast_math` flag changes `sinf(float)` into an intrinsic `__sinf(float)`, which has less accurate numeric behavior.

Parameters

a – [in] - `nv_bfloat162`. Is only being read.

Returns

`nv_bfloat162`

- The elementwise sine on vector a.

`__device__ __nv_bfloat162 h2sqrt(const __nv_bfloat162 a)`

Calculates `nv_bfloat162` vector square root in round-to-nearest-even mode.

Calculates `nv_bfloat162` square root of input vector a in round-to-nearest-even mode.

Parameters

a – [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The elementwise square root on vector a.

`__device__ __nv_bfloat162 h2trunc (const __nv_bfloat162 h)`

Truncate nv_bfloat162 vector input argument to the integral part.

Round each component of vector h to the nearest integer value that does not exceed h in magnitude.

Parameters

h – [in] - nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- ▶ The truncated h.

Groups

Bfloat16 Arithmetic Constants

To use these constants, include the header file `cuda_bf16.h` in your program.

Bfloat16 Arithmetic Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Bfloat16 Comparison Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Bfloat16 Math Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Bfloat16 Precision Conversion and Data Movement

To use these functions, include the header file `cuda_bf16.h` in your program.

Bfloat162 Arithmetic Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Bfloat162 Comparison Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Bfloat162 Math Functions

To use these functions, include the header file `cuda_bf16.h` in your program.

Structs

__nv_bfloat16

nv_bfloat16 datatype

__nv_bfloat162

nv_bfloat162 datatype

__nv_bfloat162_raw

__nv_bfloat162_raw data type

__nv_bfloat16_raw
__nv_bfloat16_raw data type

Typedefs

nv_bfloat16

This datatype is meant to be the first-class or fundamental implementation of the bfloat16 numbers format.

nv_bfloat162

This datatype is meant to be the first-class or fundamental implementation of type for pairs of bfloat16 numbers.

3.9. Typedefs

typedef __nv_bfloat16 nv_bfloat16

This datatype is meant to be the first-class or fundamental implementation of the bfloat16 numbers format.

Should be implemented in the compiler in the future. Current implementation is a simple typedef to a respective user-level type with underscores.

typedef __nv_bfloat162 nv_bfloat162

This datatype is meant to be the first-class or fundamental implementation of type for pairs of bfloat16 numbers.

Should be implemented in the compiler in the future. Current implementation is a simple typedef to a respective user-level type with underscores.

Chapter 4. Single Precision Mathematical Functions

This section describes single precision mathematical functions.

To use these functions you do not need to include any additional header files in your program.

Functions

__device__ float *acosf*(float x)

Calculate the arc cosine of the input argument.

__device__ float *acoshf*(float x)

Calculate the nonnegative inverse hyperbolic cosine of the input argument.

__device__ float *asinf*(float x)

Calculate the arc sine of the input argument.

__device__ float *asinhf*(float x)

Calculate the inverse hyperbolic sine of the input argument.

__device__ float *atan2f*(float y, float x)

Calculate the arc tangent of the ratio of first and second input arguments.

__device__ float *atanf*(float x)

Calculate the arc tangent of the input argument.

__device__ float *atanhf*(float x)

Calculate the inverse hyperbolic tangent of the input argument.

__device__ float *cbrtf*(float x)

Calculate the cube root of the input argument.

__device__ float *ceilf*(float x)

Calculate ceiling of the input argument.

__device__ float *copysignf*(float x, float y)

Create value with given magnitude, copying sign of second value.

__device__ float *cosf*(float x)

Calculate the cosine of the input argument.

__device__ float *coshf*(float x)

Calculate the hyperbolic cosine of the input argument.

__device__ float *cospif*(float x)

Calculate the cosine of the input argument $\times \pi$.

__device__ float *cy_bessel_i0f*(float x)

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument.

__device__ float *cy_bessel_i1f*(float x)

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument.

__device__ float *erfcf*(float x)

Calculate the complementary error function of the input argument.

__device__ float *erfcinvf*(float x)

Calculate the inverse complementary error function of the input argument.

__device__ float *erfcxf*(float x)

Calculate the scaled complementary error function of the input argument.

__device__ float *erff*(float x)

Calculate the error function of the input argument.

__device__ float *erfinvf*(float x)

Calculate the inverse error function of the input argument.

__device__ float *exp10f*(float x)

Calculate the base 10 exponential of the input argument.

__device__ float *exp2f*(float x)

Calculate the base 2 exponential of the input argument.

__device__ float *expf*(float x)

Calculate the base e exponential of the input argument.

__device__ float *expm1f*(float x)

Calculate the base e exponential of the input argument, minus 1.

__device__ float *fabsf*(float x)

Calculate the absolute value of its argument.

__device__ float *fdimf*(float x, float y)

Compute the positive difference between x and y .

__device__ float *fdividef*(float x, float y)

Divide two floating-point values.

__device__ float *floorf*(float x)

Calculate the largest integer less than or equal to x .

__device__ float *fmaf*(float x, float y, float z)

Compute $x \times y + z$ as a single operation.

__device__ float *fmaxf*(float x, float y)

Determine the maximum numeric value of the arguments.

__device__ float *fminf*(float x, float y)

Determine the minimum numeric value of the arguments.

__device__ float *fmodf*(float x, float y)

Calculate the floating-point remainder of x / y .

__device__ float *frexpf*(float x, int *nptr)

Extract mantissa and exponent of a floating-point value.

__device__ float *hypotf*(float x, float y)

Calculate the square root of the sum of squares of two arguments.

- __device__ int *ilogbf*(float x)**
 Compute the unbiased integer exponent of the argument.
- __device__ __RETURN_TYPE *isfinite*(float a)**
 Determine whether argument is finite.
- __device__ __RETURN_TYPE *isinf*(float a)**
 Determine whether argument is infinite.
- __device__ __RETURN_TYPE *isnan*(float a)**
 Determine whether argument is a NaN.
- __device__ float *j0f*(float x)**
 Calculate the value of the Bessel function of the first kind of order 0 for the input argument.
- __device__ float *j1f*(float x)**
 Calculate the value of the Bessel function of the first kind of order 1 for the input argument.
- __device__ float *jnf*(int n, float x)**
 Calculate the value of the Bessel function of the first kind of order n for the input argument.
- __device__ float *ldexpf*(float x, int exp)**
 Calculate the value of $x \cdot 2^{exp}$.
- __device__ float *lgammaf*(float x)**
 Calculate the natural logarithm of the absolute value of the gamma function of the input argument.
- __device__ long long int *llrintf*(float x)**
 Round input to nearest integer value.
- __device__ long long int *llroundf*(float x)**
 Round to nearest integer value.
- __device__ float *log10f*(float x)**
 Calculate the base 10 logarithm of the input argument.
- __device__ float *log1pf*(float x)**
 Calculate the value of $\log_e(1 + x)$.
- __device__ float *log2f*(float x)**
 Calculate the base 2 logarithm of the input argument.
- __device__ float *logbf*(float x)**
 Calculate the floating-point representation of the exponent of the input argument.
- __device__ float *logf*(float x)**
 Calculate the natural logarithm of the input argument.
- __device__ long int *lrintf*(float x)**
 Round input to nearest integer value.
- __device__ long int *lroundf*(float x)**
 Round to nearest integer value.
- __device__ float *max*(const float a, const float b)**
 Calculate the maximum value of the input float arguments.
- __device__ float *min*(const float a, const float b)**
 Calculate the minimum value of the input float arguments.
- __device__ float *modff*(float x, float *iptr)**
 Break down the input argument into fractional and integral parts.

__device__ float *nanf*(const char *tagp)

Returns "Not a Number" value.

__device__ float *nearbyintf*(float x)

Round the input argument to the nearest integer.

__device__ float *nextafterf*(float x, float y)

Return next representable single-precision floating-point value after argument x in the direction of y .

__device__ float *norm3df*(float a, float b, float c)

Calculate the square root of the sum of squares of three coordinates of the argument.

__device__ float *norm4df*(float a, float b, float c, float d)

Calculate the square root of the sum of squares of four coordinates of the argument.

__device__ float *normcdf*(float x)

Calculate the standard normal cumulative distribution function.

__device__ float *normcdfinvf*(float x)

Calculate the inverse of the standard normal cumulative distribution function.

__device__ float *normf*(int dim, float const *p)

Calculate the square root of the sum of squares of any number of coordinates.

__device__ float *powf*(float x, float y)

Calculate the value of first argument to the power of second argument.

__device__ float *rcbrtf*(float x)

Calculate reciprocal cube root function.

__device__ float *remainderf*(float x, float y)

Compute single-precision floating-point remainder.

__device__ float *remquof*(float x, float y, int *quo)

Compute single-precision floating-point remainder and part of quotient.

__device__ float *rhypotf*(float x, float y)

Calculate one over the square root of the sum of squares of two arguments.

__device__ float *rintf*(float x)

Round input to nearest integer value in floating-point.

__device__ float *rnorm3df*(float a, float b, float c)

Calculate one over the square root of the sum of squares of three coordinates.

__device__ float *rnorm4df*(float a, float b, float c, float d)

Calculate one over the square root of the sum of squares of four coordinates.

__device__ float *rnormf*(int dim, float const *p)

Calculate the reciprocal of square root of the sum of squares of any number of coordinates.

__device__ float *roundf*(float x)

Round to nearest integer value in floating-point.

__device__ float *rsqrtf*(float x)

Calculate the reciprocal of the square root of the input argument.

__device__ float *scalblnf*(float x, long int n)

Scale floating-point input by integer power of two.

__device__ float *scalbnf*(float x, int n)

Scale floating-point input by integer power of two.

__device__ __RETURN_TYPE *signbit*(float a)

Return the sign bit of the input.

__device__ void *sincosf*(float x, float *sptr, float *cptr)

Calculate the sine and cosine of the first input argument.

__device__ void *sincospif*(float x, float *sptr, float *cptr)

Calculate the sine and cosine of the first input argument $\times \pi$.

__device__ float *sinf*(float x)

Calculate the sine of the input argument.

__device__ float *sinhf*(float x)

Calculate the hyperbolic sine of the input argument.

__device__ float *sinpif*(float x)

Calculate the sine of the input argument $\times \pi$.

__device__ float *sqrtof*(float x)

Calculate the square root of the input argument.

__device__ float *tanf*(float x)

Calculate the tangent of the input argument.

__device__ float *tanhf*(float x)

Calculate the hyperbolic tangent of the input argument.

__device__ float *tgammaf*(float x)

Calculate the gamma function of the input argument.

__device__ float *truncf*(float x)

Truncate input argument to the integral part.

__device__ float *y0f*(float x)

Calculate the value of the Bessel function of the second kind of order 0 for the input argument.

__device__ float *y1f*(float x)

Calculate the value of the Bessel function of the second kind of order 1 for the input argument.

__device__ float *ynf*(int n, float x)

Calculate the value of the Bessel function of the second kind of order n for the input argument.

4.1. Functions

__device__ float *acosf*(float x)

Calculate the arc cosine of the input argument.

Calculate the principal value of the arc cosine of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[0, \pi]$ for x inside $[-1, +1]$.

- ▶ *acosf*(1) returns +0.

- ▶ `acosf(x)` returns NaN for x outside $[-1, +1]$.
- ▶ `acosf(NaN)` returns NaN.

`__device__ float acoshf(float x)`

Calculate the nonnegative inverse hyperbolic cosine of the input argument.

Calculate the nonnegative inverse hyperbolic cosine of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Result will be in the interval $[0, +\infty]$.

- ▶ `acoshf(1)` returns 0.
- ▶ `acoshf(x)` returns NaN for x in the interval $[-\infty, 1)$.
- ▶ `acoshf(+\infty)` returns $+\infty$.
- ▶ `acoshf(NaN)` returns NaN.

`__device__ float asinf(float x)`

Calculate the arc sine of the input argument.

Calculate the principal value of the arc sine of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[-\pi/2, +\pi/2]$ for x inside $[-1, +1]$.

- ▶ `asinf(± 0)` returns ± 0 .
- ▶ `asinf(x)` returns NaN for x outside $[-1, +1]$.
- ▶ `asinf(NaN)` returns NaN.

`__device__ float asinhf(float x)`

Calculate the inverse hyperbolic sine of the input argument.

Calculate the inverse hyperbolic sine of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `asinhf(± 0)` returns ± 0 .
- ▶ `asinhf($\pm\infty$)` returns $\pm\infty$.
- ▶ `asinhf(NaN)` returns NaN.

`__device__ float atan2f(float y, float x)`

Calculate the arc tangent of the ratio of first and second input arguments.

Calculate the principal value of the arc tangent of the ratio of first and second input arguments y / x . The quadrant of the result is determined by the signs of inputs y and x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[-\pi, +\pi]$.

- ▶ `atan2f(±0, -0)` returns $\pm\pi$.
- ▶ `atan2f(±0, +0)` returns ± 0 .
- ▶ `atan2f(±0, x)` returns $\pm\pi$ for $x < 0$.
- ▶ `atan2f(±0, x)` returns ± 0 for $x > 0$.
- ▶ `atan2f(y, ±0)` returns $-\pi / 2$ for $y < 0$.
- ▶ `atan2f(y, ±0)` returns $\pi / 2$ for $y > 0$.
- ▶ `atan2f(±y, $-\infty$)` returns $\pm\pi$ for finite $y > 0$.
- ▶ `atan2f(±y, $+\infty$)` returns ± 0 for finite $y > 0$.
- ▶ `atan2f(±∞, x)` returns $\pm\pi / 2$ for finite x .
- ▶ `atan2f(±∞, $-\infty$)` returns $\pm 3\pi / 4$.
- ▶ `atan2f(±∞, $+\infty$)` returns $\pm\pi / 4$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float atanf(float x)`

Calculate the arc tangent of the input argument.

Calculate the principal value of the arc tangent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[-\pi/2, +\pi/2]$.

- ▶ `atanf(±0)` returns ± 0 .
- ▶ `atanf(±∞)` returns $\pm\pi / 2$.
- ▶ `atanf(NaN)` returns NaN.

`__device__ float atanhf(float x)`

Calculate the inverse hyperbolic tangent of the input argument.

Calculate the inverse hyperbolic tangent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `atanhf(±0)` returns ± 0 .
- ▶ `atanhf(±1)` returns $\pm\infty$.
- ▶ `atanhf(x)` returns NaN for x outside interval $[-1, 1]$.
- ▶ `atanhf(NaN)` returns NaN.

`__device__ float cbrtf(float x)`

Calculate the cube root of the input argument.

Calculate the cube root of x , $x^{1/3}$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns $x^{1/3}$.

- ▶ `cbrtf(±0)` returns ± 0 .
- ▶ `cbrtf(±∞)` returns $\pm\infty$.
- ▶ `cbrtf(NaN)` returns NaN.

`__device__ float ceilf(float x)`

Calculate ceiling of the input argument.

Compute the smallest integer value not less than x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns $\lceil x \rceil$ expressed as a floating-point number.

- ▶ `ceilf(±0)` returns ± 0 .
- ▶ `ceilf(±∞)` returns $\pm\infty$.
- ▶ `ceilf(NaN)` returns NaN.

`__device__ float copysignf(float x, float y)`

Create value with given magnitude, copying sign of second value.

Create a floating-point value with the magnitude x and the sign of y .

Returns

- ▶ a value with the magnitude of x and the sign of y .
- ▶ `copysignf(NaN, y)` returns a NaN with the sign of y .

`__device__ float cosf(float x)`

Calculate the cosine of the input argument.

Calculate the cosine of the input argument x (measured in radians).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `cosf(±0)` returns 1.
- ▶ `cosf(±∞)` returns NaN.
- ▶ `cosf(NaN)` returns NaN.

`__device__ float coshf(float x)`

Calculate the hyperbolic cosine of the input argument.

Calculate the hyperbolic cosine of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `coshf(±0)` returns 1.
- ▶ `coshf(±∞)` returns $+\infty$.
- ▶ `coshf(NaN)` returns NaN.

`__device__ float cospif(float x)`

Calculate the cosine of the input argument $\times \pi$.

Calculate the cosine of $x \times \pi$ (measured in radians), where x is the input argument.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `cospif(±0)` returns 1.
- ▶ `cospif(±∞)` returns NaN.
- ▶ `cospif(NaN)` returns NaN.

`__device__ float cyl_bessel_i0f(float x)`

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument.

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument x , $I_0(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 0.

- ▶ `cyl_bessel_i0f(±0)` returns +1.
- ▶ `cyl_bessel_i0f(±∞)` returns +∞.
- ▶ `cyl_bessel_i0f(NaN)` returns NaN.

`__device__ float cyl_bessel_i1f(float x)`

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument.

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument x , $I_1(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 1.

- ▶ `cyl_bessel_i1f(±0)` returns ±0.
- ▶ `cyl_bessel_i1f(±∞)` returns ±∞.
- ▶ `cyl_bessel_i1f(NaN)` returns NaN.

`__device__ float erfcf(float x)`

Calculate the complementary error function of the input argument.

Calculate the complementary error function of the input argument x , $1 - \text{erf}(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `erfcf(-∞)` returns 2.
- ▶ `erfcf(+∞)` returns +0.
- ▶ `erfcf(NaN)` returns NaN.

`__device__ float erfcinvf(float x)`

Calculate the inverse complementary error function of the input argument.

Calculate the inverse complementary error function $\text{erfc}^{-1}(x)$, of the input argument x in the interval $[0, 2]$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `erfcinvf(±0)` returns $±∞$.
- ▶ `erfcinvf(2)` returns $-∞$.
- ▶ `erfcinvf(x)` returns NaN for x outside $[0, 2]$.
- ▶ `erfcinvf(NaN)` returns NaN.

`__device__ float erfcxf(float x)`

Calculate the scaled complementary error function of the input argument.

Calculate the scaled complementary error function of the input argument x , $e^{x^2} \cdot \text{erfc}(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `erfcxf(-∞)` returns $±∞$.
- ▶ `erfcxf(+∞)` returns +0.
- ▶ `erfcxf(NaN)` returns NaN.

`__device__ float erff(float x)`

Calculate the error function of the input argument.

Calculate the value of the error function for the input argument x , $\frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `erff(±0)` returns $±0$.

- ▶ `erff(±∞)` returns ± 1 .
- ▶ `erff(NaN)` returns NaN.

`__device__ float erfinvf(float x)`

Calculate the inverse error function of the input argument.

Calculate the inverse error function $\text{erf}^{-1}(x)$, of the input argument x in the interval $[-1, 1]$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `erfinvf(±0)` returns ± 0 .
- ▶ `erfinvf(1)` returns $+\infty$.
- ▶ `erfinvf(-1)` returns $-\infty$.
- ▶ `erfinvf(x)` returns NaN for x outside $[-1, +1]$.
- ▶ `erfinvf(NaN)` returns NaN.

`__device__ float exp10f(float x)`

Calculate the base 10 exponential of the input argument.

Calculate 10^x , the base 10 exponential of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `exp10f(±0)` returns 1.
- ▶ `exp10f(-∞)` returns +0.
- ▶ `exp10f(+∞)` returns $+\infty$.
- ▶ `exp10f(NaN)` returns NaN.

`__device__ float exp2f(float x)`

Calculate the base 2 exponential of the input argument.

Calculate 2^x , the base 2 exponential of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `exp2f(±0)` returns 1.
- ▶ `exp2f(-∞)` returns +0.
- ▶ `exp2f(+∞)` returns +∞.
- ▶ `exp2f(NaN)` returns NaN.

`__device__ float expf(float x)`

Calculate the base e exponential of the input argument.

Calculate e^x , the base e exponential of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `expf(±0)` returns 1.
- ▶ `expf(-∞)` returns +0.
- ▶ `expf(+∞)` returns +∞.
- ▶ `expf(NaN)` returns NaN.

`__device__ float expm1f(float x)`

Calculate the base e exponential of the input argument, minus 1.

Calculate $e^x - 1$, the base e exponential of the input argument x , minus 1.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `expm1f(±0)` returns ±0.
- ▶ `expm1f(-∞)` returns -1.
- ▶ `expm1f(+∞)` returns +∞.

- ▶ `expm1f(NaN)` returns NaN.

`__device__ float fabsf(float x)`

Calculate the absolute value of its argument.

Calculate the absolute value of the input argument `x`.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the absolute value of its argument.

- ▶ `fabsf($\pm\infty$)` returns $+\infty$.
- ▶ `fabsf(± 0)` returns $+0$.
- ▶ `fabsf(NaN)` returns an unspecified NaN.

`__device__ float fdimf(float x, float y)`

Compute the positive difference between `x` and `y`.

Compute the positive difference between `x` and `y`. The positive difference is `x - y` when `x > y` and $+0$ otherwise.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the positive difference between `x` and `y`.

- ▶ `fdimf(x, y)` returns `x - y` if `x > y`.
- ▶ `fdimf(x, y)` returns $+0$ if `x ≤ y`.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float fdividef(float x, float y)`

Divide two floating-point values.

Compute `x` divided by `y`.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

Returns `x / y`.

- ▶ Follows the regular division operation behavior by default.
- ▶ If `-use_fast_math` is specified and is not amended by an explicit `-prec_div=true`, uses `__fdividef()` for higher performance

`__device__` float **floorf**(float x)

Calculate the largest integer less than or equal to x.

Calculate the largest integer value which is less than or equal to x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns $\lfloor x \rfloor$ expressed as a floating-point number.

- ▶ `floorf(±∞)` returns $\pm\infty$.
- ▶ `floorf(±0)` returns ± 0 .
- ▶ `floorf(NaN)` returns NaN.

`__device__` float **fmaf**(float x, float y, float z)

Compute $x \times y + z$ as a single operation.

Compute the value of $x \times y + z$ as a single ternary operation. After computing the value to infinite precision, the value is rounded once using round-to-nearest, ties-to-even rounding mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `fmaf(±∞, ±0, z)` returns NaN.
- ▶ `fmaf(±0, ±∞, z)` returns NaN.
- ▶ `fmaf(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `fmaf(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `fmaf(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `fmaf(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `fmaf(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__` float **fmaxf**(float x, float y)

Determine the maximum numeric value of the arguments.

Determines the maximum numeric value of the arguments x and y. Treats NaN arguments as missing data. If one argument is a NaN and the other is legitimate numeric value, the numeric value is chosen.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the maximum numeric values of the arguments x and y .

- ▶ If both arguments are NaN, returns NaN.
- ▶ If one argument is NaN, returns the numeric argument.

`__device__ float fminf(float x, float y)`

Determine the minimum numeric value of the arguments.

Determines the minimum numeric value of the arguments x and y . Treats NaN arguments as missing data. If one argument is a NaN and the other is legitimate numeric value, the numeric value is chosen.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the minimum numeric value of the arguments x and y .

- ▶ If both arguments are NaN, returns NaN.
- ▶ If one argument is NaN, returns the numeric argument.

`__device__ float fmodf(float x, float y)`

Calculate the floating-point remainder of x / y .

Calculate the floating-point remainder of x / y . The floating-point remainder of the division operation x / y calculated by this function is exactly the value $x - n*y$, where n is x / y with its fractional part truncated. The computed value will have the same sign as x , and its magnitude will be less than the magnitude of y .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ Returns the floating-point remainder of x / y .
- ▶ `fmodf(±0, y)` returns $±0$ if y is not zero.
- ▶ `fmodf(x, ±∞)` returns x if x is finite.
- ▶ `fmodf(x, y)` returns NaN if x is $±∞$ or y is zero.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float frexpf(float x, int *nptr)`

Extract mantissa and exponent of a floating-point value.

Decomposes the floating-point value x into a component m for the normalized fraction element and another term n for the exponent. The absolute value of m will be greater than or equal to 0.5 and less than 1.0 or it will be equal to 0; $x = m \cdot 2^n$. The integer exponent n will be stored in the location to which `nptr` points.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the fractional component m .

- ▶ `frexpf(±0, nptr)` returns $±0$ and stores zero in the location pointed to by `nptr`.
- ▶ `frexpf(±∞, nptr)` returns $±∞$ and stores an unspecified value in the location to which `nptr` points.
- ▶ `frexpf(NaN, y)` returns a NaN and stores an unspecified value in the location to which `nptr` points.

`__device__ float hypotf(float x, float y)`

Calculate the square root of the sum of squares of two arguments.

Calculates the length of the hypotenuse of a right triangle whose two sides have lengths x and y without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the length of the hypotenuse $\sqrt{x^2 + y^2}$.

- ▶ `hypotf(x,y)`, `hypotf(y,x)`, and `hypotf(x, -y)` are equivalent.
- ▶ `hypotf(x, ±0)` is equivalent to `fabsf(x)`.
- ▶ `hypotf(±∞, y)` returns $+∞$, even if y is a NaN.
- ▶ `hypotf(NaN, y)` returns NaN, when y is not $±∞$.

`__device__ int ilogbf(float x)`

Compute the unbiased integer exponent of the argument.

Calculates the unbiased integer exponent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ If successful, returns the unbiased exponent of the argument.

- ▶ `ilogbf(±0)` returns `INT_MIN`.
- ▶ `ilogbf(NaN)` returns `INT_MIN`.
- ▶ `ilogbf(±∞)` returns `INT_MAX`.
- ▶ Note: above behavior does not take into account `FP_ILOGB0` nor `FP_ILOGBNAN`.

`__device__ __RETURN_TYPE isfinite(float a)`

Determine whether argument is finite.

Determine whether the floating-point value `a` is a finite value (zero, subnormal, or normal and not infinity or NaN).

Returns

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if `a` is a finite value.
- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if `a` is a finite value.

`__device__ __RETURN_TYPE isinf(float a)`

Determine whether argument is infinite.

Determine whether the floating-point value `a` is an infinite value (positive or negative).

Returns

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if `a` is an infinite value.
- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if `a` is an infinite value.

`__device__ __RETURN_TYPE isnan(float a)`

Determine whether argument is a NaN.

Determine whether the floating-point value `a` is a NaN.

Returns

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if `a` is a NaN value.
- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if `a` is a NaN value.

`__device__ float j0f(float x)`

Calculate the value of the Bessel function of the first kind of order 0 for the input argument.

Calculate the value of the Bessel function of the first kind of order 0 for the input argument `x`, $J_0(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the first kind of order 0.

- ▶ `j0f(±∞)` returns +0.
- ▶ `j0f(NaN)` returns NaN.

`__device__ float j1f(float x)`

Calculate the value of the Bessel function of the first kind of order 1 for the input argument.

Calculate the value of the Bessel function of the first kind of order 1 for the input argument x , $J_1(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the first kind of order 1.

- ▶ `j1f(±0)` returns ±0.
- ▶ `j1f(±∞)` returns ±0.
- ▶ `j1f(NaN)` returns NaN.

`__device__ float jnf(int n, float x)`

Calculate the value of the Bessel function of the first kind of order n for the input argument.

Calculate the value of the Bessel function of the first kind of order n for the input argument x , $J_n(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the first kind of order n .

- ▶ `jnf(n, NaN)` returns NaN.
- ▶ `jnf(n, x)` returns NaN for $n < 0$.
- ▶ `jnf(n, +∞)` returns +0.

`__device__ float ldexpf(float x, int exp)`

Calculate the value of $x \cdot 2^{exp}$.

Calculate the value of $x \cdot 2^{exp}$ of the input arguments x and exp .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `ldexpf(x, exp)` is equivalent to `scalbnf(x, exp)`.

`__device__ float lgammaf(float x)`

Calculate the natural logarithm of the absolute value of the gamma function of the input argument.

Calculate the natural logarithm of the absolute value of the gamma function of the input argument x , namely the value of $\log_e |\Gamma(x)|$

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `lgammaf(1)` returns `+0`.
- ▶ `lgammaf(2)` returns `+0`.
- ▶ `lgammaf(x)` returns `+\infty` if $x \leq 0$ and x is an integer.
- ▶ `lgammaf(-\infty)` returns `+\infty`.
- ▶ `lgammaf(+\infty)` returns `+\infty`.
- ▶ `lgammaf(NaN)` returns `NaN`.

`__device__ long long int llrintf(float x)`

Round input to nearest integer value.

Round x to the nearest integer value, with halfway cases rounded to the nearest even integer value. If the result is outside the range of the return type, the behavior is undefined.

Returns

Returns rounded integer value.

`__device__ long long int llroundf(float x)`

Round to nearest integer value.

Round x to the nearest integer value, with halfway cases rounded away from zero. If the result is outside the range of the return type, the behavior is undefined.

Note: This function may be slower than alternate rounding methods. See [llrintf\(\)](#).

Returns

Returns rounded integer value.

`__device__ float log10f(float x)`

Calculate the base 10 logarithm of the input argument.

Calculate the base 10 logarithm of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `log10f(±0)` returns $-\infty$.
- ▶ `log10f(1)` returns $+0$.
- ▶ `log10f(x)` returns NaN for $x < 0$.
- ▶ `log10f(+∞)` returns $+\infty$.
- ▶ `log10f(NaN)` returns NaN.

`__device__ float log1pf(float x)`

Calculate the value of $\log_e(1 + x)$.

Calculate the value of $\log_e(1 + x)$ of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `log1pf(±0)` returns ± 0 .
- ▶ `log1pf(-1)` returns $-\infty$.
- ▶ `log1pf(x)` returns NaN for $x < -1$.
- ▶ `log1pf(+∞)` returns $+\infty$.
- ▶ `log1pf(NaN)` returns NaN.

`__device__ float log2f(float x)`

Calculate the base 2 logarithm of the input argument.

Calculate the base 2 logarithm of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ $\log_2 f(\pm 0)$ returns $-\infty$.
- ▶ $\log_2 f(1)$ returns $+0$.
- ▶ $\log_2 f(x)$ returns NaN for $x < 0$.
- ▶ $\log_2 f(+\infty)$ returns $+\infty$.
- ▶ $\log_2 f(\text{NaN})$ returns NaN.

`__device__ float logbf(float x)`

Calculate the floating-point representation of the exponent of the input argument.

Calculate the floating-point representation of the exponent of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ $\log_{bf}(\pm 0)$ returns $-\infty$.
- ▶ $\log_{bf}(\pm \infty)$ returns $+\infty$.
- ▶ $\log_{bf}(\text{NaN})$ returns NaN.

`__device__ float logf(float x)`

Calculate the natural logarithm of the input argument.

Calculate the natural logarithm of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ $\log f(\pm 0)$ returns $-\infty$.
- ▶ $\log f(1)$ returns $+0$.
- ▶ $\log f(x)$ returns NaN for $x < 0$.
- ▶ $\log f(+\infty)$ returns $+\infty$.
- ▶ $\log f(\text{NaN})$ returns NaN.

`__device__ long int lrintf(float x)`

Round input to nearest integer value.

Round x to the nearest integer value, with halfway cases rounded to the nearest even integer value. If the result is outside the range of the return type, the behavior is undefined.

Returns

Returns rounded integer value.

`__device__ long int lroundf(float x)`

Round to nearest integer value.

Round x to the nearest integer value, with halfway cases rounded away from zero. If the result is outside the range of the return type, the behavior is undefined.

Note: This function may be slower than alternate rounding methods. See [lrintf\(\)](#).

Returns

Returns rounded integer value.

`__device__ float max(const float a, const float b)`

Calculate the maximum value of the input `float` arguments.

Calculate the maximum value of the arguments a and b . Behavior is equivalent to [fmaxf\(\)](#) function.

Note, this is different from `std::` specification

`__device__ float min(const float a, const float b)`

Calculate the minimum value of the input `float` arguments.

Calculate the minimum value of the arguments a and b . Behavior is equivalent to [fminf\(\)](#) function.

Note, this is different from `std::` specification

`__device__ float modff(float x, float *iptr)`

Break down the input argument into fractional and integral parts.

Break down the argument x into fractional and integral parts. The integral part is stored in the argument `iptr`. Fractional and integral parts are given the same sign as the argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `modff(±x, iptr)` returns a result with the same sign as x .
- ▶ `modff(±∞, iptr)` returns $±0$ and stores $±∞$ in the object pointed to by `iptr`.
- ▶ `modff(NaN, iptr)` stores a NaN in the object pointed to by `iptr` and returns a NaN.

`__device__ float nanf(const char *tagp)`

Returns “Not a Number” value.

Return a representation of a quiet NaN. Argument `tagp` selects one of the possible representations.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `nanf(tagp)` returns NaN.

`__device__ float nearbyintf(float x)`

Round the input argument to the nearest integer.

Round argument `x` to an integer value in single precision floating-point format. Uses round to nearest rounding, with ties rounding to even.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `nearbyintf(±0)` returns ± 0 .
- ▶ `nearbyintf(±∞)` returns $\pm\infty$.
- ▶ `nearbyintf(NaN)` returns NaN.

`__device__ float nextafterf(float x, float y)`

Return next representable single-precision floating-point value after argument `x` in the direction of `y`.

Calculate the next representable single-precision floating-point value following `x` in the direction of `y`. For example, if `y` is greater than `x`, `nextafterf()` returns the smallest representable number greater than `x`

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `nextafterf(x, y) = y` if `x` equals `y`.
- ▶ `nextafterf(x, y) = NaN` if either `x` or `y` are NaN.

`__device__ float norm3df(float a, float b, float c)`

Calculate the square root of the sum of squares of three coordinates of the argument.

Calculates the length of three dimensional vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the length of the 3D vector $\sqrt{a^2 + b^2 + c^2}$.

- ▶ In the presence of an exactly infinite coordinate $+\infty$ is returned, even if there are NaNs.
- ▶ returns +0, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ float norm4df(float a, float b, float c, float d)`

Calculate the square root of the sum of squares of four coordinates of the argument.

Calculates the length of four dimensional vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the length of the 4D vector $\sqrt{a^2 + b^2 + c^2 + d^2}$.

- ▶ In the presence of an exactly infinite coordinate $+\infty$ is returned, even if there are NaNs.
- ▶ returns +0, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ float normcdf(float x)`

Calculate the standard normal cumulative distribution function.

Calculate the cumulative distribution function of the standard normal distribution for input argument x , $\Phi(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `normcdf(+∞)` returns 1.
- ▶ `normcdf(-∞)` returns +0
- ▶ `normcdf(NaN)` returns NaN.

`__device__ float normcdfinvf(float x)`

Calculate the inverse of the standard normal cumulative distribution function.

Calculate the inverse of the standard normal cumulative distribution function for input argument x , $\Phi^{-1}(x)$. The function is defined for input values in the interval $(0, 1)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `normcdfinvf(±0)` returns $-\infty$.
- ▶ `normcdfinvf(1)` returns $+\infty$.
- ▶ `normcdfinvf(x)` returns NaN if x is not in the interval $[0, 1]$.
- ▶ `normcdfinvf(NaN)` returns NaN.

`__device__ float normf(int dim, float const *p)`

Calculate the square root of the sum of squares of any number of coordinates.

Calculates the length of a vector p , dimension of which is passed as an argument without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the length of the dim-D vector $\sqrt{\sum_{i=0}^{dim-1} p_i^2}$.

- ▶ In the presence of an exactly infinite coordinate $+\infty$ is returned, even if there are NaNs.
- ▶ returns $+0$, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ float powf(float x, float y)`

Calculate the value of first argument to the power of second argument.

Calculate the value of x to the power of y .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `powf(±0, y)` returns $±∞$ for y an odd integer less than 0.
- ▶ `powf(±0, y)` returns $+∞$ for y less than 0 and not an odd integer.
- ▶ `powf(±0, y)` returns $±0$ for y an odd integer greater than 0.
- ▶ `powf(±0, y)` returns $+0$ for $y > 0$ and not an odd integer.
- ▶ `powf(-1, ±∞)` returns 1.
- ▶ `powf(+1, y)` returns 1 for any y , even a NaN.
- ▶ `powf(x, ±0)` returns 1 for any x , even a NaN.
- ▶ `powf(x, y)` returns a NaN for finite $x < 0$ and finite non-integer y .
- ▶ `powf(x, -∞)` returns $+∞$ for $|x| < 1$.
- ▶ `powf(x, -∞)` returns $+0$ for $|x| > 1$.
- ▶ `powf(x, +∞)` returns $+0$ for $|x| < 1$.
- ▶ `powf(x, +∞)` returns $+∞$ for $|x| > 1$.
- ▶ `powf(-∞, y)` returns -0 for y an odd integer less than 0.
- ▶ `powf(-∞, y)` returns $+0$ for $y < 0$ and not an odd integer.
- ▶ `powf(-∞, y)` returns $-∞$ for y an odd integer greater than 0.
- ▶ `powf(-∞, y)` returns $+∞$ for $y > 0$ and not an odd integer.
- ▶ `powf(+∞, y)` returns $+0$ for $y < 0$.
- ▶ `powf(+∞, y)` returns $+∞$ for $y > 0$.
- ▶ `powf(x, y)` returns NaN if either x or y or both are NaN and $x ≠ +1$ and $y ≠ ±0$.

`__device__ float rcbtrf(float x)`

Calculate reciprocal cube root function.

Calculate reciprocal cube root function of x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `rcbrt(±0)` returns $±∞$.
- ▶ `rcbrt(±∞)` returns $±0$.
- ▶ `rcbrt(NaN)` returns NaN.

`__device__ float remainderf(float x, float y)`

Compute single-precision floating-point remainder.

Compute single-precision floating-point remainder r of dividing x by y for nonzero y . Thus $r = x - ny$. The value n is the integer value nearest $\frac{x}{y}$. In the case when $|n - \frac{x}{y}| = \frac{1}{2}$, the even n value is chosen.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ remainderf(x, ±0) returns NaN.
- ▶ remainderf(±∞ , y) returns NaN.
- ▶ remainderf(x, ±∞) returns x for finite x.
- ▶ If either argument is NaN, NaN is returned.

__device__ float **remquof**(float x, float y, int *quo)

Compute single-precision floating-point remainder and part of quotient.

Compute a single-precision floating-point remainder in the same way as the *remainderf()* function. Argument quo returns part of quotient upon division of x by y. Value quo has the same sign as $\frac{x}{y}$ and may not be the exact quotient but agrees with the exact quotient in the low order 3 bits.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the remainder.

- ▶ remquof(x, ±0 , quo) returns NaN and stores an unspecified value in the location to which quo points.
- ▶ remquof(±∞ , y, quo) returns NaN and stores an unspecified value in the location to which quo points.
- ▶ remquof(x, y, quo) returns NaN and stores an unspecified value in the location to which quo points if either of x or y is NaN.
- ▶ remquof(x, ±∞ , quo) returns x and stores zero in the location to which quo points for finite x.

__device__ float **rhypotf**(float x, float y)

Calculate one over the square root of the sum of squares of two arguments.

Calculates one over the length of the hypotenuse of a right triangle whose two sides have lengths x and y without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns one over the length of the hypotenuse $\frac{1}{\sqrt{x^2+y^2}}$.

- ▶ rhypotf(x,y), rhypotf(y,x), and rhypotf(x, -y) are equivalent.

- ▶ `rhyptof(±∞, y)` returns +0, even if y is a NaN.
- ▶ `rhyptof(±0, ±0)` returns +∞.
- ▶ `rhyptof(NaN, y)` returns NaN, when y is not ±∞.

`__device__ float rintf(float x)`

Round input to nearest integer value in floating-point.

Round x to the nearest integer value in floating-point format, with halfway cases rounded to the nearest even integer value.

Returns

Returns rounded integer value.

- ▶ `rintf(±0)` returns ±0.
- ▶ `rintf(±∞)` returns ±∞.
- ▶ `rintf(NaN)` returns NaN.

`__device__ float rnorm3df(float a, float b, float c)`

Calculate one over the square root of the sum of squares of three coordinates.

Calculates one over the length of three dimension vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns one over the length of the 3D vector $\frac{1}{\sqrt{a^2+b^2+c^2}}$.

- ▶ In the presence of an exactly infinite coordinate +0 is returned, even if there are NaNs.
- ▶ returns +∞, when all coordinates are ±0.
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ float rnorm4df(float a, float b, float c, float d)`

Calculate one over the square root of the sum of squares of four coordinates.

Calculates one over the length of four dimension vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns one over the length of the 4D vector $\frac{1}{\sqrt{a^2+b^2+c^2+d^2}}$.

- ▶ In the presence of an exactly infinite coordinate +0 is returned, even if there are NaNs.
- ▶ returns +∞, when all coordinates are ±0.
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ float rnormf`(int dim, float const *p)

Calculate the reciprocal of square root of the sum of squares of any number of coordinates.

Calculates one over the length of vector p, dimension of which is passed as an argument, in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns one over the length of the vector $\frac{1}{\sqrt{\sum_{i=0}^{dim-1} p_i^2}}$.

- ▶ In the presence of an exactly infinite coordinate +0 is returned, even if there are NaNs.
- ▶ returns $+\infty$, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ float roundf`(float x)

Round to nearest integer value in floating-point.

Round x to the nearest integer value in floating-point format, with halfway cases rounded away from zero.

Note: This function may be slower than alternate rounding methods. See [rintf\(\)](#).

Returns

Returns rounded integer value.

- ▶ `roundf(±0)` returns ± 0 .
- ▶ `roundf(±∞)` returns $\pm\infty$.
- ▶ `roundf(NaN)` returns NaN.

`__device__ float rsqrtf`(float x)

Calculate the reciprocal of the square root of the input argument.

Calculate the reciprocal of the nonnegative square root of x, $1/\sqrt{x}$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns $1/\sqrt{x}$.

- ▶ `rsqrtf(+∞)` returns +0.
- ▶ `rsqrtf(±0)` returns $\pm\infty$.
- ▶ `rsqrtf(x)` returns NaN if x is less than 0.
- ▶ `rsqrtf(NaN)` returns NaN.

`__device__ float scalblnf(float x, long int n)`

Scale floating-point input by integer power of two.

Scale x by 2^n by efficient manipulation of the floating-point exponent.

Returns

Returns $x * 2^n$.

- ▶ `scalblnf(±0, n)` returns $±0$.
- ▶ `scalblnf(x, 0)` returns x .
- ▶ `scalblnf(±∞, n)` returns $±∞$.
- ▶ `scalblnf(NaN, n)` returns NaN.

`__device__ float scalbnf(float x, int n)`

Scale floating-point input by integer power of two.

Scale x by 2^n by efficient manipulation of the floating-point exponent.

Returns

Returns $x * 2^n$.

- ▶ `scalbnf(±0, n)` returns $±0$.
- ▶ `scalbnf(x, 0)` returns x .
- ▶ `scalbnf(±∞, n)` returns $±∞$.
- ▶ `scalbnf(NaN, n)` returns NaN.

`__device__ __RETURN_TYPE signbit(float a)`

Return the sign bit of the input.

Determine whether the floating-point value a is negative.

Returns

Reports the sign bit of all values including infinities, zeros, and NaNs.

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if a is negative.
- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if a is negative.

`__device__ void sincosf(float x, float *sptr, float *cptr)`

Calculate the sine and cosine of the first input argument.

Calculate the sine and cosine of the first input argument x (measured in radians). The results for sine and cosine are written into the second argument, `sptr`, and, respectively, third argument, `cptr`.

See also:

[*sinf\(\)*](#) and [*cosf\(\)*](#).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

`__device__ void sincospif(float x, float *sptr, float *cptr)`

Calculate the sine and cosine of the first input argument $\times \pi$.

Calculate the sine and cosine of the first input argument, x (measured in radians), $\times \pi$. The results for sine and cosine are written into the second argument, `sptr`, and, respectively, third argument, `cptr`.

See also:

[sinpif\(\)](#) and [cospif\(\)](#).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

`__device__ float sinf(float x)`

Calculate the sine of the input argument.

Calculate the sine of the input argument x (measured in radians).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `sinf(±0)` returns ± 0 .
- ▶ `sinf(±∞)` returns NaN.
- ▶ `sinf(NaN)` returns NaN.

`__device__ float sinhf(float x)`

Calculate the hyperbolic sine of the input argument.

Calculate the hyperbolic sine of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `sinhf(±0)` returns ± 0 .
- ▶ `sinhf(±∞)` returns $\pm\infty$.
- ▶ `sinhf(NaN)` returns NaN.

`__device__ float sinpif(float x)`

Calculate the sine of the input argument $\times \pi$.

Calculate the sine of $x \times \pi$ (measured in radians), where x is the input argument.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `sinpif(±0)` returns ± 0 .
- ▶ `sinpif(±∞)` returns NaN.
- ▶ `sinpif(NaN)` returns NaN.

`__device__ float sqrtof(float x)`

Calculate the square root of the input argument.

Calculate the nonnegative square root of x , \sqrt{x} .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns \sqrt{x} .

- ▶ `sqrtof(±0)` returns ± 0 .
- ▶ `sqrtof(+∞)` returns $+\infty$.
- ▶ `sqrtof(x)` returns NaN if x is less than 0.
- ▶ `sqrtof(NaN)` returns NaN.

`__device__ float tanf(float x)`

Calculate the tangent of the input argument.

Calculate the tangent of the input argument x (measured in radians).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Note: This function is affected by the `use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section for a complete list of functions affected.

Returns

- ▶ `tanf(±0)` returns ± 0 .
- ▶ `tanf(±∞)` returns NaN.
- ▶ `tanf(NaN)` returns NaN.

`__device__ float tanhf(float x)`

Calculate the hyperbolic tangent of the input argument.

Calculate the hyperbolic tangent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `tanhf(±0)` returns ± 0 .
- ▶ `tanhf(±∞)` returns ± 1 .
- ▶ `tanhf(NaN)` returns NaN.

`__device__ float tgammaf(float x)`

Calculate the gamma function of the input argument.

Calculate the gamma function of the input argument x , namely the value of $\Gamma(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

- ▶ `tgammaf(±0)` returns $\pm\infty$.
- ▶ `tgammaf(x)` returns NaN if $x < 0$ and x is an integer.
- ▶ `tgammaf(-∞)` returns NaN.
- ▶ `tgammaf(+∞)` returns $+\infty$.
- ▶ `tgammaf(NaN)` returns NaN.

`__device__ float truncf(float x)`

Truncate input argument to the integral part.

Round x to the nearest integer value that does not exceed x in magnitude.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns truncated integer value.

- ▶ `truncf(±0)` returns ± 0 .
- ▶ `truncf(±∞)` returns $\pm\infty$.
- ▶ `truncf(NaN)` returns NaN.

`__device__ float y0f(float x)`

Calculate the value of the Bessel function of the second kind of order 0 for the input argument.

Calculate the value of the Bessel function of the second kind of order 0 for the input argument x , $Y_0(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the second kind of order 0.

- ▶ `y0f(±0)` returns $-\infty$.
- ▶ `y0f(x)` returns NaN for $x < 0$.
- ▶ `y0f(+∞)` returns $+0$.
- ▶ `y0f(NaN)` returns NaN.

`__device__ float y1f(float x)`

Calculate the value of the Bessel function of the second kind of order 1 for the input argument.

Calculate the value of the Bessel function of the second kind of order 1 for the input argument x , $Y_1(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the second kind of order 1.

- ▶ `y1f(±0)` returns $-\infty$.
- ▶ `y1f(x)` returns NaN for $x < 0$.
- ▶ `y1f(+∞)` returns $+0$.
- ▶ `y1f(NaN)` returns NaN.

`__device__ float ynf(int n, float x)`

Calculate the value of the Bessel function of the second kind of order n for the input argument.

Calculate the value of the Bessel function of the second kind of order n for the input argument x , $Y_n(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Single-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the second kind of order n .

- ▶ $y_{nf}(n, x)$ returns NaN for $n < 0$.
- ▶ $y_{nf}(n, \pm 0)$ returns $-\infty$.
- ▶ $y_{nf}(n, x)$ returns NaN for $x < 0$.
- ▶ $y_{nf}(n, +\infty)$ returns +0.
- ▶ $y_{nf}(n, \text{NaN})$ returns NaN.

Chapter 5. Single Precision Intrinsics

This section describes single precision intrinsic functions that are only supported in device code. To use these functions you do not need to include any additional header files in your program.

Functions

__device__ float __cosf(float x)

Calculate the fast approximate cosine of the input argument.

__device__ float __exp10f(float x)

Calculate the fast approximate base 10 exponential of the input argument.

__device__ float __expf(float x)

Calculate the fast approximate base e exponential of the input argument.

__device__ float __fadd_rd(float x, float y)

Add two floating-point values in round-down mode.

__device__ float __fadd_rn(float x, float y)

Add two floating-point values in round-to-nearest-even mode.

__device__ float __fadd_ru(float x, float y)

Add two floating-point values in round-up mode.

__device__ float __fadd_rz(float x, float y)

Add two floating-point values in round-towards-zero mode.

__device__ float __fdiv_rd(float x, float y)

Divide two floating-point values in round-down mode.

__device__ float __fdiv_rn(float x, float y)

Divide two floating-point values in round-to-nearest-even mode.

__device__ float __fdiv_ru(float x, float y)

Divide two floating-point values in round-up mode.

__device__ float __fdiv_rz(float x, float y)

Divide two floating-point values in round-towards-zero mode.

__device__ float __fdivdef(float x, float y)

Calculate the fast approximate division of the input arguments.

__device__ float __fmaf_ieee_rd(float x, float y, float z)

Compute fused multiply-add operation in round-down mode, ignore `-ftz=true` compiler flag.

__device__ float __fmaf_ieee_rn(float x, float y, float z)

Compute fused multiply-add operation in round-to-nearest-even mode, ignore `-ftz=true` compiler flag.

__device__ float __fmaf_ieee_ru(float x, float y, float z)

Compute fused multiply-add operation in round-up mode, ignore `-ftz=true` compiler flag.

__device__ float __fmaf_ieee_rz(float x, float y, float z)

Compute fused multiply-add operation in round-towards-zero mode, ignore `-ftz=true` compiler flag.

__device__ float __fmaf_rd(float x, float y, float z)

Compute $x \times y + z$ as a single operation, in round-down mode.

__device__ float __fmaf_rn(float x, float y, float z)

Compute $x \times y + z$ as a single operation, in round-to-nearest-even mode.

__device__ float __fmaf_ru(float x, float y, float z)

Compute $x \times y + z$ as a single operation, in round-up mode.

__device__ float __fmaf_rz(float x, float y, float z)

Compute $x \times y + z$ as a single operation, in round-towards-zero mode.

__device__ float __fmul_rd(float x, float y)

Multiply two floating-point values in round-down mode.

__device__ float __fmul_rn(float x, float y)

Multiply two floating-point values in round-to-nearest-even mode.

__device__ float __fmul_ru(float x, float y)

Multiply two floating-point values in round-up mode.

__device__ float __fmul_rz(float x, float y)

Multiply two floating-point values in round-towards-zero mode.

__device__ float __frcp_rd(float x)

Compute $\frac{1}{x}$ in round-down mode.

__device__ float __frcp_rn(float x)

Compute $\frac{1}{x}$ in round-to-nearest-even mode.

__device__ float __frcp_ru(float x)

Compute $\frac{1}{x}$ in round-up mode.

__device__ float __frcp_rz(float x)

Compute $\frac{1}{x}$ in round-towards-zero mode.

__device__ float __frsqrt_rn(float x)

Compute $1/\sqrt{x}$ in round-to-nearest-even mode.

__device__ float __fsqrt_rd(float x)

Compute \sqrt{x} in round-down mode.

__device__ float __fsqrt_rn(float x)

Compute \sqrt{x} in round-to-nearest-even mode.

__device__ float __fsqrt_ru(float x)

Compute \sqrt{x} in round-up mode.

__device__ float __fsqrt_rz(float x)

Compute \sqrt{x} in round-towards-zero mode.

__device__ float __fsub_rd(float x, float y)

Subtract two floating-point values in round-down mode.

- __device__ float __fsub_rn(float x, float y)**
Subtract two floating-point values in round-to-nearest-even mode.
- __device__ float __fsub_ru(float x, float y)**
Subtract two floating-point values in round-up mode.
- __device__ float __fsub_rz(float x, float y)**
Subtract two floating-point values in round-towards-zero mode.
- __device__ float __log10f(float x)**
Calculate the fast approximate base 10 logarithm of the input argument.
- __device__ float __log2f(float x)**
Calculate the fast approximate base 2 logarithm of the input argument.
- __device__ float __logf(float x)**
Calculate the fast approximate base e logarithm of the input argument.
- __device__ float __powf(float x, float y)**
Calculate the fast approximate of x^y .
- __device__ float __saturatef(float x)**
Clamp the input argument to $[+0.0, 1.0]$.
- __device__ void __sincosf(float x, float *sptr, float *cptr)**
Calculate the fast approximate of sine and cosine of the first input argument.
- __device__ float __sinf(float x)**
Calculate the fast approximate sine of the input argument.
- __device__ float __tanf(float x)**
Calculate the fast approximate tangent of the input argument.

5.1. Functions

- __device__ float __cosf(float x)**
Calculate the fast approximate cosine of the input argument.
Calculate the fast approximate cosine of the input argument x , measured in radians.

See also:

[cosf\(\)](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the approximate cosine of x .

- __device__ float __exp10f(float x)**
Calculate the fast approximate base 10 exponential of the input argument.
Calculate the fast approximate base 10 exponential of the input argument x , 10^x .

See also:

[exp10f\(\)](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns an approximation to 10^x .

`__device__ float __expf(float x)`

Calculate the fast approximate base e exponential of the input argument.

Calculate the fast approximate base e exponential of the input argument x , e^x .

See also:

[expf\(\)](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns an approximation to e^x .

`__device__ float __fadd_rd(float x, float y)`

Add two floating-point values in round-down mode.

Compute the sum of x and y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__fadd_rd(x, y)` is equivalent to `__fadd_rd(y, x)`.
- ▶ `__fadd_rd(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__fadd_rd($\pm\infty$, $\pm\infty$)` returns $\pm\infty$.
- ▶ `__fadd_rd($\pm\infty$, $\mp\infty$)` returns NaN.
- ▶ `__fadd_rd(± 0 , ± 0)` returns ± 0 .
- ▶ `__fadd_rd(x, $-x$)` returns -0 for finite x , including ± 0 .

- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fadd_rn(float x, float y)`

Add two floating-point values in round-to-nearest-even mode.

Compute the sum of x and y in round-to-nearest-even rounding mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__fadd_rn(x, y)` is equivalent to `__fadd_rn(y, x)`.
- ▶ `__fadd_rn(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__fadd_rn($\pm\infty$, $\pm\infty$)` returns $\pm\infty$.
- ▶ `__fadd_rn($\pm\infty$, $\mp\infty$)` returns NaN.
- ▶ `__fadd_rn(± 0 , ± 0)` returns ± 0 .
- ▶ `__fadd_rn(x, $-x$)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fadd_ru(float x, float y)`

Add two floating-point values in round-up mode.

Compute the sum of x and y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__fadd_ru(x, y)` is equivalent to `__fadd_ru(y, x)`.
- ▶ `__fadd_ru(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__fadd_ru($\pm\infty$, $\pm\infty$)` returns $\pm\infty$.
- ▶ `__fadd_ru($\pm\infty$, $\mp\infty$)` returns NaN.
- ▶ `__fadd_ru(± 0 , ± 0)` returns ± 0 .
- ▶ `__fadd_ru(x, $-x$)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fadd_rz(float x, float y)`

Add two floating-point values in round-towards-zero mode.

Compute the sum of x and y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__fadd_rz(x, y)` is equivalent to `__fadd_rz(y, x)`.
- ▶ `__fadd_rz(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__fadd_rz($\pm\infty$, $\pm\infty$)` returns $\pm\infty$.
- ▶ `__fadd_rz($\pm\infty$, $\mp\infty$)` returns NaN.
- ▶ `__fadd_rz(± 0 , ± 0)` returns ± 0 .
- ▶ `__fadd_rz(x, $-x$)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fdiv_rd(float x, float y)`

Divide two floating-point values in round-down mode.

Divide two floating-point values x by y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fdiv_rd(± 0 , ± 0)` returns NaN.
- ▶ `__fdiv_rd($\pm\infty$, $\pm\infty$)` returns NaN.
- ▶ `__fdiv_rd(x, $\pm\infty$)` returns 0 of appropriate sign for finite x .
- ▶ `__fdiv_rd($\pm\infty$, y)` returns ∞ of appropriate sign for finite y .
- ▶ `__fdiv_rd(x, ± 0)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__fdiv_rd(± 0 , y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fdiv_rn(float x, float y)`

Divide two floating-point values in round-to-nearest-even mode.

Divide two floating-point values x by y in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fdiv_rn(±0, ±0)` returns NaN.
- ▶ `__fdiv_rn(±∞, ±∞)` returns NaN.
- ▶ `__fdiv_rn(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__fdiv_rn(±∞, y)` returns ∞ of appropriate sign for finite y .
- ▶ `__fdiv_rn(x, ±0)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__fdiv_rn(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fdiv_ru(float x, float y)`

Divide two floating-point values in round-up mode.

Divide two floating-point values x by y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fdiv_ru(±0, ±0)` returns NaN.
- ▶ `__fdiv_ru(±∞, ±∞)` returns NaN.
- ▶ `__fdiv_ru(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__fdiv_ru(±∞, y)` returns ∞ of appropriate sign for finite y .
- ▶ `__fdiv_ru(x, ±0)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__fdiv_ru(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fdiv_rz(float x, float y)`

Divide two floating-point values in round-towards-zero mode.

Divide two floating-point values x by y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fdiv_rz(±0, ±0)` returns NaN.
- ▶ `__fdiv_rz(±∞, ±∞)` returns NaN.
- ▶ `__fdiv_rz(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__fdiv_rz(±∞, y)` returns $∞$ of appropriate sign for finite y .
- ▶ `__fdiv_rz(x, ±0)` returns $∞$ of appropriate sign for $x \neq 0$.
- ▶ `__fdiv_rz(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fdividef(float x, float y)`

Calculate the fast approximate division of the input arguments.

Calculate the fast approximate division of x by y .

See also:

[__fdiv_rn\(\)](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns x / y .

- ▶ `__fdividef(∞, y)` returns NaN for $2^{126} < |y| < 2^{128}$.
- ▶ `__fdividef(x, y)` returns 0 for $2^{126} < |y| < 2^{128}$ and finite x .

`__device__ float __fmaf_ieee_rd(float x, float y, float z)`

Compute fused multiply-add operation in round-down mode, ignore `-ftz=true` compiler flag.

Behavior is the same as `__fmaf_rd(x, y, z)`, the difference is in handling denormalized inputs and outputs: `-ftz` compiler flag has no effect.

`__device__ float __fmaf_ieee_rn(float x, float y, float z)`

Compute fused multiply-add operation in round-to-nearest-even mode, ignore `-ftz=true` compiler flag.

Behavior is the same as `__fmaf_rn(x, y, z)`, the difference is in handling denormalized inputs and outputs: `-ftz` compiler flag has no effect.

`__device__ float __fmaf_ieee_ru(float x, float y, float z)`

Compute fused multiply-add operation in round-up mode, ignore `-ftz=true` compiler flag.

Behavior is the same as `__fmaf_ru(x, y, z)`, the difference is in handling denormalized inputs and outputs: `-ftz` compiler flag has no effect.

`__device__ float __fmaf_ieee_rz(float x, float y, float z)`

Compute fused multiply-add operation in round-towards-zero mode, ignore `-ftz=true` compiler flag.

Behavior is the same as `__fmaf_rz(x, y, z)`, the difference is in handling denormalized inputs and outputs: `-ftz` compiler flag has no effect.

`__device__ float __fmaf_rd(float x, float y, float z)`

Compute $x \times y + z$ as a single operation, in round-down mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fmaf_rd(±∞, ±0, z)` returns NaN.
- ▶ `__fmaf_rd(±0, ±∞, z)` returns NaN.
- ▶ `__fmaf_rd(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fmaf_rd(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `__fmaf_rd(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_rd(x, y, ∓0)` returns -0 if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_rd(x, y, z)` returns -0 if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmaf_rn(float x, float y, float z)`

Compute $x \times y + z$ as a single operation, in round-to-nearest-even mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fmaf_rn(±∞, ±0, z)` returns NaN.
- ▶ `__fmaf_rn(±0, ±∞, z)` returns NaN.
- ▶ `__fmaf_rn(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fmaf_rn(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `__fmaf_rn(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_rn(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_rn(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmaf_ru(float x, float y, float z)`

Compute $x \times y + z$ as a single operation, in round-up mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fmaf_ru(±∞, ±0, z)` returns NaN.
- ▶ `__fmaf_ru(±0, ±∞, z)` returns NaN.
- ▶ `__fmaf_ru(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fmaf_ru(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `__fmaf_ru(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_ru(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_ru(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmaf_rz(float x, float y, float z)`

Compute $x \times y + z$ as a single operation, in round-towards-zero mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fmaf_rz(±∞, ±0, z)` returns NaN.

- ▶ `__fmaf_rz(±0 , ±∞ , z)` returns NaN.
- ▶ `__fmaf_rz(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fmaf_rz(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `__fmaf_rz(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_rz(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `__fmaf_rz(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmul_rd(float x, float y)`

Multiply two floating-point values in round-down mode.

Compute the product of x and y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fmul_rd(x, y)` is equivalent to `__fmul_rd(y, x)`.
- ▶ `__fmul_rd(x, ±∞)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__fmul_rd(±0, ±∞)` returns NaN.
- ▶ `__fmul_rd(±0, y)` returns 0 of appropriate sign for finite y.
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmul_rn(float x, float y)`

Multiply two floating-point values in round-to-nearest-even mode.

Compute the product of x and y in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.

- ▶ `__fmul_rn(x, y)` is equivalent to `__fmul_rn(y, x)`.
- ▶ `__fmul_rn(x, ±∞)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__fmul_rn(±0, ±∞)` returns NaN.
- ▶ `__fmul_rn(±0, y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmu1_ru(float x, float y)`

Multiply two floating-point values in round-up mode.

Compute the product of x and y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fmul_ru(x, y)` is equivalent to `__fmul_ru(y, x)`.
- ▶ `__fmul_ru(x, ±∞)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__fmul_ru(±0, ±∞)` returns NaN.
- ▶ `__fmul_ru(±0, y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fmu1_rz(float x, float y)`

Multiply two floating-point values in round-towards-zero mode.

Compute the product of x and y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__fmul_rz(x, y)` is equivalent to `__fmul_rz(y, x)`.
- ▶ `__fmul_rz(x, ±∞)` returns ∞ of appropriate sign for $x \neq 0$.

- ▶ `__fmul_rz(±0, ±∞)` returns NaN.
- ▶ `__fmul_rz(±0, y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __frcp_rd(float x)`

Compute $\frac{1}{x}$ in round-down mode.

Compute the reciprocal of x in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns $\frac{1}{x}$.

- ▶ `__frcp_rd(±0)` returns $±∞$.
- ▶ `__frcp_rd(±∞)` returns $±0$.
- ▶ `__frcp_rd(NaN)` returns NaN.

`__device__ float __frcp_rn(float x)`

Compute $\frac{1}{x}$ in round-to-nearest-even mode.

Compute the reciprocal of x in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns $\frac{1}{x}$.

- ▶ `__frcp_rn(±0)` returns $±∞$.
- ▶ `__frcp_rn(±∞)` returns $±0$.
- ▶ `__frcp_rn(NaN)` returns NaN.

`__device__ float __frcp_ru(float x)`

Compute $\frac{1}{x}$ in round-up mode.

Compute the reciprocal of x in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns $\frac{1}{x}$.

- ▶ `__frcp_ru(±0)` returns $±∞$.
- ▶ `__frcp_ru(±∞)` returns $±0$.

- ▶ `__frcp_ru(NaN)` returns NaN.

`__device__ float __frcp_rz(float x)`

Compute $\frac{1}{x}$ in round-towards-zero mode.

Compute the reciprocal of x in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns $\frac{1}{x}$.

- ▶ `__frcp_rz(±0)` returns $±∞$.
- ▶ `__frcp_rz(±∞)` returns $±0$.
- ▶ `__frcp_rz(NaN)` returns NaN.

`__device__ float __frsqrt_rn(float x)`

Compute $1/\sqrt{x}$ in round-to-nearest-even mode.

Compute the reciprocal square root of x in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns $1/\sqrt{x}$.

- ▶ `__frsqrt_rn(±0)` returns $±∞$.
- ▶ `__frsqrt_rn(+∞)` returns $+0$.
- ▶ `__frsqrt_rn(x)` returns NaN for $x < 0$.
- ▶ `__frsqrt_rn(NaN)` returns NaN.

`__device__ float __fsqrt_rd(float x)`

Compute \sqrt{x} in round-down mode.

Compute the square root of x in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns \sqrt{x} .

- ▶ `__fsqrt_rd(±0)` returns $±0$.
- ▶ `__fsqrt_rd(+∞)` returns $+∞$.
- ▶ `__fsqrt_rd(x)` returns NaN for $x < 0$.
- ▶ `__fsqrt_rd(NaN)` returns NaN.

`__device__ float __fsqrt_rn(float x)`

Compute \sqrt{x} in round-to-nearest-even mode.

Compute the square root of x in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns \sqrt{x} .

- ▶ `__fsqrt_rn(±0)` returns ± 0 .
- ▶ `__fsqrt_rn(+∞)` returns $+\infty$.
- ▶ `__fsqrt_rn(x)` returns NaN for $x < 0$.
- ▶ `__fsqrt_rn(NaN)` returns NaN.

`__device__ float __fsqrt_ru(float x)`

Compute \sqrt{x} in round-up mode.

Compute the square root of x in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns \sqrt{x} .

- ▶ `__fsqrt_ru(±0)` returns ± 0 .
- ▶ `__fsqrt_ru(+∞)` returns $+\infty$.
- ▶ `__fsqrt_ru(x)` returns NaN for $x < 0$.
- ▶ `__fsqrt_ru(NaN)` returns NaN.

`__device__ float __fsqrt_rz(float x)`

Compute \sqrt{x} in round-towards-zero mode.

Compute the square root of x in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns \sqrt{x} .

- ▶ `__fsqrt_rz(±0)` returns ± 0 .
- ▶ `__fsqrt_rz(+∞)` returns $+\infty$.
- ▶ `__fsqrt_rz(x)` returns NaN for $x < 0$.
- ▶ `__fsqrt_rz(NaN)` returns NaN.

`__device__ float __fsub_rd(float x, float y)`

Subtract two floating-point values in round-down mode.

Compute the difference of x and y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__fsub_rd($\pm\infty$, y)` returns $\pm\infty$ for finite y .
- ▶ `__fsub_rd(x , $\pm\infty$)` returns $\mp\infty$ for finite x .
- ▶ `__fsub_rd($\pm\infty$, $\pm\infty$)` returns NaN.
- ▶ `__fsub_rd($\pm\infty$, $\mp\infty$)` returns $\pm\infty$.
- ▶ `__fsub_rd(± 0 , ∓ 0)` returns ± 0 .
- ▶ `__fsub_rd(x , x)` returns -0 for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fsub_rn(float x, float y)`

Subtract two floating-point values in round-to-nearest-even mode.

Compute the difference of x and y in round-to-nearest-even rounding mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__fsub_rn($\pm\infty$, y)` returns $\pm\infty$ for finite y .
- ▶ `__fsub_rn(x , $\pm\infty$)` returns $\mp\infty$ for finite x .
- ▶ `__fsub_rn($\pm\infty$, $\pm\infty$)` returns NaN.
- ▶ `__fsub_rn($\pm\infty$, $\mp\infty$)` returns $\pm\infty$.
- ▶ `__fsub_rn(± 0 , ∓ 0)` returns ± 0 .
- ▶ `__fsub_rn(x , x)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fsub_ru(float x, float y)`

Subtract two floating-point values in round-up mode.

Compute the difference of x and y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__fsub_ru($\pm\infty$, y)` returns $\pm\infty$ for finite y .
- ▶ `__fsub_ru(x, $\pm\infty$)` returns $\mp\infty$ for finite x .
- ▶ `__fsub_ru($\pm\infty$, $\pm\infty$)` returns NaN.
- ▶ `__fsub_ru($\pm\infty$, $\mp\infty$)` returns $\pm\infty$.
- ▶ `__fsub_ru(± 0 , ∓ 0)` returns ± 0 .
- ▶ `__fsub_ru(x, x)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __fsub_rz(float x, float y)`

Subtract two floating-point values in round-towards-zero mode.

Compute the difference of x and y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__fsub_rz($\pm\infty$, y)` returns $\pm\infty$ for finite y .
- ▶ `__fsub_rz(x, $\pm\infty$)` returns $\mp\infty$ for finite x .
- ▶ `__fsub_rz($\pm\infty$, $\pm\infty$)` returns NaN.
- ▶ `__fsub_rz($\pm\infty$, $\mp\infty$)` returns $\pm\infty$.
- ▶ `__fsub_rz(± 0 , ∓ 0)` returns ± 0 .
- ▶ `__fsub_rz(x, x)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ float __log10f(float x)`

Calculate the fast approximate base 10 logarithm of the input argument.

Calculate the fast approximate base 10 logarithm of the input argument x .

See also:

[*log10f\(\)*](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns an approximation to $\log_{10}(x)$.

`__device__ float __log2f(float x)`

Calculate the fast approximate base 2 logarithm of the input argument.

Calculate the fast approximate base 2 logarithm of the input argument x .

See also:

[*log2f\(\)*](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns an approximation to $\log_2(x)$.

`__device__ float __logf(float x)`

Calculate the fast approximate base e logarithm of the input argument.

Calculate the fast approximate base e logarithm of the input argument x .

See also:

[*logf\(\)*](#) for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns an approximation to $\log_e(x)$.

`__device__ float __powf(float x, float y)`

Calculate the fast approximate of x^y .

Calculate the fast approximate of x , the first input argument, raised to the power of y , the second input argument, x^y .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns an approximation to x^y .

`__device__ float __saturatef(float x)`

Clamp the input argument to $[+0.0, 1.0]$.

Clamp the input argument x to be within the interval $[+0.0, 1.0]$.

Returns

- ▶ `__saturatef(x)` returns $+0$ if $x \leq 0$.
- ▶ `__saturatef(x)` returns 1 if $x \geq 1$.
- ▶ `__saturatef(x)` returns x if $0 < x < 1$.
- ▶ `__saturatef(NaN)` returns $+0$.

`__device__ void __sincosf(float x, float *sptr, float *cptr)`

Calculate the fast approximate of sine and cosine of the first input argument.

Calculate the fast approximate of sine and cosine of the first input argument x (measured in radians). The results for sine and cosine are written into the second argument, `sptr`, and, respectively, third argument, `cptr`.

See also:

`__sinf()` and `__cosf()`.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Denorm input/output is flushed to sign preserving 0.0.

`__device__ float __sinf(float x)`

Calculate the fast approximate sine of the input argument.

Calculate the fast approximate sine of the input argument x , measured in radians.

See also:

`sinf()` for further special case behavior specification.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Output in the denormal range is flushed to sign preserving 0.0.

Returns

Returns the approximate sine of x.

`__device__ float __tanf(float x)`

Calculate the fast approximate tangent of the input argument.

Calculate the fast approximate tangent of the input argument x, measured in radians.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: The result is computed as the fast divide of `__sinf()` by `__cosf()`. Denormal output is flushed to sign-preserving 0.0.

Returns

Returns the approximate tangent of x.

Chapter 6. Double Precision Mathematical Functions

This section describes double precision mathematical functions.

To use these functions you do not need to include any additional header files in your program.

Functions

__device__ double *acos*(double x)

Calculate the arc cosine of the input argument.

__device__ double *acosh*(double x)

Calculate the nonnegative inverse hyperbolic cosine of the input argument.

__device__ double *asin*(double x)

Calculate the arc sine of the input argument.

__device__ double *asinh*(double x)

Calculate the inverse hyperbolic sine of the input argument.

__device__ double *atan*(double x)

Calculate the arc tangent of the input argument.

__device__ double *atan2*(double y, double x)

Calculate the arc tangent of the ratio of first and second input arguments.

__device__ double *atanh*(double x)

Calculate the inverse hyperbolic tangent of the input argument.

__device__ double *cbrt*(double x)

Calculate the cube root of the input argument.

__device__ double *ceil*(double x)

Calculate ceiling of the input argument.

__device__ double *copysign*(double x, double y)

Create value with given magnitude, copying sign of second value.

__device__ double *cos*(double x)

Calculate the cosine of the input argument.

__device__ double *cosh*(double x)

Calculate the hyperbolic cosine of the input argument.

__device__ double *cospi*(double x)

Calculate the cosine of the input argument $\times \pi$.

__device__ double *cyl_bessel_i0*(double x)

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument.

__device__ double *cyl_bessel_i1*(double x)

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument.

__device__ double *erf*(double x)

Calculate the error function of the input argument.

__device__ double *erfc*(double x)

Calculate the complementary error function of the input argument.

__device__ double *erfcinv*(double x)

Calculate the inverse complementary error function of the input argument.

__device__ double *erfcx*(double x)

Calculate the scaled complementary error function of the input argument.

__device__ double *erfinv*(double x)

Calculate the inverse error function of the input argument.

__device__ double *exp*(double x)

Calculate the base e exponential of the input argument.

__device__ double *exp10*(double x)

Calculate the base 10 exponential of the input argument.

__device__ double *exp2*(double x)

Calculate the base 2 exponential of the input argument.

__device__ double *expm1*(double x)

Calculate the base e exponential of the input argument, minus 1.

__device__ double *fabs*(double x)

Calculate the absolute value of the input argument.

__device__ double *fdim*(double x, double y)

Compute the positive difference between x and y .

__device__ double *floor*(double x)

Calculate the largest integer less than or equal to x .

__device__ double *fma*(double x, double y, double z)

Compute $x \times y + z$ as a single operation.

__device__ double *fmax*(double, double)

Determine the maximum numeric value of the arguments.

__device__ double *fmin*(double x, double y)

Determine the minimum numeric value of the arguments.

__device__ double *fmod*(double x, double y)

Calculate the double-precision floating-point remainder of x / y .

__device__ double *frexp*(double x, int *nptr)

Extract mantissa and exponent of a floating-point value.

__device__ double *hypot*(double x, double y)

Calculate the square root of the sum of squares of two arguments.

__device__ int *ilogb*(double x)

Compute the unbiased integer exponent of the argument.

- __device__ __RETURN_TYPE *isfinite*(double a)**
 Determine whether argument is finite.
- __device__ __RETURN_TYPE *isinf*(double a)**
 Determine whether argument is infinite.
- __device__ __RETURN_TYPE *isnan*(double a)**
 Determine whether argument is a NaN.
- __device__ double *j0*(double x)**
 Calculate the value of the Bessel function of the first kind of order 0 for the input argument.
- __device__ double *j1*(double x)**
 Calculate the value of the Bessel function of the first kind of order 1 for the input argument.
- __device__ double *jn*(int n, double x)**
 Calculate the value of the Bessel function of the first kind of order n for the input argument.
- __device__ double *ldexp*(double x, int exp)**
 Calculate the value of $x \cdot 2^{exp}$.
- __device__ double *lgamma*(double x)**
 Calculate the natural logarithm of the absolute value of the gamma function of the input argument.
- __device__ long long int *llrint*(double x)**
 Round input to nearest integer value.
- __device__ long long int *llround*(double x)**
 Round to nearest integer value.
- __device__ double *log*(double x)**
 Calculate the base e logarithm of the input argument.
- __device__ double *log10*(double x)**
 Calculate the base 10 logarithm of the input argument.
- __device__ double *log1p*(double x)**
 Calculate the value of $\log_e(1 + x)$.
- __device__ double *log2*(double x)**
 Calculate the base 2 logarithm of the input argument.
- __device__ double *logb*(double x)**
 Calculate the floating-point representation of the exponent of the input argument.
- __device__ long int *lrint*(double x)**
 Round input to nearest integer value.
- __device__ long int *lround*(double x)**
 Round to nearest integer value.
- __device__ double *max*(const float a, const double b)**
 Calculate the maximum value of the input float and double arguments.
- __device__ double *max*(const double a, const float b)**
 Calculate the maximum value of the input double and float arguments.
- __device__ double *max*(const double a, const double b)**
 Calculate the maximum value of the input float arguments.
- __device__ double *min*(const float a, const double b)**
 Calculate the minimum value of the input float and double arguments.

__device__ double *min*(const double a, const double b)

Calculate the minimum value of the input float arguments.

__device__ double *min*(const double a, const float b)

Calculate the minimum value of the input double and float arguments.

__device__ double *modf*(double x, double *iptr)

Break down the input argument into fractional and integral parts.

__device__ double *nan*(const char *tagp)

Returns "Not a Number" value.

__device__ double *nearbyint*(double x)

Round the input argument to the nearest integer.

__device__ double *nextafter*(double x, double y)

Return next representable double-precision floating-point value after argument x in the direction of y .

__device__ double *norm*(int dim, double const *p)

Calculate the square root of the sum of squares of any number of coordinates.

__device__ double *norm3d*(double a, double b, double c)

Calculate the square root of the sum of squares of three coordinates of the argument.

__device__ double *norm4d*(double a, double b, double c, double d)

Calculate the square root of the sum of squares of four coordinates of the argument.

__device__ double *normcdf*(double x)

Calculate the standard normal cumulative distribution function.

__device__ double *normcdfinv*(double x)

Calculate the inverse of the standard normal cumulative distribution function.

__device__ double *pow*(double x, double y)

Calculate the value of first argument to the power of second argument.

__device__ double *rcbrt*(double x)

Calculate reciprocal cube root function.

__device__ double *remainder*(double x, double y)

Compute double-precision floating-point remainder.

__device__ double *remquo*(double x, double y, int *quo)

Compute double-precision floating-point remainder and part of quotient.

__device__ double *rhypot*(double x, double y)

Calculate one over the square root of the sum of squares of two arguments.

__device__ double *rint*(double x)

Round to nearest integer value in floating-point.

__device__ double *rnorm*(int dim, double const *p)

Calculate the reciprocal of square root of the sum of squares of any number of coordinates.

__device__ double *rnorm3d*(double a, double b, double c)

Calculate one over the square root of the sum of squares of three coordinates.

__device__ double *rnorm4d*(double a, double b, double c, double d)

Calculate one over the square root of the sum of squares of four coordinates.

__device__ double *round*(double x)

Round to nearest integer value in floating-point.

__device__ double *rsqrt*(double x)

Calculate the reciprocal of the square root of the input argument.

__device__ double *scalbln*(double x, long int n)

Scale floating-point input by integer power of two.

__device__ double *scalbn*(double x, int n)

Scale floating-point input by integer power of two.

__device__ __RETURN_TYPE *signbit*(double a)

Return the sign bit of the input.

__device__ double *sin*(double x)

Calculate the sine of the input argument.

__device__ void *sincos*(double x, double *sptr, double *cptr)

Calculate the sine and cosine of the first input argument.

__device__ void *sincospi*(double x, double *sptr, double *cptr)

Calculate the sine and cosine of the first input argument $\times \pi$.

__device__ double *sinh*(double x)

Calculate the hyperbolic sine of the input argument.

__device__ double *sinpi*(double x)

Calculate the sine of the input argument $\times \pi$.

__device__ double *sqrt*(double x)

Calculate the square root of the input argument.

__device__ double *tan*(double x)

Calculate the tangent of the input argument.

__device__ double *tanh*(double x)

Calculate the hyperbolic tangent of the input argument.

__device__ double *tgamma*(double x)

Calculate the gamma function of the input argument.

__device__ double *trunc*(double x)

Truncate input argument to the integral part.

__device__ double *y0*(double x)

Calculate the value of the Bessel function of the second kind of order 0 for the input argument.

__device__ double *y1*(double x)

Calculate the value of the Bessel function of the second kind of order 1 for the input argument.

__device__ double *yn*(int n, double x)

Calculate the value of the Bessel function of the second kind of order n for the input argument.

6.1. Functions

`__device__ double acos(double x)`

Calculate the arc cosine of the input argument.

Calculate the principal value of the arc cosine of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[0, \pi]$ for x inside $[-1, +1]$.

- ▶ `acos(1)` returns +0.
- ▶ `acos(x)` returns NaN for x outside $[-1, +1]$.
- ▶ `acos(NaN)` returns NaN.

`__device__ double acosh(double x)`

Calculate the nonnegative inverse hyperbolic cosine of the input argument.

Calculate the nonnegative inverse hyperbolic cosine of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Result will be in the interval $[0, +\infty]$.

- ▶ `acosh(1)` returns 0.
- ▶ `acosh(x)` returns NaN for x in the interval $[-\infty, 1)$.
- ▶ `acosh(+\infty)` returns $+\infty$.
- ▶ `acosh(NaN)` returns NaN.

`__device__ double asin(double x)`

Calculate the arc sine of the input argument.

Calculate the principal value of the arc sine of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[-\pi/2, +\pi/2]$ for x inside $[-1, +1]$.

- ▶ `asin(± 0)` returns ± 0 .
- ▶ `asin(x)` returns NaN for x outside $[-1, +1]$.
- ▶ `asin(NaN)` returns NaN.

`__device__ double asinh(double x)`

Calculate the inverse hyperbolic sine of the input argument.

Calculate the inverse hyperbolic sine of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `asinh(±0)` returns ± 0 .
- ▶ `asinh(±∞)` returns $\pm\infty$.
- ▶ `asinh(NaN)` returns NaN.

`__device__ double atan(double x)`

Calculate the arc tangent of the input argument.

Calculate the principal value of the arc tangent of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[-\pi/2, +\pi/2]$.

- ▶ `atan(±0)` returns ± 0 .
- ▶ `atan(±∞)` returns $\pm\pi/2$.
- ▶ `atan(NaN)` returns NaN.

`__device__ double atan2(double y, double x)`

Calculate the arc tangent of the ratio of first and second input arguments.

Calculate the principal value of the arc tangent of the ratio of first and second input arguments y/x . The quadrant of the result is determined by the signs of inputs y and x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Result will be in radians, in the interval $[-\pi, +\pi]$.

- ▶ `atan2(±0, -0)` returns $\pm\pi$.
- ▶ `atan2(±0, +0)` returns ± 0 .
- ▶ `atan2(±0, x)` returns $\pm\pi$ for $x < 0$.
- ▶ `atan2(±0, x)` returns ± 0 for $x > 0$.
- ▶ `atan2(y, ±0)` returns $-\pi/2$ for $y < 0$.

- ▶ `atan2(y, ±0)` returns $\pi/2$ for $y > 0$.
- ▶ `atan2(±y, -∞)` returns $\pm\pi$ for finite $y > 0$.
- ▶ `atan2(±y, +∞)` returns ± 0 for finite $y > 0$.
- ▶ `atan2(±∞, x)` returns $\pm\pi/2$ for finite x .
- ▶ `atan2(±∞, -∞)` returns $\pm 3\pi/4$.
- ▶ `atan2(±∞, +∞)` returns $\pm\pi/4$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double atanh(double x)`

Calculate the inverse hyperbolic tangent of the input argument.

Calculate the inverse hyperbolic tangent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `atanh(±0)` returns ± 0 .
- ▶ `atanh(±1)` returns $\pm\infty$.
- ▶ `atanh(x)` returns NaN for x outside interval $[-1, 1]$.
- ▶ `atanh(NaN)` returns NaN.

`__device__ double cbrt(double x)`

Calculate the cube root of the input argument.

Calculate the cube root of x , $x^{1/3}$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns $x^{1/3}$.

- ▶ `cbrt(±0)` returns ± 0 .
- ▶ `cbrt(±∞)` returns $\pm\infty$.
- ▶ `cbrt(NaN)` returns NaN.

`__device__ double ceil(double x)`

Calculate ceiling of the input argument.

Compute the smallest integer value not less than x .

Returns

Returns $\lceil x \rceil$ expressed as a floating-point number.

- ▶ `ceil(±0)` returns ± 0 .

- ▶ `ceil(±∞)` returns $±∞$.
- ▶ `ceil(NaN)` returns NaN.

`__device__ double copysign(double x, double y)`

Create value with given magnitude, copying sign of second value.

Create a floating-point value with the magnitude x and the sign of y.

Returns

- ▶ a value with the magnitude of x and the sign of y.
- ▶ `copysign(NaN, y)` returns a NaN with the sign of y.

`__device__ double cos(double x)`

Calculate the cosine of the input argument.

Calculate the cosine of the input argument x (measured in radians).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `cos(±0)` returns 1.
- ▶ `cos(±∞)` returns NaN.
- ▶ `cos(NaN)` returns NaN.

`__device__ double cosh(double x)`

Calculate the hyperbolic cosine of the input argument.

Calculate the hyperbolic cosine of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `cosh(±0)` returns 1.
- ▶ `cosh(±∞)` returns $+∞$.
- ▶ `cosh(NaN)` returns NaN.

`__device__ double cospi(double x)`

Calculate the cosine of the input argument $×π$.

Calculate the cosine of $x ×π$ (measured in radians), where x is the input argument.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{cospi}(\pm 0)$ returns 1.
- ▶ $\text{cospi}(\pm \infty)$ returns NaN.
- ▶ $\text{cospi}(\text{NaN})$ returns NaN.

`__device__ double cyl_bessel_i0(double x)`

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument.

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument x , $I_0(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 0.

- ▶ $\text{cyl_bessel_i0}(\pm 0)$ returns +1.
- ▶ $\text{cyl_bessel_i0}(\pm \infty)$ returns $+\infty$.
- ▶ $\text{cyl_bessel_i0}(\text{NaN})$ returns NaN.

`__device__ double cyl_bessel_i1(double x)`

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument.

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument x , $I_1(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 1.

- ▶ $\text{cyl_bessel_i1}(\pm 0)$ returns ± 0 .
- ▶ $\text{cyl_bessel_i1}(\pm \infty)$ returns $\pm \infty$.
- ▶ $\text{cyl_bessel_i1}(\text{NaN})$ returns NaN.

`__device__ double erf(double x)`

Calculate the error function of the input argument.

Calculate the value of the error function for the input argument x , $\frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{erf}(\pm 0)$ returns ± 0 .
- ▶ $\text{erf}(\pm \infty)$ returns ± 1 .
- ▶ $\text{erf}(\text{NaN})$ returns NaN.

`__device__ double erfc(double x)`

Calculate the complementary error function of the input argument.

Calculate the complementary error function of the input argument x , $1 - \text{erf}(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{erfc}(-\infty)$ returns 2.
- ▶ $\text{erfc}(+\infty)$ returns +0.
- ▶ $\text{erfc}(\text{NaN})$ returns NaN.

`__device__ double erfcinv(double x)`

Calculate the inverse complementary error function of the input argument.

Calculate the inverse complementary error function $\text{erfc}^{-1}(x)$, of the input argument x in the interval $[0, 2]$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{erfcinv}(\pm 0)$ returns $+\infty$.
- ▶ $\text{erfcinv}(2)$ returns $-\infty$.
- ▶ $\text{erfcinv}(x)$ returns NaN for x outside $[0, 2]$.
- ▶ $\text{erfcinv}(\text{NaN})$ returns NaN.

`__device__ double erfcx(double x)`

Calculate the scaled complementary error function of the input argument.

Calculate the scaled complementary error function of the input argument x , $e^{x^2} \cdot \text{erfc}(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `erfcx(-∞)` returns $+\infty$.
- ▶ `erfcx(+∞)` returns $+0$.
- ▶ `erfcx(NaN)` returns NaN.

`__device__ double erfinv(double x)`

Calculate the inverse error function of the input argument.

Calculate the inverse error function $\text{erf}^{-1}(x)$, of the input argument x in the interval $[-1, 1]$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `erfinv(±0)` returns ± 0 .
- ▶ `erfinv(1)` returns $+\infty$.
- ▶ `erfinv(-1)` returns $-\infty$.
- ▶ `erfinv(x)` returns NaN for x outside $[-1, +1]$.
- ▶ `erfinv(NaN)` returns NaN.

`__device__ double exp(double x)`

Calculate the base e exponential of the input argument.

Calculate e^x , the base e exponential of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `exp(±0)` returns 1.
- ▶ `exp(-∞)` returns $+0$.
- ▶ `exp(+∞)` returns $+\infty$.
- ▶ `exp(NaN)` returns NaN.

`__device__ double exp10(double x)`

Calculate the base 10 exponential of the input argument.

Calculate 10^x , the base 10 exponential of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{exp10}(\pm 0)$ returns 1.
- ▶ $\text{exp10}(-\infty)$ returns +0.
- ▶ $\text{exp10}(+\infty)$ returns $+\infty$.
- ▶ $\text{exp10}(\text{NaN})$ returns NaN.

`__device__ double exp2(double x)`

Calculate the base 2 exponential of the input argument.

Calculate 2^x , the base 2 exponential of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{exp2}(\pm 0)$ returns 1.
- ▶ $\text{exp2}(-\infty)$ returns +0.
- ▶ $\text{exp2}(+\infty)$ returns $+\infty$.
- ▶ $\text{exp2}(\text{NaN})$ returns NaN.

`__device__ double expm1(double x)`

Calculate the base e exponential of the input argument, minus 1.

Calculate $e^x - 1$, the base e exponential of the input argument x, minus 1.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{expm1}(\pm 0)$ returns ± 0 .
- ▶ $\text{expm1}(-\infty)$ returns -1.
- ▶ $\text{expm1}(+\infty)$ returns $+\infty$.
- ▶ $\text{expm1}(\text{NaN})$ returns NaN.

`__device__ double fabs(double x)`

Calculate the absolute value of the input argument.

Calculate the absolute value of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the absolute value of the input argument.

- ▶ `fabs(±∞)` returns $+\infty$.
- ▶ `fabs(±0)` returns $+0$.
- ▶ `fabs(NaN)` returns an unspecified NaN.

`__device__ double fdim(double x, double y)`

Compute the positive difference between x and y .

Compute the positive difference between x and y . The positive difference is $x - y$ when $x > y$ and $+0$ otherwise.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the positive difference between x and y .

- ▶ `fdim(x, y)` returns $x - y$ if $x > y$.
- ▶ `fdim(x, y)` returns $+0$ if $x \leq y$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double floor(double x)`

Calculate the largest integer less than or equal to x .

Calculates the largest integer value which is less than or equal to x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns $\lfloor x \rfloor$ expressed as a floating-point number.

- ▶ `floor(±∞)` returns $\pm\infty$.
- ▶ `floor(±0)` returns ± 0 .
- ▶ `floor(NaN)` returns NaN.

`__device__ double fma(double x, double y, double z)`

Compute $x \times y + z$ as a single operation.

Compute the value of $x \times y + z$ as a single ternary operation. After computing the value to infinite precision, the value is rounded once using round-to-nearest, ties-to-even rounding mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `fma(±∞, ±0, z)` returns NaN.
- ▶ `fma(±0, ±∞, z)` returns NaN.
- ▶ `fma(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `fma(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `fma(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `fma(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `fma(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double fmax(double, double)`

Determine the maximum numeric value of the arguments.

Determines the maximum numeric value of the arguments x and y . Treats NaN arguments as missing data. If one argument is a NaN and the other is legitimate numeric value, the numeric value is chosen.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the maximum numeric values of the arguments x and y .

- ▶ If both arguments are NaN, returns NaN.
- ▶ If one argument is NaN, returns the numeric argument.

`__device__ double fmin(double x, double y)`

Determine the minimum numeric value of the arguments.

Determines the minimum numeric value of the arguments x and y . Treats NaN arguments as missing data. If one argument is a NaN and the other is legitimate numeric value, the numeric value is chosen.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the minimum numeric value of the arguments x and y .

- ▶ If both arguments are NaN, returns NaN.
- ▶ If one argument is NaN, returns the numeric argument.

`__device__ double fmod(double x, double y)`

Calculate the double-precision floating-point remainder of x / y .

Calculate the double-precision floating-point remainder of x / y . The floating-point remainder of the division operation x / y calculated by this function is exactly the value $x - n \times y$, where n is x / y with its fractional part truncated. The computed value will have the same sign as x , and its magnitude will be less than the magnitude of y .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ Returns the floating-point remainder of x / y .
- ▶ $fmod(\pm 0, y)$ returns ± 0 if y is not zero.
- ▶ $fmod(x, \pm\infty)$ returns x if x is finite.
- ▶ $fmod(x, y)$ returns NaN if x is $\pm\infty$ or y is zero.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double frexp(double x, int *nptr)`

Extract mantissa and exponent of a floating-point value.

Decompose the floating-point value x into a component m for the normalized fraction element and another term n for the exponent. The absolute value of m will be greater than or equal to 0.5 and less than 1.0 or it will be equal to 0; $x = m \cdot 2^n$. The integer exponent n will be stored in the location to which `nptr` points.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the fractional component m .

- ▶ $frexp(\pm 0, nptr)$ returns ± 0 and stores zero in the location pointed to by `nptr`.
- ▶ $frexp(\pm\infty, nptr)$ returns $\pm\infty$ and stores an unspecified value in the location to which `nptr` points.
- ▶ $frexp(\text{NaN}, y)$ returns a NaN and stores an unspecified value in the location to which `nptr` points.

`__device__ double hypot(double x, double y)`

Calculate the square root of the sum of squares of two arguments.

Calculate the length of the hypotenuse of a right triangle whose two sides have lengths x and y without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the length of the hypotenuse $\sqrt{x^2 + y^2}$.

- ▶ $hypot(x,y)$, $hypot(y,x)$, and $hypot(x, -y)$ are equivalent.
- ▶ $hypot(x, \pm 0)$ is equivalent to $fabs(x)$.
- ▶ $hypot(\pm\infty, y)$ returns $+\infty$, even if y is a NaN.

- ▶ `hypot(NaN, y)` returns NaN, when y is not $\pm\infty$.

`__device__ int ilogb(double x)`

Compute the unbiased integer exponent of the argument.

Calculates the unbiased integer exponent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ If successful, returns the unbiased exponent of the argument.
- ▶ `ilogb(± 0)` returns `INT_MIN`.
- ▶ `ilogb(NaN)` returns `INT_MIN`.
- ▶ `ilogb($\pm\infty$)` returns `INT_MAX`.
- ▶ Note: above behavior does not take into account `FP_ILOGB0` nor `FP_ILOGBNAN`.

`__device__ __RETURN_TYPE isfinite(double a)`

Determine whether argument is finite.

Determine whether the floating-point value a is a finite value (zero, subnormal, or normal and not infinity or NaN).

Returns

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if a is a finite value.
- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if a is a finite value.

`__device__ __RETURN_TYPE isinf(double a)`

Determine whether argument is infinite.

Determine whether the floating-point value a is an infinite value (positive or negative).

Returns

- ▶ With Visual Studio 2013 host compiler: Returns true if and only if a is an infinite value.
- ▶ With other host compilers: Returns a nonzero value if and only if a is an infinite value.

`__device__ __RETURN_TYPE isnan(double a)`

Determine whether argument is a NaN.

Determine whether the floating-point value a is a NaN.

Returns

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if `a` is a NaN value.
- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if `a` is a NaN value.

`__device__ double j0(double x)`

Calculate the value of the Bessel function of the first kind of order 0 for the input argument.

Calculate the value of the Bessel function of the first kind of order 0 for the input argument x , $J_0(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the first kind of order 0.

- ▶ `j0(±∞)` returns +0.
- ▶ `j0(NaN)` returns NaN.

`__device__ double j1(double x)`

Calculate the value of the Bessel function of the first kind of order 1 for the input argument.

Calculate the value of the Bessel function of the first kind of order 1 for the input argument x , $J_1(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the first kind of order 1.

- ▶ `j1(±0)` returns ±0.
- ▶ `j1(±∞)` returns ±0.
- ▶ `j1(NaN)` returns NaN.

`__device__ double jn(int n, double x)`

Calculate the value of the Bessel function of the first kind of order n for the input argument.

Calculate the value of the Bessel function of the first kind of order n for the input argument x , $J_n(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the first kind of order n .

- ▶ `jn(n, NaN)` returns NaN.
- ▶ `jn(n, x)` returns NaN for $n < 0$.

- ▶ $\text{jn}(n, +\infty)$ returns +0.

`__device__ double ldexp(double x, int exp)`

Calculate the value of $x \cdot 2^{\text{exp}}$.

Calculate the value of $x \cdot 2^{\text{exp}}$ of the input arguments x and exp.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{ldexp}(x, \text{exp})$ is equivalent to $\text{scalbn}(x, \text{exp})$.

`__device__ double lgamma(double x)`

Calculate the natural logarithm of the absolute value of the gamma function of the input argument.

Calculate the natural logarithm of the absolute value of the gamma function of the input argument x, namely the value of $\log_e |\Gamma(x)|$

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{lgamma}(1)$ returns +0.
- ▶ $\text{lgamma}(2)$ returns +0.
- ▶ $\text{lgamma}(x)$ returns $+\infty$ if $x \leq 0$ and x is an integer.
- ▶ $\text{lgamma}(-\infty)$ returns $+\infty$.
- ▶ $\text{lgamma}(+\infty)$ returns $+\infty$.
- ▶ $\text{lgamma}(\text{NaN})$ returns NaN.

`__device__ long long int llrint(double x)`

Round input to nearest integer value.

Round x to the nearest integer value, with halfway cases rounded to the nearest even integer value. If the result is outside the range of the return type, the behavior is undefined.

Returns

Returns rounded integer value.

`__device__ long long int llround(double x)`

Round to nearest integer value.

Round x to the nearest integer value, with halfway cases rounded away from zero. If the result is outside the range of the return type, the behavior is undefined.

Note: This function may be slower than alternate rounding methods. See `llrint()`.

Returns

Returns rounded integer value.

`__device__ double log(double x)`

Calculate the base e logarithm of the input argument.

Calculate the base e logarithm of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `log(±0)` returns $-\infty$.
- ▶ `log(1)` returns $+0$.
- ▶ `log(x)` returns NaN for $x < 0$.
- ▶ `log(+∞)` returns $+\infty$.
- ▶ `log(NaN)` returns NaN.

`__device__ double log10(double x)`

Calculate the base 10 logarithm of the input argument.

Calculate the base 10 logarithm of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `log10(±0)` returns $-\infty$.
- ▶ `log10(1)` returns $+0$.
- ▶ `log10(x)` returns NaN for $x < 0$.
- ▶ `log10(+∞)` returns $+\infty$.
- ▶ `log10(NaN)` returns NaN.

`__device__ double log1p(double x)`

Calculate the value of $\log_e(1 + x)$.

Calculate the value of $\log_e(1 + x)$ of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\log_{1p}(\pm 0)$ returns ± 0 .
- ▶ $\log_{1p}(-1)$ returns $-\infty$.
- ▶ $\log_{1p}(x)$ returns NaN for $x < -1$.
- ▶ $\log_{1p}(+\infty)$ returns $+\infty$.
- ▶ $\log_{1p}(\text{NaN})$ returns NaN.

`__device__ double log2(double x)`

Calculate the base 2 logarithm of the input argument.

Calculate the base 2 logarithm of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\log_2(\pm 0)$ returns $-\infty$.
- ▶ $\log_2(1)$ returns +0.
- ▶ $\log_2(x)$ returns NaN for $x < 0$.
- ▶ $\log_2(+\infty)$ returns $+\infty$.
- ▶ $\log_2(\text{NaN})$ returns NaN.

`__device__ double logb(double x)`

Calculate the floating-point representation of the exponent of the input argument.

Calculate the floating-point representation of the exponent of the input argument x.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\log_b(\pm 0)$ returns $-\infty$.
- ▶ $\log_b(\pm\infty)$ returns $+\infty$.
- ▶ $\log_b(\text{NaN})$ returns NaN.

`__device__ long int lrint(double x)`

Round input to nearest integer value.

Round `x` to the nearest integer value, with halfway cases rounded to the nearest even integer value. If the result is outside the range of the return type, the behavior is undefined.

Returns

Returns rounded integer value.

`__device__ long int lround(double x)`

Round to nearest integer value.

Round `x` to the nearest integer value, with halfway cases rounded away from zero. If the result is outside the range of the return type, the behavior is undefined.

Note: This function may be slower than alternate rounding methods. See [lrint\(\)](#).

Returns

Returns rounded integer value.

`__device__ double max(const float a, const double b)`

Calculate the maximum value of the input `float` and `double` arguments.

Convert `float` argument `a` to `double`, followed by [fmax\(\)](#).

Note, this is different from `std::` specification

`__device__ double max(const double a, const float b)`

Calculate the maximum value of the input `double` and `float` arguments.

Convert `float` argument `b` to `double`, followed by [fmax\(\)](#).

Note, this is different from `std::` specification

`__device__ double max(const double a, const double b)`

Calculate the maximum value of the input `float` arguments.

Calculate the maximum value of the arguments `a` and `b`. Behavior is equivalent to [fmax\(\)](#) function.

Note, this is different from `std::` specification

`__device__ double min(const float a, const double b)`

Calculate the minimum value of the input `float` and `double` arguments.

Convert `float` argument `a` to `double`, followed by [fmin\(\)](#).

Note, this is different from `std::` specification

`__device__ double min(const double a, const double b)`

Calculate the minimum value of the input `float` arguments.

Calculate the minimum value of the arguments `a` and `b`. Behavior is equivalent to [fmin\(\)](#) function.

Note, this is different from `std::` specification

`__device__ double min(const double a, const float b)`

Calculate the minimum value of the input `double` and `float` arguments.

Convert `float` argument `b` to `double`, followed by [fmin\(\)](#).

Note, this is different from `std::` specification

`__device__ double modf(double x, double *iptr)`

Break down the input argument into fractional and integral parts.

Break down the argument x into fractional and integral parts. The integral part is stored in the argument `iptr`. Fractional and integral parts are given the same sign as the argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `modf(±x, iptr)` returns a result with the same sign as x .
- ▶ `modf(±∞, iptr)` returns $±0$ and stores $±∞$ in the object pointed to by `iptr`.
- ▶ `modf(NaN, iptr)` stores a NaN in the object pointed to by `iptr` and returns a NaN.

`__device__ double nan(const char *tagp)`

Returns “Not a Number” value.

Return a representation of a quiet NaN. Argument `tagp` selects one of the possible representations.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `nan(tagp)` returns NaN.

`__device__ double nearbyint(double x)`

Round the input argument to the nearest integer.

Round argument x to an integer value in double precision floating-point format. Uses round to nearest rounding, with ties rounding to even.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `nearbyint(±0)` returns $±0$.
- ▶ `nearbyint(±∞)` returns $±∞$.
- ▶ `nearbyint(NaN)` returns NaN.

`__device__ double nextafter(double x, double y)`

Return next representable double-precision floating-point value after argument x in the direction of y.

Calculate the next representable double-precision floating-point value following x in the direction of y. For example, if y is greater than x, `nextafter()` returns the smallest representable number greater than x

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `nextafter(x, y) = y` if x equals y.
- ▶ `nextafter(x, y) = NaN` if either x or y are NaN.

`__device__ double norm(int dim, double const *p)`

Calculate the square root of the sum of squares of any number of coordinates.

Calculate the length of a vector p, dimension of which is passed as an argument without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the length of the dim-D vector $\sqrt{\sum_{i=0}^{dim-1} p_i^2}$.

- ▶ In the presence of an exactly infinite coordinate $+\infty$ is returned, even if there are NaNs.
- ▶ returns $+0$, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ double norm3d(double a, double b, double c)`

Calculate the square root of the sum of squares of three coordinates of the argument.

Calculate the length of three dimensional vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the length of 3D vector $\sqrt{a^2 + b^2 + c^2}$.

- ▶ In the presence of an exactly infinite coordinate $+\infty$ is returned, even if there are NaNs.
- ▶ returns $+0$, when all coordinates are ± 0 .

- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ double norm4d(double a, double b, double c, double d)`

Calculate the square root of the sum of squares of four coordinates of the argument.

Calculate the length of four dimensional vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the length of 4D vector $\sqrt{a^2 + b^2 + c^2 + d^2}$.

- ▶ In the presence of an exactly infinite coordinate $+\infty$ is returned, even if there are NaNs.
- ▶ returns +0, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ double normcdf(double x)`

Calculate the standard normal cumulative distribution function.

Calculate the cumulative distribution function of the standard normal distribution for input argument x , $\Phi(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `normcdf($+\infty$)` returns 1.
- ▶ `normcdf($-\infty$)` returns +0.
- ▶ `normcdf(NaN)` returns NaN.

`__device__ double normcdfinv(double x)`

Calculate the inverse of the standard normal cumulative distribution function.

Calculate the inverse of the standard normal cumulative distribution function for input argument x , $\Phi^{-1}(x)$. The function is defined for input values in the interval $(0, 1)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `normcdfinv(± 0)` returns $-\infty$.
- ▶ `normcdfinv(1)` returns $+\infty$.

- ▶ `normcdfinv(x)` returns NaN if x is not in the interval $[0, 1]$.
- ▶ `normcdfinv(NaN)` returns NaN.

`__device__ double pow(double x, double y)`

Calculate the value of first argument to the power of second argument.

Calculate the value of x to the power of y .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `pow(± 0 , y)` returns $\pm\infty$ for y an odd integer less than 0.
- ▶ `pow(± 0 , y)` returns $+\infty$ for y less than 0 and not an odd integer.
- ▶ `pow(± 0 , y)` returns ± 0 for y an odd integer greater than 0.
- ▶ `pow(± 0 , y)` returns $+0$ for $y > 0$ and not an odd integer.
- ▶ `pow(-1, $\pm\infty$)` returns 1.
- ▶ `pow(+1, y)` returns 1 for any y , even a NaN.
- ▶ `pow(x , ± 0)` returns 1 for any x , even a NaN.
- ▶ `pow(x , y)` returns a NaN for finite $x < 0$ and finite non-integer y .
- ▶ `pow(x , $-\infty$)` returns $+\infty$ for $|x| < 1$.
- ▶ `pow(x , $-\infty$)` returns $+0$ for $|x| > 1$.
- ▶ `pow(x , $+\infty$)` returns $+0$ for $|x| < 1$.
- ▶ `pow(x , $+\infty$)` returns $+\infty$ for $|x| > 1$.
- ▶ `pow($-\infty$, y)` returns -0 for y an odd integer less than 0.
- ▶ `pow($-\infty$, y)` returns $+0$ for $y < 0$ and not an odd integer.
- ▶ `pow($-\infty$, y)` returns $-\infty$ for y an odd integer greater than 0.
- ▶ `pow($-\infty$, y)` returns $+\infty$ for $y > 0$ and not an odd integer.
- ▶ `pow($+\infty$, y)` returns $+0$ for $y < 0$.
- ▶ `pow($+\infty$, y)` returns $+\infty$ for $y > 0$.
- ▶ `pow(x , y)` returns NaN if either x or y or both are NaN and $x \neq +1$ and $y \neq \pm 0$.

`__device__ double rcbirt(double x)`

Calculate reciprocal cube root function.

Calculate reciprocal cube root function of x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `rcbrt(±0)` returns $\pm\infty$.
- ▶ `rcbrt(±∞)` returns ± 0 .
- ▶ `rcbrt(NaN)` returns NaN.

`__device__ double remainder(double x, double y)`

Compute double-precision floating-point remainder.

Compute double-precision floating-point remainder r of dividing x by y for nonzero y . Thus $r = x - ny$. The value n is the integer value nearest $\frac{x}{y}$. In the case when $|n - \frac{x}{y}| = \frac{1}{2}$, the even n value is chosen.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `remainder(x, ±0)` returns NaN.
- ▶ `remainder(±∞, y)` returns NaN.
- ▶ `remainder(x, ±∞)` returns x for finite x .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double remquo(double x, double y, int *quo)`

Compute double-precision floating-point remainder and part of quotient.

Compute a double-precision floating-point remainder in the same way as the `remainder()` function. Argument `quo` returns part of quotient upon division of x by y . Value `quo` has the same sign as $\frac{x}{y}$ and may not be the exact quotient but agrees with the exact quotient in the low order 3 bits.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the remainder.

- ▶ `remquo(x, ±0, quo)` returns NaN and stores an unspecified value in the location to which `quo` points.
- ▶ `remquo(±∞, y, quo)` returns NaN and stores an unspecified value in the location to which `quo` points.
- ▶ `remquo(x, y, quo)` returns NaN and stores an unspecified value in the location to which `quo` points if either of x or y is NaN.
- ▶ `remquo(x, ±∞, quo)` returns x and stores zero in the location to which `quo` points for finite x .

`__device__ double rhygot (double x, double y)`

Calculate one over the square root of the sum of squares of two arguments.

Calculate one over the length of the hypotenuse of a right triangle whose two sides have lengths x and y without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns one over the length of the hypotenuse $\frac{1}{\sqrt{x^2+y^2}}$.

- ▶ `rhygot(x,y)`, `rhygot(y,x)`, and `rhygot(x, -y)` are equivalent.
- ▶ `rhygot(±∞, y)` returns `+0`, even if y is a NaN.
- ▶ `rhygot(±0, ±0)` returns `+∞`.
- ▶ `rhygot(NaN, y)` returns NaN, when y is not `±∞`.

`__device__ double rint (double x)`

Round to nearest integer value in floating-point.

Round x to the nearest integer value in floating-point format, with halfway cases rounded to the nearest even integer value.

Returns

Returns rounded integer value.

- ▶ `rint(±0)` returns `±0`.
- ▶ `rint(±∞)` returns `±∞`.
- ▶ `rint(NaN)` returns NaN.

`__device__ double rnorm (int dim, double const *p)`

Calculate the reciprocal of square root of the sum of squares of any number of coordinates.

Calculates one over the length of vector p , dimension of which is passed as an argument, in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns one over the length of the vector $\frac{1}{\sqrt{\sum_{i=0}^{dim-1} p_i^2}}$.

- ▶ In the presence of an exactly infinite coordinate `+0` is returned, even if there are NaNs.
- ▶ returns `+∞`, when all coordinates are `±0`.
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ double rnorm3d(double a, double b, double c)`

Calculate one over the square root of the sum of squares of three coordinates.

Calculate one over the length of three dimensional vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns one over the length of the 3D vector $\frac{1}{\sqrt{a^2+b^2+c^2}}$.

- ▶ In the presence of an exactly infinite coordinate +0 is returned, even if there are NaNs.
- ▶ returns $+\infty$, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ double rnorm4d(double a, double b, double c, double d)`

Calculate one over the square root of the sum of squares of four coordinates.

Calculate one over the length of four dimensional vector in Euclidean space without undue overflow or underflow.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns one over the length of the 4D vector $\frac{1}{\sqrt{a^2+b^2+c^2+d^2}}$.

- ▶ In the presence of an exactly infinite coordinate +0 is returned, even if there are NaNs.
- ▶ returns $+\infty$, when all coordinates are ± 0 .
- ▶ returns NaN, when at least one of the coordinates is NaN and none are infinite.

`__device__ double round(double x)`

Round to nearest integer value in floating-point.

Round x to the nearest integer value in floating-point format, with halfway cases rounded away from zero.

Note: This function may be slower than alternate rounding methods. See [rint\(\)](#).

Returns

Returns rounded integer value.

- ▶ round(± 0) returns ± 0 .
- ▶ round($\pm \infty$) returns $\pm \infty$.
- ▶ round(NaN) returns NaN.

`__device__ double rsqrt(double x)`

Calculate the reciprocal of the square root of the input argument.

Calculate the reciprocal of the nonnegative square root of x , $1/\sqrt{x}$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns $1/\sqrt{x}$.

- ▶ `rsqrt(+∞)` returns `+0`.
- ▶ `rsqrt(±0)` returns `±∞`.
- ▶ `rsqrt(x)` returns NaN if x is less than 0.
- ▶ `rsqrt(NaN)` returns NaN.

`__device__ double scalbln(double x, long int n)`

Scale floating-point input by integer power of two.

Scale x by 2^n by efficient manipulation of the floating-point exponent.

Returns

Returns $x * 2^n$.

- ▶ `scalbln(±0, n)` returns `±0`.
- ▶ `scalbln(x, 0)` returns x .
- ▶ `scalbln(±∞, n)` returns `±∞`.
- ▶ `scalbln(NaN, n)` returns NaN.

`__device__ double scalbn(double x, int n)`

Scale floating-point input by integer power of two.

Scale x by 2^n by efficient manipulation of the floating-point exponent.

Returns

Returns $x * 2^n$.

- ▶ `scalbn(±0, n)` returns `±0`.
- ▶ `scalbn(x, 0)` returns x .
- ▶ `scalbn(±∞, n)` returns `±∞`.
- ▶ `scalbn(NaN, n)` returns NaN.

`__device__ __RETURN_TYPE signbit(double a)`

Return the sign bit of the input.

Determine whether the floating-point value a is negative.

Returns

Reports the sign bit of all values including infinities, zeros, and NaNs.

- ▶ With Visual Studio 2013 host compiler: `__RETURN_TYPE` is 'bool'. Returns true if and only if a is negative.

- ▶ With other host compilers: `__RETURN_TYPE` is 'int'. Returns a nonzero value if and only if `a` is negative.

`__device__ double sin(double x)`

Calculate the sine of the input argument.

Calculate the sine of the input argument `x` (measured in radians).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ `sin(±0)` returns ± 0 .
- ▶ `sin(±∞)` returns NaN.
- ▶ `sin(NaN)` returns NaN.

`__device__ void sincos(double x, double *sptr, double *cptr)`

Calculate the sine and cosine of the first input argument.

Calculate the sine and cosine of the first input argument `x` (measured in radians). The results for sine and cosine are written into the second argument, `sptr`, and, respectively, third argument, `cptr`.

See also:

[`sin\(\)`](#) and [`cos\(\)`](#).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

`__device__ void sincospi(double x, double *sptr, double *cptr)`

Calculate the sine and cosine of the first input argument $\times \pi$.

Calculate the sine and cosine of the first input argument, `x` (measured in radians), $\times \pi$. The results for sine and cosine are written into the second argument, `sptr`, and, respectively, third argument, `cptr`.

See also:

[`sinpi\(\)`](#) and [`cospi\(\)`](#).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

`__device__ double sinh(double x)`

Calculate the hyperbolic sine of the input argument.

Calculate the hyperbolic sine of the input argument `x`.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\sinh(\pm 0)$ returns ± 0 .
- ▶ $\sinh(\pm\infty)$ returns $\pm\infty$.
- ▶ $\sinh(\text{NaN})$ returns NaN.

`__device__ double sinpi(double x)`

Calculate the sine of the input argument $\times \pi$.

Calculate the sine of $x \times \pi$ (measured in radians), where x is the input argument.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\sinpi(\pm 0)$ returns ± 0 .
- ▶ $\sinpi(\pm\infty)$ returns NaN.
- ▶ $\sinpi(\text{NaN})$ returns NaN.

`__device__ double sqrt(double x)`

Calculate the square root of the input argument.

Calculate the nonnegative square root of x, \sqrt{x} .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns \sqrt{x} .

- ▶ $\text{sqrt}(\pm 0)$ returns ± 0 .
- ▶ $\text{sqrt}(+\infty)$ returns $+\infty$.
- ▶ $\text{sqrt}(x)$ returns NaN if x is less than 0.
- ▶ $\text{sqrt}(\text{NaN})$ returns NaN.

`__device__ double tan(double x)`

Calculate the tangent of the input argument.

Calculate the tangent of the input argument x (measured in radians).

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\tan(\pm 0)$ returns ± 0 .
- ▶ $\tan(\pm\infty)$ returns NaN.
- ▶ $\tan(\text{NaN})$ returns NaN.

`__device__ double tanh(double x)`

Calculate the hyperbolic tangent of the input argument.

Calculate the hyperbolic tangent of the input argument x .

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\tanh(\pm 0)$ returns ± 0 .
- ▶ $\tanh(\pm\infty)$ returns ± 1 .
- ▶ $\tanh(\text{NaN})$ returns NaN.

`__device__ double tgamma(double x)`

Calculate the gamma function of the input argument.

Calculate the gamma function of the input argument x , namely the value of $\Gamma(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

- ▶ $\text{tgamma}(\pm 0)$ returns $\pm\infty$.
- ▶ $\text{tgamma}(x)$ returns NaN if $x < 0$ and x is an integer.
- ▶ $\text{tgamma}(-\infty)$ returns NaN.
- ▶ $\text{tgamma}(+\infty)$ returns $+\infty$.
- ▶ $\text{tgamma}(\text{NaN})$ returns NaN.

`__device__ double trunc(double x)`

Truncate input argument to the integral part.

Round x to the nearest integer value that does not exceed x in magnitude.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns truncated integer value.

- ▶ `trunc(±0)` returns ± 0 .
- ▶ `trunc(±∞)` returns $\pm\infty$.
- ▶ `trunc(NaN)` returns NaN.

`__device__ double y0` (double `x`)

Calculate the value of the Bessel function of the second kind of order 0 for the input argument.

Calculate the value of the Bessel function of the second kind of order 0 for the input argument `x`, $Y_0(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the second kind of order 0.

- ▶ `y0(±0)` returns $-\infty$.
- ▶ `y0(x)` returns NaN for $x < 0$.
- ▶ `y0(+∞)` returns $+\infty$.
- ▶ `y0(NaN)` returns NaN.

`__device__ double y1` (double `x`)

Calculate the value of the Bessel function of the second kind of order 1 for the input argument.

Calculate the value of the Bessel function of the second kind of order 1 for the input argument `x`, $Y_1(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the second kind of order 1.

- ▶ `y1(±0)` returns $-\infty$.
- ▶ `y1(x)` returns NaN for $x < 0$.
- ▶ `y1(+∞)` returns $+\infty$.
- ▶ `y1(NaN)` returns NaN.

`__device__ double yn(int n, double x)`

Calculate the value of the Bessel function of the second kind of order n for the input argument.

Calculate the value of the Bessel function of the second kind of order n for the input argument x , $Y_n(x)$.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Double-Precision Floating-Point Functions section.

Returns

Returns the value of the Bessel function of the second kind of order n .

- ▶ `yn(n, x)` returns NaN for $n < 0$.
- ▶ `yn(n, ±0)` returns $-\infty$.
- ▶ `yn(n, x)` returns NaN for $x < 0$.
- ▶ `yn(n, +∞)` returns $+0$.
- ▶ `yn(n, NaN)` returns NaN.

Chapter 7. Double Precision Intrinsics

This section describes double precision intrinsic functions that are only supported in device code. To use these functions you do not need to include any additional header files in your program.

Functions

- __device__ double __dadd_rd(double x, double y)**
Add two floating-point values in round-down mode.
- __device__ double __dadd_rn(double x, double y)**
Add two floating-point values in round-to-nearest-even mode.
- __device__ double __dadd_ru(double x, double y)**
Add two floating-point values in round-up mode.
- __device__ double __dadd_rz(double x, double y)**
Add two floating-point values in round-towards-zero mode.
- __device__ double __ddiv_rd(double x, double y)**
Divide two floating-point values in round-down mode.
- __device__ double __ddiv_rn(double x, double y)**
Divide two floating-point values in round-to-nearest-even mode.
- __device__ double __ddiv_ru(double x, double y)**
Divide two floating-point values in round-up mode.
- __device__ double __ddiv_rz(double x, double y)**
Divide two floating-point values in round-towards-zero mode.
- __device__ double __dmul_rd(double x, double y)**
Multiply two floating-point values in round-down mode.
- __device__ double __dmul_rn(double x, double y)**
Multiply two floating-point values in round-to-nearest-even mode.
- __device__ double __dmul_ru(double x, double y)**
Multiply two floating-point values in round-up mode.
- __device__ double __dmul_rz(double x, double y)**
Multiply two floating-point values in round-towards-zero mode.
- __device__ double __drcep_rd(double x)**
Compute $\frac{1}{x}$ in round-down mode.
- __device__ double __drcep_rn(double x)**
Compute $\frac{1}{x}$ in round-to-nearest-even mode.

__device__ double __drcp_ru(double x)

Compute $\frac{1}{x}$ in round-up mode.

__device__ double __drcp_rz(double x)

Compute $\frac{1}{x}$ in round-towards-zero mode.

__device__ double __dsqrt_rd(double x)

Compute \sqrt{x} in round-down mode.

__device__ double __dsqrt_rn(double x)

Compute \sqrt{x} in round-to-nearest-even mode.

__device__ double __dsqrt_ru(double x)

Compute \sqrt{x} in round-up mode.

__device__ double __dsqrt_rz(double x)

Compute \sqrt{x} in round-towards-zero mode.

__device__ double __dsub_rd(double x, double y)

Subtract two floating-point values in round-down mode.

__device__ double __dsub_rn(double x, double y)

Subtract two floating-point values in round-to-nearest-even mode.

__device__ double __dsub_ru(double x, double y)

Subtract two floating-point values in round-up mode.

__device__ double __dsub_rz(double x, double y)

Subtract two floating-point values in round-towards-zero mode.

__device__ double __fma_rd(double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-down mode.

__device__ double __fma_rn(double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-to-nearest-even mode.

__device__ double __fma_ru(double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-up mode.

__device__ double __fma_rz(double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-towards-zero mode.

7.1. Functions

__device__ double __dadd_rd(double x, double y)

Add two floating-point values in round-down mode.

Adds two floating-point values x and y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__dadd_rd(x, y)` is equivalent to `__dadd_rd(y, x)`.
- ▶ `__dadd_rd(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__dadd_rd($\pm\infty, \pm\infty$)` returns $\pm\infty$.
- ▶ `__dadd_rd($\pm\infty, \mp\infty$)` returns NaN.
- ▶ `__dadd_rd($\pm 0, \pm 0$)` returns ± 0 .
- ▶ `__dadd_rd(x, $-x$)` returns -0 for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dadd_rn(double x, double y)`

Add two floating-point values in round-to-nearest-even mode.

Adds two floating-point values x and y in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__dadd_rn(x, y)` is equivalent to `__dadd_rn(y, x)`.
- ▶ `__dadd_rn(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__dadd_rn($\pm\infty, \pm\infty$)` returns $\pm\infty$.
- ▶ `__dadd_rn($\pm\infty, \mp\infty$)` returns NaN.
- ▶ `__dadd_rn($\pm 0, \pm 0$)` returns ± 0 .
- ▶ `__dadd_rn(x, $-x$)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dadd_ru(double x, double y)`

Add two floating-point values in round-up mode.

Adds two floating-point values x and y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__dadd_ru(x, y)` is equivalent to `__dadd_ru(y, x)`.
- ▶ `__dadd_ru(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__dadd_ru($\pm\infty$, $\pm\infty$)` returns $\pm\infty$.
- ▶ `__dadd_ru($\pm\infty$, $\mp\infty$)` returns NaN.
- ▶ `__dadd_ru(± 0 , ± 0)` returns ± 0 .
- ▶ `__dadd_ru(x, $-x$)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dadd_rz(double x, double y)`

Add two floating-point values in round-towards-zero mode.

Adds two floating-point values x and y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x + y$.

- ▶ `__dadd_rz(x, y)` is equivalent to `__dadd_rz(y, x)`.
- ▶ `__dadd_rz(x, $\pm\infty$)` returns $\pm\infty$ for finite x .
- ▶ `__dadd_rz($\pm\infty$, $\pm\infty$)` returns $\pm\infty$.
- ▶ `__dadd_rz($\pm\infty$, $\mp\infty$)` returns NaN.
- ▶ `__dadd_rz(± 0 , ± 0)` returns ± 0 .
- ▶ `__dadd_rz(x, $-x$)` returns $+0$ for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __ddiv_rd(double x, double y)`

Divide two floating-point values in round-down mode.

Divides two floating-point values x by y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__ddiv_rd(±0, ±0)` returns NaN.
- ▶ `__ddiv_rd(±∞, ±∞)` returns NaN.
- ▶ `__ddiv_rd(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__ddiv_rd(±∞, y)` returns $∞$ of appropriate sign for finite y .
- ▶ `__ddiv_rd(x, ±0)` returns $∞$ of appropriate sign for $x \neq 0$.
- ▶ `__ddiv_rd(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __ddiv_rn(double x, double y)`

Divide two floating-point values in round-to-nearest-even mode.

Divides two floating-point values x by y in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__ddiv_rn(±0, ±0)` returns NaN.
- ▶ `__ddiv_rn(±∞, ±∞)` returns NaN.
- ▶ `__ddiv_rn(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__ddiv_rn(±∞, y)` returns $∞$ of appropriate sign for finite y .
- ▶ `__ddiv_rn(x, ±0)` returns $∞$ of appropriate sign for $x \neq 0$.
- ▶ `__ddiv_rn(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __ddiv_ru(double x, double y)`

Divide two floating-point values in round-up mode.

Divides two floating-point values x by y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__ddiv_ru(±0, ±0)` returns NaN.
- ▶ `__ddiv_ru(±∞, ±∞)` returns NaN.
- ▶ `__ddiv_ru(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__ddiv_ru(±∞, y)` returns ∞ of appropriate sign for finite y .
- ▶ `__ddiv_ru(x, ±0)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__ddiv_ru(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __ddiv_rz(double x, double y)`

Divide two floating-point values in round-towards-zero mode.

Divides two floating-point values x by y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns x / y .

- ▶ sign of the quotient x / y is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__ddiv_rz(±0, ±0)` returns NaN.
- ▶ `__ddiv_rz(±∞, ±∞)` returns NaN.
- ▶ `__ddiv_rz(x, ±∞)` returns 0 of appropriate sign for finite x .
- ▶ `__ddiv_rz(±∞, y)` returns ∞ of appropriate sign for finite y .
- ▶ `__ddiv_rz(x, ±0)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__ddiv_rz(±0, y)` returns 0 of appropriate sign for $y \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dmul_rd(double x, double y)`

Multiply two floating-point values in round-down mode.

Multiplies two floating-point values x and y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__dmul_rd(x, y)` is equivalent to `__dmul_rd(y, x)`.
- ▶ `__dmul_rd(x, $\pm\infty$)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__dmul_rd(± 0 , $\pm\infty$)` returns NaN.
- ▶ `__dmul_rd(± 0 , y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dmul_rn(double x, double y)`

Multiply two floating-point values in round-to-nearest-even mode.

Multiplies two floating-point values x and y in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__dmul_rn(x, y)` is equivalent to `__dmul_rn(y, x)`.
- ▶ `__dmul_rn(x, $\pm\infty$)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__dmul_rn(± 0 , $\pm\infty$)` returns NaN.
- ▶ `__dmul_rn(± 0 , y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dmul_ru(double x, double y)`

Multiply two floating-point values in round-up mode.

Multiplies two floating-point values x and y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__dmul_ru(x, y)` is equivalent to `__dmul_ru(y, x)`.
- ▶ `__dmul_ru(x, $\pm\infty$)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__dmul_ru(± 0 , $\pm\infty$)` returns NaN.
- ▶ `__dmul_ru(± 0 , y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dmul_rz(double x, double y)`

Multiply two floating-point values in round-towards-zero mode.

Multiplies two floating-point values x and y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x * y$.

- ▶ sign of the product $x * y$ is XOR of the signs of x and y when neither inputs nor result are NaN.
- ▶ `__dmul_rz(x, y)` is equivalent to `__dmul_rz(y, x)`.
- ▶ `__dmul_rz(x, $\pm\infty$)` returns ∞ of appropriate sign for $x \neq 0$.
- ▶ `__dmul_rz(± 0 , $\pm\infty$)` returns NaN.
- ▶ `__dmul_rz(± 0 , y)` returns 0 of appropriate sign for finite y .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __drcp_rd(double x)`

Compute $\frac{1}{x}$ in round-down mode.

Compute the reciprocal of x in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns $\frac{1}{x}$.

`__device__ double __drcp_rn(double x)`

Compute $\frac{1}{x}$ in round-to-nearest-even mode.

Compute the reciprocal of x in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns $\frac{1}{x}$.

`__device__ double __drcp_ru(double x)`

Compute $\frac{1}{x}$ in round-up mode.

Compute the reciprocal of x in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns $\frac{1}{x}$.

`__device__ double __drcp_rz(double x)`

Compute $\frac{1}{x}$ in round-towards-zero mode.

Compute the reciprocal of x in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns $\frac{1}{x}$.

`__device__ double __dsqrt_rd(double x)`

Compute \sqrt{x} in round-down mode.

Compute the square root of x in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns \sqrt{x} .

`__device__ double __dsqrt_rn(double x)`

Compute \sqrt{x} in round-to-nearest-even mode.

Compute the square root of x in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns \sqrt{x} .

`__device__ double __dsqrt_ru(double x)`

Compute \sqrt{x} in round-up mode.

Compute the square root of x in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns \sqrt{x} .

`__device__ double __dsqrt_rz(double x)`

Compute \sqrt{x} in round-towards-zero mode.

Compute the square root of x in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: Requires compute capability ≥ 2.0 .

Returns

Returns \sqrt{x} .

`__device__ double __dsub_rd(double x, double y)`

Subtract two floating-point values in round-down mode.

Subtracts two floating-point values x and y in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__dsub_rd($\pm\infty$, y)` returns $\pm\infty$ for finite y .
- ▶ `__dsub_rd(x , $\pm\infty$)` returns $\mp\infty$ for finite x .
- ▶ `__dsub_rd($\pm\infty$, $\pm\infty$)` returns NaN.
- ▶ `__dsub_rd($\pm\infty$, $\mp\infty$)` returns $\pm\infty$.
- ▶ `__dsub_rd(± 0 , ∓ 0)` returns ± 0 .
- ▶ `__dsub_rd(x , x)` returns -0 for finite x , including ± 0 .
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dsub_rn(double x, double y)`

Subtract two floating-point values in round-to-nearest-even mode.

Subtracts two floating-point values x and y in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__dsub_rn(±∞, y)` returns $±∞$ for finite y .
- ▶ `__dsub_rn(x, ±∞)` returns $∓∞$ for finite x .
- ▶ `__dsub_rn(±∞, ±∞)` returns NaN.
- ▶ `__dsub_rn(±∞, ∓∞)` returns $±∞$.
- ▶ `__dsub_rn(±0, ∓0)` returns $±0$.
- ▶ `__dsub_rn(x, x)` returns $+0$ for finite x , including $±0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dsub_ru(double x, double y)`

Subtract two floating-point values in round-up mode.

Subtracts two floating-point values x and y in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__dsub_ru(±∞, y)` returns $±∞$ for finite y .
- ▶ `__dsub_ru(x, ±∞)` returns $∓∞$ for finite x .
- ▶ `__dsub_ru(±∞, ±∞)` returns NaN.
- ▶ `__dsub_ru(±∞, ∓∞)` returns $±∞$.
- ▶ `__dsub_ru(±0, ∓0)` returns $±0$.
- ▶ `__dsub_ru(x, x)` returns $+0$ for finite x , including $±0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __dsub_rz(double x, double y)`

Subtract two floating-point values in round-towards-zero mode.

Subtracts two floating-point values x and y in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Note: This operation will never be merged into a single multiply-add instruction.

Returns

Returns $x - y$.

- ▶ `__dsub_rz(±∞, y)` returns $±∞$ for finite y .
- ▶ `__dsub_rz(x, ±∞)` returns $∓∞$ for finite x .
- ▶ `__dsub_rz(±∞, ±∞)` returns NaN.
- ▶ `__dsub_rz(±∞, ∓∞)` returns $±∞$.
- ▶ `__dsub_rz(±0, ∓0)` returns $±0$.
- ▶ `__dsub_rz(x, x)` returns $+0$ for finite x , including $±0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __fma_rd(double x, double y, double z)`

Compute $x \times y + z$ as a single operation in round-down mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-down (to negative infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fma_rd(±∞, ±0, z)` returns NaN.
- ▶ `__fma_rd(±0, ±∞, z)` returns NaN.
- ▶ `__fma_rd(x, y, -∞)` returns NaN if $x \times y$ is an exact $+∞$.
- ▶ `__fma_rd(x, y, +∞)` returns NaN if $x \times y$ is an exact $-∞$.
- ▶ `__fma_rd(x, y, ±0)` returns $±0$ if $x \times y$ is exact $±0$.
- ▶ `__fma_rd(x, y, ∓0)` returns -0 if $x \times y$ is exact $±0$.
- ▶ `__fma_rd(x, y, z)` returns -0 if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __fma_rn(double x, double y, double z)`

Compute $x \times y + z$ as a single operation in round-to-nearest-even mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-to-nearest-even mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fma_rn(±∞, ±0, z)` returns NaN.
- ▶ `__fma_rn(±0, ±∞, z)` returns NaN.

- ▶ `__fma_rn(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fma_rn(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `__fma_rn(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fma_rn(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `__fma_rn(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __fma_ru(double x, double y, double z)`

Compute $x \times y + z$ as a single operation in round-up mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-up (to positive infinity) mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fma_ru(±∞, ±0, z)` returns NaN.
- ▶ `__fma_ru(±0, ±∞, z)` returns NaN.
- ▶ `__fma_ru(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fma_ru(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.
- ▶ `__fma_ru(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fma_ru(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `__fma_ru(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

`__device__ double __fma_rz(double x, double y, double z)`

Compute $x \times y + z$ as a single operation in round-towards-zero mode.

Computes the value of $x \times y + z$ as a single ternary operation, rounding the result once in round-towards-zero mode.

Note: For accuracy information see the CUDA C++ Programming Guide, Mathematical Functions Appendix, Intrinsic Functions section.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- ▶ `__fma_rz(±∞, ±0, z)` returns NaN.
- ▶ `__fma_rz(±0, ±∞, z)` returns NaN.
- ▶ `__fma_rz(x, y, -∞)` returns NaN if $x \times y$ is an exact $+\infty$.
- ▶ `__fma_rz(x, y, +∞)` returns NaN if $x \times y$ is an exact $-\infty$.

- ▶ `__fma_rz(x, y, ±0)` returns ± 0 if $x \times y$ is exact ± 0 .
- ▶ `__fma_rz(x, y, ∓0)` returns $+0$ if $x \times y$ is exact ± 0 .
- ▶ `__fma_rz(x, y, z)` returns $+0$ if $x \times y + z$ is exactly zero and $z \neq 0$.
- ▶ If either argument is NaN, NaN is returned.

Chapter 8. Type Casting Intrinsic Functions

This section describes type casting intrinsic functions that are only supported in device code. To use these functions you do not need to include any additional header files in your program.

Functions

__device__ float __double2float_rd(double x)

Convert a double to a float in round-down mode.

__device__ float __double2float_rn(double x)

Convert a double to a float in round-to-nearest-even mode.

__device__ float __double2float_ru(double x)

Convert a double to a float in round-up mode.

__device__ float __double2float_rz(double x)

Convert a double to a float in round-towards-zero mode.

__device__ int __double2hiint(double x)

Reinterpret high 32 bits in a double as a signed integer.

__device__ int __double2int_rd(double x)

Convert a double to a signed int in round-down mode.

__device__ int __double2int_rn(double x)

Convert a double to a signed int in round-to-nearest-even mode.

__device__ int __double2int_ru(double x)

Convert a double to a signed int in round-up mode.

__device__ int __double2int_rz(double x)

Convert a double to a signed int in round-towards-zero mode.

__device__ long long int __double2ll_rd(double x)

Convert a double to a signed 64-bit int in round-down mode.

__device__ long long int __double2ll_rn(double x)

Convert a double to a signed 64-bit int in round-to-nearest-even mode.

__device__ long long int __double2ll_ru(double x)

Convert a double to a signed 64-bit int in round-up mode.

__device__ long long int __double2ll_rz(double x)

Convert a double to a signed 64-bit int in round-towards-zero mode.

__device__ int __double2loint(double x)

Reinterpret low 32 bits in a double as a signed integer.

__device__ unsigned int __double2uint_rd(double x)

Convert a double to an unsigned int in round-down mode.

__device__ unsigned int __double2uint_rn(double x)

Convert a double to an unsigned int in round-to-nearest-even mode.

__device__ unsigned int __double2uint_ru(double x)

Convert a double to an unsigned int in round-up mode.

__device__ unsigned int __double2uint_rz(double x)

Convert a double to an unsigned int in round-towards-zero mode.

__device__ unsigned long long int __double2ull_rd(double x)

Convert a double to an unsigned 64-bit int in round-down mode.

__device__ unsigned long long int __double2ull_rn(double x)

Convert a double to an unsigned 64-bit int in round-to-nearest-even mode.

__device__ unsigned long long int __double2ull_ru(double x)

Convert a double to an unsigned 64-bit int in round-up mode.

__device__ unsigned long long int __double2ull_rz(double x)

Convert a double to an unsigned 64-bit int in round-towards-zero mode.

__device__ long long int __double_as_longlong(double x)

Reinterpret bits in a double as a 64-bit signed integer.

__device__ int __float2int_rd(float x)

Convert a float to a signed integer in round-down mode.

__device__ int __float2int_rn(float x)

Convert a float to a signed integer in round-to-nearest-even mode.

__device__ int __float2int_ru(float)

Convert a float to a signed integer in round-up mode.

__device__ int __float2int_rz(float x)

Convert a float to a signed integer in round-towards-zero mode.

__device__ long long int __float2ll_rd(float x)

Convert a float to a signed 64-bit integer in round-down mode.

__device__ long long int __float2ll_rn(float x)

Convert a float to a signed 64-bit integer in round-to-nearest-even mode.

__device__ long long int __float2ll_ru(float x)

Convert a float to a signed 64-bit integer in round-up mode.

__device__ long long int __float2ll_rz(float x)

Convert a float to a signed 64-bit integer in round-towards-zero mode.

__device__ unsigned int __float2uint_rd(float x)

Convert a float to an unsigned integer in round-down mode.

__device__ unsigned int __float2uint_rn(float x)

Convert a float to an unsigned integer in round-to-nearest-even mode.

__device__ unsigned int __float2uint_ru(float x)

Convert a float to an unsigned integer in round-up mode.

__device__ unsigned int __float2uint_rz(float x)

Convert a float to an unsigned integer in round-towards-zero mode.

- __device__ unsigned long long int __float2ull_rd(float x)**
 Convert a float to an unsigned 64-bit integer in round-down mode.
- __device__ unsigned long long int __float2ull_rn(float x)**
 Convert a float to an unsigned 64-bit integer in round-to-nearest-even mode.
- __device__ unsigned long long int __float2ull_ru(float x)**
 Convert a float to an unsigned 64-bit integer in round-up mode.
- __device__ unsigned long long int __float2ull_rz(float x)**
 Convert a float to an unsigned 64-bit integer in round-towards-zero mode.
- __device__ int __float_as_int(float x)**
 Reinterpret bits in a float as a signed integer.
- __device__ unsigned int __float_as_uint(float x)**
 Reinterpret bits in a float as a unsigned integer.
- __device__ double __hiloInt2double(int hi, int lo)**
 Reinterpret high and low 32-bit integer values as a double.
- __device__ double __int2double_rn(int x)**
 Convert a signed int to a double.
- __device__ float __int2float_rd(int x)**
 Convert a signed integer to a float in round-down mode.
- __device__ float __int2float_rn(int x)**
 Convert a signed integer to a float in round-to-nearest-even mode.
- __device__ float __int2float_ru(int x)**
 Convert a signed integer to a float in round-up mode.
- __device__ float __int2float_rz(int x)**
 Convert a signed integer to a float in round-towards-zero mode.
- __device__ float __int_as_float(int x)**
 Reinterpret bits in an integer as a float.
- __device__ double __ll2double_rd(long long int x)**
 Convert a signed 64-bit int to a double in round-down mode.
- __device__ double __ll2double_rn(long long int x)**
 Convert a signed 64-bit int to a double in round-to-nearest-even mode.
- __device__ double __ll2double_ru(long long int x)**
 Convert a signed 64-bit int to a double in round-up mode.
- __device__ double __ll2double_rz(long long int x)**
 Convert a signed 64-bit int to a double in round-towards-zero mode.
- __device__ float __ll2float_rd(long long int x)**
 Convert a signed integer to a float in round-down mode.
- __device__ float __ll2float_rn(long long int x)**
 Convert a signed 64-bit integer to a float in round-to-nearest-even mode.
- __device__ float __ll2float_ru(long long int x)**
 Convert a signed integer to a float in round-up mode.
- __device__ float __ll2float_rz(long long int x)**
 Convert a signed integer to a float in round-towards-zero mode.

__device__ double __longlong_as_double(long long int x)

Reinterpret bits in a 64-bit signed integer as a double.

__device__ double __uint2double_rn(unsigned int x)

Convert an unsigned int to a double.

__device__ float __uint2float_rd(unsigned int x)

Convert an unsigned integer to a float in round-down mode.

__device__ float __uint2float_rn(unsigned int x)

Convert an unsigned integer to a float in round-to-nearest-even mode.

__device__ float __uint2float_ru(unsigned int x)

Convert an unsigned integer to a float in round-up mode.

__device__ float __uint2float_rz(unsigned int x)

Convert an unsigned integer to a float in round-towards-zero mode.

__device__ float __uint_as_float(unsigned int x)

Reinterpret bits in an unsigned integer as a float.

__device__ double __ull2double_rd(unsigned long long int x)

Convert an unsigned 64-bit int to a double in round-down mode.

__device__ double __ull2double_rn(unsigned long long int x)

Convert an unsigned 64-bit int to a double in round-to-nearest-even mode.

__device__ double __ull2double_ru(unsigned long long int x)

Convert an unsigned 64-bit int to a double in round-up mode.

__device__ double __ull2double_rz(unsigned long long int x)

Convert an unsigned 64-bit int to a double in round-towards-zero mode.

__device__ float __ull2float_rd(unsigned long long int x)

Convert an unsigned integer to a float in round-down mode.

__device__ float __ull2float_rn(unsigned long long int x)

Convert an unsigned integer to a float in round-to-nearest-even mode.

__device__ float __ull2float_ru(unsigned long long int x)

Convert an unsigned integer to a float in round-up mode.

__device__ float __ull2float_rz(unsigned long long int x)

Convert an unsigned integer to a float in round-towards-zero mode.

8.1. Functions

__device__ float __double2float_rd(double x)

Convert a double to a float in round-down mode.

Convert the double-precision floating-point value *x* to a single-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ float __double2float_rn(double x)`

Convert a double to a float in round-to-nearest-even mode.

Convert the double-precision floating-point value `x` to a single-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ float __double2float_ru(double x)`

Convert a double to a float in round-up mode.

Convert the double-precision floating-point value `x` to a single-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ float __double2float_rz(double x)`

Convert a double to a float in round-towards-zero mode.

Convert the double-precision floating-point value `x` to a single-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

`__device__ int __double2hiint(double x)`

Reinterpret high 32 bits in a double as a signed integer.

Reinterpret the high 32 bits in the double-precision floating-point value `x` as a signed integer.

Returns

Returns reinterpreted value.

`__device__ int __double2int_rd(double x)`

Convert a double to a signed int in round-down mode.

Convert the double-precision floating-point value `x` to a signed integer value in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __double2int_rn(double x)`

Convert a double to a signed int in round-to-nearest-even mode.

Convert the double-precision floating-point value `x` to a signed integer value in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __double2int_ru(double x)`

Convert a double to a signed int in round-up mode.

Convert the double-precision floating-point value *x* to a signed integer value in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __double2int_rz(double x)`

Convert a double to a signed int in round-towards-zero mode.

Convert the double-precision floating-point value *x* to a signed integer value in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __double211_rd(double x)`

Convert a double to a signed 64-bit int in round-down mode.

Convert the double-precision floating-point value *x* to a signed 64-bit integer value in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __double211_rn(double x)`

Convert a double to a signed 64-bit int in round-to-nearest-even mode.

Convert the double-precision floating-point value *x* to a signed 64-bit integer value in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __double211_ru(double x)`

Convert a double to a signed 64-bit int in round-up mode.

Convert the double-precision floating-point value *x* to a signed 64-bit integer value in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __double211_rz(double x)`

Convert a double to a signed 64-bit int in round-towards-zero mode.

Convert the double-precision floating-point value *x* to a signed 64-bit integer value in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __double21oint(double x)`

Reinterpret low 32 bits in a double as a signed integer.

Reinterpret the low 32 bits in the double-precision floating-point value *x* as a signed integer.

Returns

Returns reinterpreted value.

`__device__ unsigned int __double2uint_rd(double x)`

Convert a double to an unsigned int in round-down mode.

Convert the double-precision floating-point value *x* to an unsigned integer value in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __double2uint_rn(double x)`

Convert a double to an unsigned int in round-to-nearest-even mode.

Convert the double-precision floating-point value *x* to an unsigned integer value in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __double2uint_ru(double x)`

Convert a double to an unsigned int in round-up mode.

Convert the double-precision floating-point value *x* to an unsigned integer value in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __double2uint_rz(double x)`

Convert a double to an unsigned int in round-towards-zero mode.

Convert the double-precision floating-point value *x* to an unsigned integer value in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __double2ull_rd(double x)`

Convert a double to an unsigned 64-bit int in round-down mode.

Convert the double-precision floating-point value *x* to an unsigned 64-bit integer value in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __double2ull_rn(double x)`

Convert a double to an unsigned 64-bit int in round-to-nearest-even mode.

Convert the double-precision floating-point value *x* to an unsigned 64-bit integer value in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __double2ull_ru(double x)`

Convert a double to an unsigned 64-bit int in round-up mode.

Convert the double-precision floating-point value *x* to an unsigned 64-bit integer value in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __double2ull_rz(double x)`

Convert a double to an unsigned 64-bit int in round-towards-zero mode.

Convert the double-precision floating-point value *x* to an unsigned 64-bit integer value in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __double_as_longlong(double x)`

Reinterpret bits in a double as a 64-bit signed integer.

Reinterpret the bits in the double-precision floating-point value *x* as a signed 64-bit integer.

Returns

Returns reinterpreted value.

`__device__ int __float2int_rd(float x)`

Convert a float to a signed integer in round-down mode.

Convert the single-precision floating-point value *x* to a signed integer in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __float2int_rn(float x)`

Convert a float to a signed integer in round-to-nearest-even mode.

Convert the single-precision floating-point value `x` to a signed integer in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __float2int_ru(float)`

Convert a float to a signed integer in round-up mode.

Convert the single-precision floating-point value `x` to a signed integer in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __float2int_rz(float x)`

Convert a float to a signed integer in round-towards-zero mode.

Convert the single-precision floating-point value `x` to a signed integer in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __float2ll_rd(float x)`

Convert a float to a signed 64-bit integer in round-down mode.

Convert the single-precision floating-point value `x` to a signed 64-bit integer in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __float211_rn(float x)`

Convert a float to a signed 64-bit integer in round-to-nearest-even mode.

Convert the single-precision floating-point value `x` to a signed 64-bit integer in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __float211_ru(float x)`

Convert a float to a signed 64-bit integer in round-up mode.

Convert the single-precision floating-point value `x` to a signed 64-bit integer in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ long long int __float211_rz(float x)`

Convert a float to a signed 64-bit integer in round-towards-zero mode.

Convert the single-precision floating-point value `x` to a signed 64-bit integer in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __float2uint_rd(float x)`

Convert a float to an unsigned integer in round-down mode.

Convert the single-precision floating-point value `x` to an unsigned integer in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __float2uint_rn(float x)`

Convert a float to an unsigned integer in round-to-nearest-even mode.

Convert the single-precision floating-point value `x` to an unsigned integer in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __float2uint_ru(float x)`

Convert a float to an unsigned integer in round-up mode.

Convert the single-precision floating-point value `x` to an unsigned integer in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned int __float2uint_rz(float x)`

Convert a float to an unsigned integer in round-towards-zero mode.

Convert the single-precision floating-point value `x` to an unsigned integer in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __float2ull_rd(float x)`

Convert a float to an unsigned 64-bit integer in round-down mode.

Convert the single-precision floating-point value `x` to an unsigned 64-bit integer in round-down (to negative infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __float2ull_rn(float x)`

Convert a float to an unsigned 64-bit integer in round-to-nearest-even mode.

Convert the single-precision floating-point value `x` to an unsigned 64-bit integer in round-to-nearest-even mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __float2ull_ru(float x)`

Convert a float to an unsigned 64-bit integer in round-up mode.

Convert the single-precision floating-point value `x` to an unsigned 64-bit integer in round-up (to positive infinity) mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ unsigned long long int __float2ull_rz(float x)`

Convert a float to an unsigned 64-bit integer in round-towards-zero mode.

Convert the single-precision floating-point value `x` to an unsigned 64-bit integer in round-towards-zero mode.

Note: When the floating-point input rounded to integral is outside the range of the return type, the behavior is undefined.

Returns

Returns converted value.

`__device__ int __float_as_int(float x)`

Reinterpret bits in a float as a signed integer.

Reinterpret the bits in the single-precision floating-point value `x` as a signed integer.

Returns

Returns reinterpreted value.

`__device__ unsigned int __float_as_uint(float x)`

Reinterpret bits in a float as a unsigned integer.

Reinterpret the bits in the single-precision floating-point value `x` as a unsigned integer.

Returns

Returns reinterpreted value.

`__device__ double __hiloint2double(int hi, int lo)`

Reinterpret high and low 32-bit integer values as a double.

Reinterpret the integer value of `hi` as the high 32 bits of a double-precision floating-point value and the integer value of `lo` as the low 32 bits of the same double-precision floating-point value.

Returns

Returns reinterpreted value.

`__device__ double __int2double_rn(int x)`

Convert a signed int to a double.

Convert the signed integer value `x` to a double-precision floating-point value.

Returns

Returns converted value.

`__device__ float __int2float_rd(int x)`

Convert a signed integer to a float in round-down mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ float __int2float_rn(int x)`

Convert a signed integer to a float in round-to-nearest-even mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ float __int2float_ru(int x)`

Convert a signed integer to a float in round-up mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ float __int2float_rz(int x)`

Convert a signed integer to a float in round-towards-zero mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

`__device__ float __int_as_float(int x)`

Reinterpret bits in an integer as a float.

Reinterpret the bits in the signed integer value `x` as a single-precision floating-point value.

Returns

Returns reinterpreted value.

`__device__ double __112double_rd(long long int x)`

Convert a signed 64-bit int to a double in round-down mode.

Convert the signed 64-bit integer value `x` to a double-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ double __112double_rn(long long int x)`

Convert a signed 64-bit int to a double in round-to-nearest-even mode.

Convert the signed 64-bit integer value `x` to a double-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ double __112double_ru(long long int x)`

Convert a signed 64-bit int to a double in round-up mode.

Convert the signed 64-bit integer value `x` to a double-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ double __112double_rz(long long int x)`

Convert a signed 64-bit int to a double in round-towards-zero mode.

Convert the signed 64-bit integer value `x` to a double-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

`__device__ float __112float_rd(long long int x)`

Convert a signed integer to a float in round-down mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ float __112float_rn(long long int x)`

Convert a signed 64-bit integer to a float in round-to-nearest-even mode.

Convert the signed 64-bit integer value `x` to a single-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ float __112float_ru(long long int x)`

Convert a signed integer to a float in round-up mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ float __l12float_rz(long long int x)`

Convert a signed integer to a float in round-towards-zero mode.

Convert the signed integer value `x` to a single-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

`__device__ double __longlong_as_double(long long int x)`

Reinterpret bits in a 64-bit signed integer as a double.

Reinterpret the bits in the 64-bit signed integer value `x` as a double-precision floating-point value.

Returns

Returns reinterpreted value.

`__device__ double __uint2double_rn(unsigned int x)`

Convert an unsigned int to a double.

Convert the unsigned integer value `x` to a double-precision floating-point value.

Returns

Returns converted value.

`__device__ float __uint2float_rd(unsigned int x)`

Convert an unsigned integer to a float in round-down mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ float __uint2float_rn(unsigned int x)`

Convert an unsigned integer to a float in round-to-nearest-even mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ float __uint2float_ru(unsigned int x)`

Convert an unsigned integer to a float in round-up mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ float __uint2float_rz(unsigned int x)`

Convert an unsigned integer to a float in round-towards-zero mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

`__device__ float __uint_as_float(unsigned int x)`

Reinterpret bits in an unsigned integer as a float.

Reinterpret the bits in the unsigned integer value `x` as a single-precision floating-point value.

Returns

Returns reinterpreted value.

`__device__ double __u112double_rd(unsigned long long int x)`

Convert an unsigned 64-bit int to a double in round-down mode.

Convert the unsigned 64-bit integer value `x` to a double-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ double __u112double_rn(unsigned long long int x)`

Convert an unsigned 64-bit int to a double in round-to-nearest-even mode.

Convert the unsigned 64-bit integer value `x` to a double-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ double __u112double_ru(unsigned long long int x)`

Convert an unsigned 64-bit int to a double in round-up mode.

Convert the unsigned 64-bit integer value `x` to a double-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ double __u112double_rz(unsigned long long int x)`

Convert an unsigned 64-bit int to a double in round-towards-zero mode.

Convert the unsigned 64-bit integer value `x` to a double-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

`__device__ float __u112float_rd(unsigned long long int x)`

Convert an unsigned integer to a float in round-down mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-down (to negative infinity) mode.

Returns

Returns converted value.

`__device__ float __u112float_rn(unsigned long long int x)`

Convert an unsigned integer to a float in round-to-nearest-even mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-to-nearest-even mode.

Returns

Returns converted value.

`__device__ float __u112float_ru(unsigned long long int x)`

Convert an unsigned integer to a float in round-up mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-up (to positive infinity) mode.

Returns

Returns converted value.

`__device__ float __u112float_rz(unsigned long long int x)`

Convert an unsigned integer to a float in round-towards-zero mode.

Convert the unsigned integer value `x` to a single-precision floating-point value in round-towards-zero mode.

Returns

Returns converted value.

Chapter 9. Integer Mathematical Functions

This section describes integer mathematical functions.

To use these functions you do not need to include any additional header files in your program.

Functions

__device__ long int *abs*(long int a)

Calculate the absolute value of the input long int argument.

__device__ int *abs*(int a)

Calculate the absolute value of the input int argument.

__device__ long long int *abs*(long long int a)

Calculate the absolute value of the input long long int argument.

__device__ long int *labs*(long int a)

Calculate the absolute value of the input long int argument.

__device__ long long int *llabs*(long long int a)

Calculate the absolute value of the input long long int argument.

__device__ long long int *llmax*(const long long int a, const long long int b)

Calculate the maximum value of the input long long int arguments.

__device__ long long int *llmin*(const long long int a, const long long int b)

Calculate the minimum value of the input long long int arguments.

__device__ unsigned long int *max*(const long int a, const unsigned long int b)

Calculate the maximum value of the input long int and unsigned long int arguments.

__device__ unsigned long long int *max*(const unsigned long long int a, const unsigned long long int b)

Calculate the maximum value of the input unsigned long long int arguments.

__device__ unsigned int *max*(const unsigned int a, const int b)

Calculate the maximum value of the input unsigned int and int arguments.

__device__ unsigned long long int *max*(const long long int a, const unsigned long long int b)

Calculate the maximum value of the input long long int and unsigned long long int arguments.

__device__ unsigned long int *max*(const unsigned long int a, const unsigned long int b)

Calculate the maximum value of the input unsigned long int arguments.

__device__ long long int *max*(const long long int a, const long long int b)

Calculate the maximum value of the input long long int arguments.

__device__ unsigned long long int *max*(const unsigned long long int a, const long long int b)

Calculate the maximum value of the input unsigned long long int and long long int arguments.

__device__ unsigned long int *max*(const unsigned long int a, const long int b)

Calculate the maximum value of the input unsigned long int and long int arguments.

__device__ long int *max*(const long int a, const long int b)

Calculate the maximum value of the input long int arguments.

__device__ int *max*(const int a, const int b)

Calculate the maximum value of the input int arguments.

__device__ unsigned int *max*(const unsigned int a, const unsigned int b)

Calculate the maximum value of the input unsigned int arguments.

__device__ unsigned int *max*(const int a, const unsigned int b)

Calculate the maximum value of the input int and unsigned int arguments.

__device__ unsigned long int *min*(const long int a, const unsigned long int b)

Calculate the minimum value of the input long int and unsigned long int arguments.

__device__ unsigned long long int *min*(const unsigned long long int a, const unsigned long long int b)

Calculate the minimum value of the input unsigned long long int arguments.

__device__ unsigned long long int *min*(const unsigned long long int a, const long long int b)

Calculate the minimum value of the input unsigned long long int and long long int arguments.

__device__ int *min*(const int a, const int b)

Calculate the minimum value of the input int arguments.

__device__ unsigned int *min*(const unsigned int a, const int b)

Calculate the minimum value of the input unsigned int and int arguments.

__device__ unsigned long long int *min*(const long long int a, const unsigned long long int b)

Calculate the minimum value of the input long long int and unsigned long long int arguments.

__device__ long long int *min*(const long long int a, const long long int b)

Calculate the minimum value of the input long long int arguments.

__device__ unsigned int *min*(const int a, const unsigned int b)

Calculate the minimum value of the input int and unsigned int arguments.

__device__ long int *min*(const long int a, const long int b)

Calculate the minimum value of the input long int arguments.

__device__ unsigned int *min*(const unsigned int a, const unsigned int b)

Calculate the minimum value of the input unsigned int arguments.

__device__ unsigned long int *min*(const unsigned long int a, const long int b)

Calculate the minimum value of the input unsigned long int and long int arguments.

__device__ unsigned long int *min*(const unsigned long int a, const unsigned long int b)

Calculate the minimum value of the input unsigned long int arguments.

__device__ unsigned long long int ullmax(const unsigned long long int a, const unsigned long long int b)

Calculate the maximum value of the input unsigned long long int arguments.

__device__ unsigned long long int ullmin(const unsigned long long int a, const unsigned long long int b)

Calculate the minimum value of the input unsigned long long int arguments.

__device__ unsigned int umax(const unsigned int a, const unsigned int b)

Calculate the maximum value of the input unsigned int arguments.

__device__ unsigned int umin(const unsigned int a, const unsigned int b)

Calculate the minimum value of the input unsigned int arguments.

9.1. Functions

__device__ long int abs(long int a)

Calculate the absolute value of the input long int argument.

Calculate the absolute value of the input argument a.

Returns

Returns the absolute value of the input argument.

► abs(LONG_MIN) is Undefined

__device__ int abs(int a)

Calculate the absolute value of the input int argument.

Calculate the absolute value of the input argument a.

Returns

Returns the absolute value of the input argument.

► abs(INT_MIN) is Undefined

__device__ long long int abs(long long int a)

Calculate the absolute value of the input long long int argument.

Calculate the absolute value of the input argument a.

Returns

Returns the absolute value of the input argument.

► abs(LLONG_MIN) is Undefined

__device__ long int labs(long int a)

Calculate the absolute value of the input long int argument.

Calculate the absolute value of the input argument a.

Returns

Returns the absolute value of the input argument.

► labs(LONG_MIN) is Undefined

__device__ long long int llabs(long long int a)

Calculate the absolute value of the input long long int argument.

Calculate the absolute value of the input argument a.

Returns

Returns the absolute value of the input argument.

► `llabs(LLONG_MIN)` is Undefined

`__device__ long long int llmax(const long long int a, const long long int b)`

Calculate the maximum value of the input `long long int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ long long int llmin(const long long int a, const long long int b)`

Calculate the minimum value of the input `long long int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned long int max(const long int a, const unsigned long int b)`

Calculate the maximum value of the input `long int` and `unsigned long int` arguments.

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long long int max(const unsigned long long int a, const unsigned long long int b)`

Calculate the maximum value of the input `unsigned long long int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ unsigned int max(const unsigned int a, const int b)`

Calculate the maximum value of the input `unsigned int` and `int` arguments.

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long long int max(const long long int a, const unsigned long long int b)`

Calculate the maximum value of the input `long long int` and `unsigned long long int` arguments.

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long int max(const unsigned long int a, const unsigned long int b)`

Calculate the maximum value of the input `unsigned long int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ long long int max(const long long int a, const long long int b)`

Calculate the maximum value of the input `long long int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ unsigned long long int max(const unsigned long long int a, const long long int b)`

Calculate the maximum value of the input `unsigned long long int` and `long long int` arguments.

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long int max(const unsigned long int a, const long int b)`

Calculate the maximum value of the input `unsigned long int` and `long int` arguments.

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ long int max(const long int a, const long int b)`

Calculate the maximum value of the input `long int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ int max(const int a, const int b)`

Calculate the maximum value of the input `int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ unsigned int max(const unsigned int a, const unsigned int b)`

Calculate the maximum value of the input `unsigned int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ unsigned int max(const int a, const unsigned int b)`

Calculate the maximum value of the input `int` and `unsigned int` arguments.

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long int min(const long int a, const unsigned long int b)`

Calculate the minimum value of the input `long int` and `unsigned long int` arguments.

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long long int min(const unsigned long long int a, const unsigned long long int b)`

Calculate the minimum value of the input `unsigned long long int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned long long int min(const unsigned long long int a, const long long int b)`

Calculate the minimum value of the input `unsigned long long int` and `long long int` arguments.

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ int min(const int a, const int b)`

Calculate the minimum value of the input `int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned int min(const unsigned int a, const int b)`

Calculate the minimum value of the input `unsigned int` and `int` arguments.

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long long int min(const long long int a, const unsigned long long int b)`

Calculate the minimum value of the input `long long int` and `unsigned long long int` arguments.

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ long long int min(const long long int a, const long long int b)`

Calculate the minimum value of the input `long long int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned int min(const int a, const unsigned int b)`

Calculate the minimum value of the input `int` and `unsigned int` arguments.

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ long int min(const long int a, const long int b)`

Calculate the minimum value of the input `long int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned int min(const unsigned int a, const unsigned int b)`

Calculate the minimum value of the input `unsigned int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned long int min(const unsigned long int a, const long int b)`

Calculate the minimum value of the input `unsigned long int` and `long int` arguments.

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

`__device__ unsigned long int min(const unsigned long int a, const unsigned long int b)`

Calculate the minimum value of the input `unsigned long int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned long long int ullmax(const unsigned long long int a, const unsigned long long int b)`

Calculate the maximum value of the input `unsigned long long int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ unsigned long long int ullmin(const unsigned long long int a, const unsigned long long int b)`

Calculate the minimum value of the input `unsigned long long int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

`__device__ unsigned int umax(const unsigned int a, const unsigned int b)`

Calculate the maximum value of the input `unsigned int` arguments.

Calculate the maximum value of the arguments `a` and `b`.

`__device__ unsigned int umin(const unsigned int a, const unsigned int b)`

Calculate the minimum value of the input `unsigned int` arguments.

Calculate the minimum value of the arguments `a` and `b`.

Chapter 10. Integer Intrinsics

This section describes integer intrinsic functions that are only supported in device code. To use these functions you do not need to include any additional header files in your program.

Functions

__device__ unsigned int __brev(unsigned int x)

Reverse the bit order of a 32-bit unsigned integer.

__device__ unsigned long long int __brevll(unsigned long long int x)

Reverse the bit order of a 64-bit unsigned integer.

__device__ unsigned int __byte_perm(unsigned int x, unsigned int y, unsigned int s)

Return selected bytes from two 32-bit unsigned integers.

__device__ int __clz(int x)

Return the number of consecutive high-order zero bits in a 32-bit integer.

__device__ int __clzll(long long int x)

Count the number of consecutive high-order zero bits in a 64-bit integer.

__device__ int __dp2a_hi(int srcA, int srcB, int c)

Two-way signed int16 by int8 dot product with int32 accumulate, taking the upper half of the second input.

__device__ unsigned int __dp2a_hi(unsigned int srcA, unsigned int srcB, unsigned int c)

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the upper half of the second input.

__device__ unsigned int __dp2a_hi(ushort2 srcA, uchar4 srcB, unsigned int c)

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the upper half of the second input.

__device__ int __dp2a_hi(short2 srcA, char4 srcB, int c)

Two-way signed int16 by int8 dot product with int32 accumulate, taking the upper half of the second input.

__device__ unsigned int __dp2a_lo(ushort2 srcA, uchar4 srcB, unsigned int c)

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the lower half of the second input.

__device__ int __dp2a_lo(short2 srcA, char4 srcB, int c)

Two-way signed int16 by int8 dot product with int32 accumulate, taking the lower half of the second input.

- __device__ unsigned int __dp2a_lo(unsigned int srcA, unsigned int srcB, unsigned int c)**
 Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the lower half of the second input.
- __device__ int __dp2a_lo(int srcA, int srcB, int c)**
 Two-way signed int16 by int8 dot product with int32 accumulate, taking the lower half of the second input.
- __device__ unsigned int __dp4a(uchar4 srcA, uchar4 srcB, unsigned int c)**
 Four-way unsigned int8 dot product with unsigned int32 accumulate.
- __device__ unsigned int __dp4a(unsigned int srcA, unsigned int srcB, unsigned int c)**
 Four-way unsigned int8 dot product with unsigned int32 accumulate.
- __device__ int __dp4a(int srcA, int srcB, int c)**
 Four-way signed int8 dot product with int32 accumulate.
- __device__ int __dp4a(char4 srcA, char4 srcB, int c)**
 Four-way signed int8 dot product with int32 accumulate.
- __device__ int __ffs(int x)**
 Find the position of the least significant bit set to 1 in a 32-bit integer.
- __device__ int __ffsll(long long int x)**
 Find the position of the least significant bit set to 1 in a 64-bit integer.
- __device__ unsigned __fns(unsigned mask, unsigned base, int offset)**
 Find the position of the n-th set to 1 bit in a 32-bit integer.
- __device__ unsigned int __funnelshift_l(unsigned int lo, unsigned int hi, unsigned int shift)**
 Concatenate hi : lo , shift left by shift & 31 bits, return the most significant 32 bits.
- __device__ unsigned int __funnelshift_lc(unsigned int lo, unsigned int hi, unsigned int shift)**
 Concatenate hi : lo , shift left by min(shift , 32) bits, return the most significant 32 bits.
- __device__ unsigned int __funnelshift_r(unsigned int lo, unsigned int hi, unsigned int shift)**
 Concatenate hi : lo , shift right by shift & 31 bits, return the least significant 32 bits.
- __device__ unsigned int __funnelshift_rc(unsigned int lo, unsigned int hi, unsigned int shift)**
 Concatenate hi : lo , shift right by min(shift , 32) bits, return the least significant 32 bits.
- __device__ int __hadd(int x, int y)**
 Compute average of signed input arguments, avoiding overflow in the intermediate sum.
- __device__ int __mul24(int x, int y)**
 Calculate the least significant 32 bits of the product of the least significant 24 bits of two integers.
- __device__ long long int __mul64hi(long long int x, long long int y)**
 Calculate the most significant 64 bits of the product of the two 64-bit integers.
- __device__ int __mulhi(int x, int y)**
 Calculate the most significant 32 bits of the product of the two 32-bit integers.
- __device__ int __popc(unsigned int x)**
 Count the number of bits that are set to 1 in a 32-bit integer.
- __device__ int __popcll(unsigned long long int x)**
 Count the number of bits that are set to 1 in a 64-bit integer.
- __device__ int __rhadd(int x, int y)**
 Compute rounded average of signed input arguments, avoiding overflow in the intermediate sum.

__device__ unsigned int __sad(int x, int y, unsigned int z)

Calculate $|x - y| + z$, the sum of absolute difference.

__device__ unsigned int __uhadd(unsigned int x, unsigned int y)

Compute average of unsigned input arguments, avoiding overflow in the intermediate sum.

__device__ unsigned int __umul24(unsigned int x, unsigned int y)

Calculate the least significant 32 bits of the product of the least significant 24 bits of two unsigned integers.

__device__ unsigned long long int __umul64hi(unsigned long long int x, unsigned long long int y)

Calculate the most significant 64 bits of the product of the two 64 unsigned bit integers.

__device__ unsigned int __umulhi(unsigned int x, unsigned int y)

Calculate the most significant 32 bits of the product of the two 32-bit unsigned integers.

__device__ unsigned int __urhadd(unsigned int x, unsigned int y)

Compute rounded average of unsigned input arguments, avoiding overflow in the intermediate sum.

__device__ unsigned int __usad(unsigned int x, unsigned int y, unsigned int z)

Calculate $|x - y| + z$, the sum of absolute difference.

10.1. Functions

__device__ unsigned int __brev(unsigned int x)

Reverse the bit order of a 32-bit unsigned integer.

Reverses the bit order of the 32-bit unsigned integer x.

Returns

Returns the bit-reversed value of x. i.e. bit N of the return value corresponds to bit 31-N of x.

__device__ unsigned long long int __brev11(unsigned long long int x)

Reverse the bit order of a 64-bit unsigned integer.

Reverses the bit order of the 64-bit unsigned integer x.

Returns

Returns the bit-reversed value of x. i.e. bit N of the return value corresponds to bit 63-N of x.

__device__ unsigned int __byte_perm(unsigned int x, unsigned int y, unsigned int s)

Return selected bytes from two 32-bit unsigned integers.

Create 8-byte source

▶ `uint64_t tmp64 = ((uint64_t)y << 32) | x;`

Extract selector bits

▶ `selector0 = (s >> 0) & 0x7;`

▶ `selector1 = (s >> 4) & 0x7;`

▶ `selector2 = (s >> 8) & 0x7;`

▶ selector3 = (s >> 12) & 0x7;

Return 4 selected bytes from 8-byte source:

▶ res[07:00] = tmp64[selector0];
 ▶ res[15:08] = tmp64[selector1];
 ▶ res[23:16] = tmp64[selector2];
 ▶ res[31:24] = tmp64[selector3];

Returns

Returns a 32-bit integer consisting of four bytes from eight input bytes provided in the two input integers x and y, as specified by a selector, s.

`__device__ int __clz(int x)`

Return the number of consecutive high-order zero bits in a 32-bit integer.

Count the number of consecutive leading zero bits, starting at the most significant bit (bit 31) of x.

Returns

Returns a value between 0 and 32 inclusive representing the number of zero bits.

`__device__ int __clzll(long long int x)`

Count the number of consecutive high-order zero bits in a 64-bit integer.

Count the number of consecutive leading zero bits, starting at the most significant bit (bit 63) of x.

Returns

Returns a value between 0 and 64 inclusive representing the number of zero bits.

`__device__ int __dp2a_hi(int srcA, int srcB, int c)`

Two-way signed int16 by int8 dot product with int32 accumulate, taking the upper half of the second input.

Extracts two packed 16-bit integers from srcA and two packed 8-bit integers from the upper 16 bits of srcB, then creates two pairwise 8x16 products and adds them together to a signed 32-bit integer c.

`__device__ unsigned int __dp2a_hi(unsigned int srcA, unsigned int srcB, unsigned int c)`

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the upper half of the second input.

Extracts two packed 16-bit integers from srcA and two packed 8-bit integers from the upper 16 bits of srcB, then creates two pairwise 8x16 products and adds them together to an unsigned 32-bit integer c.

`__device__ unsigned int __dp2a_hi(ushort2 srcA, uchar4 srcB, unsigned int c)`

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the upper half of the second input.

Takes two packed 16-bit integers from srcA vector and two packed 8-bit integers from the upper 16 bits of srcB vector, then creates two pairwise 8x16 products and adds them together to an unsigned 32-bit integer c.

`__device__ int __dp2a_hi`(short2 srcA, char4 srcB, int c)

Two-way signed int16 by int8 dot product with int32 accumulate, taking the upper half of the second input.

Takes two packed 16-bit integers from srcA vector and two packed 8-bit integers from the upper 16 bits of srcB vector, then creates two pairwise 8x16 products and adds them together to a signed 32-bit integer c.

`__device__ unsigned int __dp2a_lo`(ushort2 srcA, uchar4 srcB, unsigned int c)

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the lower half of the second input.

Takes two packed 16-bit integers from srcA vector and two packed 8-bit integers from the lower 16 bits of srcB vector, then creates two pairwise 8x16 products and adds them together to an unsigned 32-bit integer c.

`__device__ int __dp2a_lo`(short2 srcA, char4 srcB, int c)

Two-way signed int16 by int8 dot product with int32 accumulate, taking the lower half of the second input.

Takes two packed 16-bit integers from srcA vector and two packed 8-bit integers from the lower 16 bits of srcB vector, then creates two pairwise 8x16 products and adds them together to a signed 32-bit integer c.

`__device__ unsigned int __dp2a_lo`(unsigned int srcA, unsigned int srcB, unsigned int c)

Two-way unsigned int16 by int8 dot product with unsigned int32 accumulate, taking the lower half of the second input.

Extracts two packed 16-bit integers from srcA and two packed 8-bit integers from the lower 16 bits of srcB, then creates two pairwise 8x16 products and adds them together to an unsigned 32-bit integer c.

`__device__ int __dp2a_lo`(int srcA, int srcB, int c)

Two-way signed int16 by int8 dot product with int32 accumulate, taking the lower half of the second input.

Extracts two packed 16-bit integers from srcA and two packed 8-bit integers from the lower 16 bits of srcB, then creates two pairwise 8x16 products and adds them together to a signed 32-bit integer c.

`__device__ unsigned int __dp4a`(uchar4 srcA, uchar4 srcB, unsigned int c)

Four-way unsigned int8 dot product with unsigned int32 accumulate.

Takes four pairs of packed byte-sized integers from srcA and srcB vectors, then creates four pairwise products and adds them together to an unsigned 32-bit integer c.

`__device__ unsigned int __dp4a`(unsigned int srcA, unsigned int srcB, unsigned int c)

Four-way unsigned int8 dot product with unsigned int32 accumulate.

Extracts four pairs of packed byte-sized integers from srcA and srcB, then creates four pairwise products and adds them together to an unsigned 32-bit integer c.

`__device__ int __dp4a`(int srcA, int srcB, int c)

Four-way signed int8 dot product with int32 accumulate.

Extracts four pairs of packed byte-sized integers from srcA and srcB, then creates four pairwise products and adds them together to a signed 32-bit integer c.

`__device__ int __dp4a(char4 srcA, char4 srcB, int c)`

Four-way signed `int8` dot product with `int32` accumulate.

Takes four pairs of packed byte-sized integers from `srcA` and `srcB` vectors, then creates four pairwise products and adds them together to a signed 32-bit integer `c`.

`__device__ int __ffs(int x)`

Find the position of the least significant bit set to 1 in a 32-bit integer.

Find the position of the first (least significant) bit set to 1 in `x`, where the least significant bit position is 1.

Returns

Returns a value between 0 and 32 inclusive representing the position of the first bit set.

► `__ffs(0)` returns 0.

`__device__ int __ffsll(long long int x)`

Find the position of the least significant bit set to 1 in a 64-bit integer.

Find the position of the first (least significant) bit set to 1 in `x`, where the least significant bit position is 1.

Returns

Returns a value between 0 and 64 inclusive representing the position of the first bit set.

► `__ffsll(0)` returns 0.

`__device__ unsigned __fns(unsigned mask, unsigned base, int offset)`

Find the position of the `n`-th set to 1 bit in a 32-bit integer.

Given a 32-bit value `mask` and an integer value `base` (between 0 and 31), find the `n`-th (given by `offset`) set bit in `mask` from the `base` bit. If not found, return `0xFFFFFFFF`.

See also <https://docs.nvidia.com/cuda/parallel-thread-execution/index.html#integer-arithmetic-instructions-fns> for more information.

Returns

Returns a value between 0 and 32 inclusive representing the position of the `n`-th set bit.

► parameter `base` must be ≤ 31 , otherwise behavior is undefined.

`__device__ unsigned int __funnelshift_1(unsigned int lo, unsigned int hi, unsigned int shift)`

Concatenate `hi : lo`, shift left by `shift & 31` bits, return the most significant 32 bits.

Shift the 64-bit value formed by concatenating argument `lo` and `hi` left by the amount specified by the argument `shift`. Argument `lo` holds bits 31:0 and argument `hi` holds bits 63:32 of the 64-bit source value. The source is shifted left by the wrapped value of `shift` (`shift & 31`). The most significant 32-bits of the result are returned.

Returns

Returns the most significant 32 bits of the shifted 64-bit value.

`__device__ unsigned int __funnelshift_lc(unsigned int lo, unsigned int hi, unsigned int shift)`

Concatenate `hi : lo`, shift left by `min(shift, 32)` bits, return the most significant 32 bits.

Shift the 64-bit value formed by concatenating argument `lo` and `hi` left by the amount specified by the argument `shift`. Argument `lo` holds bits 31:0 and argument `hi` holds bits 63:32 of the

64-bit source value. The source is shifted left by the clamped value of `shift` ($\min(\text{shift}, 32)$). The most significant 32-bits of the result are returned.

Returns

Returns the most significant 32 bits of the shifted 64-bit value.

`__device__ unsigned int __funnelshift_r(unsigned int lo, unsigned int hi, unsigned int shift)`

Concatenate `hi : lo`, shift right by `shift & 31` bits, return the least significant 32 bits.

Shift the 64-bit value formed by concatenating argument `lo` and `hi` right by the amount specified by the argument `shift`. Argument `lo` holds bits 31:0 and argument `hi` holds bits 63:32 of the 64-bit source value. The source is shifted right by the wrapped value of `shift` ($\text{shift} \& 31$). The least significant 32-bits of the result are returned.

Returns

Returns the least significant 32 bits of the shifted 64-bit value.

`__device__ unsigned int __funnelshift_rc(unsigned int lo, unsigned int hi, unsigned int shift)`

Concatenate `hi : lo`, shift right by $\min(\text{shift}, 32)$ bits, return the least significant 32 bits.

Shift the 64-bit value formed by concatenating argument `lo` and `hi` right by the amount specified by the argument `shift`. Argument `lo` holds bits 31:0 and argument `hi` holds bits 63:32 of the 64-bit source value. The source is shifted right by the clamped value of `shift` ($\min(\text{shift}, 32)$). The least significant 32-bits of the result are returned.

Returns

Returns the least significant 32 bits of the shifted 64-bit value.

`__device__ int __hadd(int x, int y)`

Compute average of signed input arguments, avoiding overflow in the intermediate sum.

Compute average of signed input arguments `x` and `y` as $(x + y) \gg 1$, avoiding overflow in the intermediate sum.

Returns

Returns a signed integer value representing the signed average value of the two inputs.

`__device__ int __mul24(int x, int y)`

Calculate the least significant 32 bits of the product of the least significant 24 bits of two integers.

Calculate the least significant 32 bits of the product of the least significant 24 bits of `x` and `y`. The high order 8 bits of `x` and `y` are ignored.

Returns

Returns the least significant 32 bits of the product `x * y`.

`__device__ long long int __mul64hi(long long int x, long long int y)`

Calculate the most significant 64 bits of the product of the two 64-bit integers.

Calculate the most significant 64 bits of the 128-bit product `x * y`, where `x` and `y` are 64-bit integers.

Returns

Returns the most significant 64 bits of the product `x * y`.

`__device__ int __mulhi(int x, int y)`

Calculate the most significant 32 bits of the product of the two 32-bit integers.

Calculate the most significant 32 bits of the 64-bit product `x * y`, where `x` and `y` are 32-bit integers.

Returns

Returns the most significant 32 bits of the product $x * y$.

`__device__ int __popc(unsigned int x)`

Count the number of bits that are set to 1 in a 32-bit integer.

Count the number of bits that are set to 1 in x .

Returns

Returns a value between 0 and 32 inclusive representing the number of set bits.

`__device__ int __popc11(unsigned long long int x)`

Count the number of bits that are set to 1 in a 64-bit integer.

Count the number of bits that are set to 1 in x .

Returns

Returns a value between 0 and 64 inclusive representing the number of set bits.

`__device__ int __rhadd(int x, int y)`

Compute rounded average of signed input arguments, avoiding overflow in the intermediate sum.

Compute average of signed input arguments x and y as $(x + y + 1) >> 1$, avoiding overflow in the intermediate sum.

Returns

Returns a signed integer value representing the signed rounded average value of the two inputs.

`__device__ unsigned int __sad(int x, int y, unsigned int z)`

Calculate $|x - y| + z$, the sum of absolute difference.

Calculate $|x - y| + z$, the 32-bit sum of the third argument z plus and the absolute value of the difference between the first argument, x , and second argument, y .

Inputs x and y are signed 32-bit integers, input z is a 32-bit unsigned integer.

Returns

Returns $|x - y| + z$.

`__device__ unsigned int __uhadd(unsigned int x, unsigned int y)`

Compute average of unsigned input arguments, avoiding overflow in the intermediate sum.

Compute average of unsigned input arguments x and y as $(x + y) >> 1$, avoiding overflow in the intermediate sum.

Returns

Returns an unsigned integer value representing the unsigned average value of the two inputs.

`__device__ unsigned int __umu124(unsigned int x, unsigned int y)`

Calculate the least significant 32 bits of the product of the least significant 24 bits of two unsigned integers.

Calculate the least significant 32 bits of the product of the least significant 24 bits of x and y . The high order 8 bits of x and y are ignored.

Returns

Returns the least significant 32 bits of the product $x * y$.

`__device__ unsigned long long int __umul64hi`(unsigned long long int x, unsigned long long int y)

Calculate the most significant 64 bits of the product of the two 64 unsigned bit integers.

Calculate the most significant 64 bits of the 128-bit product $x * y$, where x and y are 64-bit unsigned integers.

Returns

Returns the most significant 64 bits of the product $x * y$.

`__device__ unsigned int __umulhi`(unsigned int x, unsigned int y)

Calculate the most significant 32 bits of the product of the two 32-bit unsigned integers.

Calculate the most significant 32 bits of the 64-bit product $x * y$, where x and y are 32-bit unsigned integers.

Returns

Returns the most significant 32 bits of the product $x * y$.

`__device__ unsigned int __urhadd`(unsigned int x, unsigned int y)

Compute rounded average of unsigned input arguments, avoiding overflow in the intermediate sum.

Compute average of unsigned input arguments x and y as $(x + y + 1) >> 1$, avoiding overflow in the intermediate sum.

Returns

Returns an unsigned integer value representing the unsigned rounded average value of the two inputs.

`__device__ unsigned int __usad`(unsigned int x, unsigned int y, unsigned int z)

Calculate $|x - y| + z$, the sum of absolute difference.

Calculate $|x - y| + z$, the 32-bit sum of the third argument z plus and the absolute value of the difference between the first argument, x , and second argument, y .

Inputs x , y , and z are unsigned 32-bit integers.

Returns

Returns $|x - y| + z$.

Chapter 11. SIMD Intrinsics

This section describes SIMD intrinsic functions that are only supported in device code.

To use these functions you do not need to include any additional header files in your program.

Functions

__device__ unsigned int __vabs2(unsigned int a)

Computes per-halfword absolute value.

__device__ unsigned int __vabs4(unsigned int a)

Computes per-byte absolute value.

__device__ unsigned int __vabsdiffs2(unsigned int a, unsigned int b)

Computes per-halfword sum of absolute difference of signed integer.

__device__ unsigned int __vabsdiffs4(unsigned int a, unsigned int b)

Computes per-byte absolute difference of signed integer.

__device__ unsigned int __vabsdiffu2(unsigned int a, unsigned int b)

Performs per-halfword absolute difference of unsigned integer computation: $|a - b|$.

__device__ unsigned int __vabsdiffu4(unsigned int a, unsigned int b)

Computes per-byte absolute difference of unsigned integer.

__device__ unsigned int __vabsss2(unsigned int a)

Computes per-halfword absolute value with signed saturation.

__device__ unsigned int __vabsss4(unsigned int a)

Computes per-byte absolute value with signed saturation.

__device__ unsigned int __vadd2(unsigned int a, unsigned int b)

Performs per-halfword (un)signed addition, with wrap-around: $a + b$.

__device__ unsigned int __vadd4(unsigned int a, unsigned int b)

Performs per-byte (un)signed addition.

__device__ unsigned int __vaddss2(unsigned int a, unsigned int b)

Performs per-halfword addition with signed saturation.

__device__ unsigned int __vaddss4(unsigned int a, unsigned int b)

Performs per-byte addition with signed saturation.

__device__ unsigned int __vaddus2(unsigned int a, unsigned int b)

Performs per-halfword addition with unsigned saturation.

__device__ unsigned int __vaddus4(unsigned int a, unsigned int b)

Performs per-byte addition with unsigned saturation.

- __device__ unsigned int __vavgs2(unsigned int a, unsigned int b)**
Performs per-halfword signed rounded average computation.
- __device__ unsigned int __vavgs4(unsigned int a, unsigned int b)**
Computes per-byte signed rounded average.
- __device__ unsigned int __vavgu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned rounded average computation.
- __device__ unsigned int __vavgu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned rounded average.
- __device__ unsigned int __vcmpeq2(unsigned int a, unsigned int b)**
Performs per-halfword (un)signed comparison.
- __device__ unsigned int __vcmpeq4(unsigned int a, unsigned int b)**
Performs per-byte (un)signed comparison.
- __device__ unsigned int __vcmpges2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison: $a \geq b ? 0xffff : 0$.
- __device__ unsigned int __vcmpges4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vcmpgeu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned comparison: $a \geq b ? 0xffff : 0$.
- __device__ unsigned int __vcmpgeu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vcmpgts2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison: $a > b ? 0xffff : 0$.
- __device__ unsigned int __vcmpgts4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vcmpgtu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned comparison: $a > b ? 0xffff : 0$.
- __device__ unsigned int __vcmpgtu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vcmples2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison: $a \leq b ? 0xffff : 0$.
- __device__ unsigned int __vcmples4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vcmpleu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned comparison: $a \leq b ? 0xffff : 0$.
- __device__ unsigned int __vcmpleu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vcmplts2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison: $a < b ? 0xffff : 0$.
- __device__ unsigned int __vcmplts4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vcmpltu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned comparison: $a < b ? 0xffff : 0$.

- __device__ unsigned int __vcmpltu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vcmpne2(unsigned int a, unsigned int b)**
Performs per-halfword (un)signed comparison: $a \neq b ? 0xffff : 0$.
- __device__ unsigned int __vcmpne4(unsigned int a, unsigned int b)**
Performs per-byte (un)signed comparison.
- __device__ unsigned int __vhaddu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned average computation.
- __device__ unsigned int __vhaddu4(unsigned int a, unsigned int b)**
Computes per-byte unsigned average.
- __host__ __device__ unsigned int __viaddmax_s16x2(const unsigned int a, const unsigned int b, const unsigned int c)**
Performs per-halfword $\max(a + b, c)$
- __host__ __device__ unsigned int __viaddmax_s16x2_relu(const unsigned int a, const unsigned int b, const unsigned int c)**
Performs per-halfword $\max(\max(a + b, c), 0)$
- __host__ __device__ int __viaddmax_s32(const int a, const int b, const int c)**
Computes $\max(a + b, c)$
- __host__ __device__ int __viaddmax_s32_relu(const int a, const int b, const int c)**
Computes $\max(\max(a + b, c), 0)$
- __host__ __device__ unsigned int __viaddmax_u16x2(const unsigned int a, const unsigned int b, const unsigned int c)**
Performs per-halfword $\max(a + b, c)$
- __host__ __device__ unsigned int __viaddmax_u32(const unsigned int a, const unsigned int b, const unsigned int c)**
Computes $\max(a + b, c)$
- __host__ __device__ unsigned int __viaddmin_s16x2(const unsigned int a, const unsigned int b, const unsigned int c)**
Performs per-halfword $\min(a + b, c)$
- __host__ __device__ unsigned int __viaddmin_s16x2_relu(const unsigned int a, const unsigned int b, const unsigned int c)**
Performs per-halfword $\max(\min(a + b, c), 0)$
- __host__ __device__ int __viaddmin_s32(const int a, const int b, const int c)**
Computes $\min(a + b, c)$
- __host__ __device__ int __viaddmin_s32_relu(const int a, const int b, const int c)**
Computes $\max(\min(a + b, c), 0)$
- __host__ __device__ unsigned int __viaddmin_u16x2(const unsigned int a, const unsigned int b, const unsigned int c)**
Performs per-halfword $\min(a + b, c)$
- __host__ __device__ unsigned int __viaddmin_u32(const unsigned int a, const unsigned int b, const unsigned int c)**
Computes $\min(a + b, c)$
- __host__ __device__ unsigned int __vibmax_s16x2(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)**

Performs per-halfword $\max(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \geq b)$.

__host__ __device__ int __vibmax_s32(const int a, const int b, bool *const pred)

Computes $\max(a, b)$, also sets the value pointed to by `pred` to $(a \geq b)$.

__host__ __device__ unsigned int __vibmax_u16x2(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)

Performs per-halfword $\max(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \geq b)$.

__host__ __device__ unsigned int __vibmax_u32(const unsigned int a, const unsigned int b, bool *const pred)

Computes $\max(a, b)$, also sets the value pointed to by `pred` to $(a \geq b)$.

__host__ __device__ unsigned int __vibmin_s16x2(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)

Performs per-halfword $\min(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \leq b)$.

__host__ __device__ int __vibmin_s32(const int a, const int b, bool *const pred)

Computes $\min(a, b)$, also sets the value pointed to by `pred` to $(a \leq b)$.

__host__ __device__ unsigned int __vibmin_u16x2(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)

Performs per-halfword $\min(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \leq b)$.

__host__ __device__ unsigned int __vibmin_u32(const unsigned int a, const unsigned int b, bool *const pred)

Computes $\min(a, b)$, also sets the value pointed to by `pred` to $(a \leq b)$.

__host__ __device__ unsigned int __vimax3_s16x2(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\max(\max(a, b), c)$

__host__ __device__ unsigned int __vimax3_s16x2_relu(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\max(\max(\max(a, b), c), 0)$

__host__ __device__ int __vimax3_s32(const int a, const int b, const int c)

Computes $\max(\max(a, b), c)$

__host__ __device__ int __vimax3_s32_relu(const int a, const int b, const int c)

Computes $\max(\max(\max(a, b), c), 0)$

__host__ __device__ unsigned int __vimax3_u16x2(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\max(\max(a, b), c)$

__host__ __device__ unsigned int __vimax3_u32(const unsigned int a, const unsigned int b, const unsigned int c)

Computes $\max(\max(a, b), c)$

__host__ __device__ unsigned int __vimax_s16x2_relu(const unsigned int a, const unsigned int b)

Performs per-halfword $\max(\max(a, b), 0)$

__host__ __device__ int __vimax_s32_relu(const int a, const int b)

Computes $\max(\max(a, b), 0)$

- __host__ __device__ unsigned int __vimin3_s16x2(const unsigned int a, const unsigned int b, const unsigned int c)**
 Performs per-halfword min(min(a, b), c)
- __host__ __device__ unsigned int __vimin3_s16x2_relu(const unsigned int a, const unsigned int b, const unsigned int c)**
 Performs per-halfword max(min(min(a, b), c), 0)
- __host__ __device__ int __vimin3_s32(const int a, const int b, const int c)**
 Computes min(min(a, b), c)
- __host__ __device__ int __vimin3_s32_relu(const int a, const int b, const int c)**
 Computes max(min(min(a, b), c), 0)
- __host__ __device__ unsigned int __vimin3_u16x2(const unsigned int a, const unsigned int b, const unsigned int c)**
 Performs per-halfword min(min(a, b), c)
- __host__ __device__ unsigned int __vimin3_u32(const unsigned int a, const unsigned int b, const unsigned int c)**
 Computes min(min(a, b), c)
- __host__ __device__ unsigned int __vimin_s16x2_relu(const unsigned int a, const unsigned int b)**
 Performs per-halfword max(min(a, b), 0)
- __host__ __device__ int __vimin_s32_relu(const int a, const int b)**
 Computes max(min(a, b), 0)
- __device__ unsigned int __vmaxs2(unsigned int a, unsigned int b)**
 Performs per-halfword signed maximum computation.
- __device__ unsigned int __vmaxs4(unsigned int a, unsigned int b)**
 Computes per-byte signed maximum.
- __device__ unsigned int __vmaxu2(unsigned int a, unsigned int b)**
 Performs per-halfword unsigned maximum computation.
- __device__ unsigned int __vmaxu4(unsigned int a, unsigned int b)**
 Computes per-byte unsigned maximum.
- __device__ unsigned int __vmins2(unsigned int a, unsigned int b)**
 Performs per-halfword signed minimum computation.
- __device__ unsigned int __vmins4(unsigned int a, unsigned int b)**
 Computes per-byte signed minimum.
- __device__ unsigned int __vminu2(unsigned int a, unsigned int b)**
 Performs per-halfword unsigned minimum computation.
- __device__ unsigned int __vminu4(unsigned int a, unsigned int b)**
 Computes per-byte unsigned minimum.
- __device__ unsigned int __vneg2(unsigned int a)**
 Computes per-halfword negation.
- __device__ unsigned int __vneg4(unsigned int a)**
 Performs per-byte negation.
- __device__ unsigned int __vnegss2(unsigned int a)**
 Computes per-halfword negation with signed saturation.
- __device__ unsigned int __vnegss4(unsigned int a)**
 Performs per-byte negation with signed saturation.

- __device__ unsigned int __vsads2(unsigned int a, unsigned int b)**
Performs per-halfword sum of absolute difference of signed.
- __device__ unsigned int __vsads4(unsigned int a, unsigned int b)**
Computes per-byte sum of abs difference of signed.
- __device__ unsigned int __vsadu2(unsigned int a, unsigned int b)**
Computes per-halfword sum of abs diff of unsigned.
- __device__ unsigned int __vsadu4(unsigned int a, unsigned int b)**
Computes per-byte sum of abs difference of unsigned.
- __device__ unsigned int __vseteq2(unsigned int a, unsigned int b)**
Performs per-halfword (un)signed comparison.
- __device__ unsigned int __vseteq4(unsigned int a, unsigned int b)**
Performs per-byte (un)signed comparison.
- __device__ unsigned int __vsetges2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison.
- __device__ unsigned int __vsetges4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vsetgeu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned minimum unsigned comparison.
- __device__ unsigned int __vsetgeu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vsetgts2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison.
- __device__ unsigned int __vsetgts4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vsetgtu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned comparison.
- __device__ unsigned int __vsetgtu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vsetles2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned minimum computation.
- __device__ unsigned int __vsetles4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vsetleu2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison.
- __device__ unsigned int __vsetleu4(unsigned int a, unsigned int b)**
Performs per-byte unsigned comparison.
- __device__ unsigned int __vsetlts2(unsigned int a, unsigned int b)**
Performs per-halfword signed comparison.
- __device__ unsigned int __vsetlts4(unsigned int a, unsigned int b)**
Performs per-byte signed comparison.
- __device__ unsigned int __vsetltu2(unsigned int a, unsigned int b)**
Performs per-halfword unsigned comparison.

__device__ unsigned int __vsetltu4(unsigned int a, unsigned int b)
 Performs per-byte unsigned comparison.

__device__ unsigned int __vsetne2(unsigned int a, unsigned int b)
 Performs per-halfword (un)signed comparison.

__device__ unsigned int __vsetne4(unsigned int a, unsigned int b)
 Performs per-byte (un)signed comparison.

__device__ unsigned int __vsub2(unsigned int a, unsigned int b)
 Performs per-halfword (un)signed subtraction, with wrap-around.

__device__ unsigned int __vsub4(unsigned int a, unsigned int b)
 Performs per-byte subtraction.

__device__ unsigned int __vsubss2(unsigned int a, unsigned int b)
 Performs per-halfword (un)signed subtraction, with signed saturation.

__device__ unsigned int __vsubss4(unsigned int a, unsigned int b)
 Performs per-byte subtraction with signed saturation.

__device__ unsigned int __vsubus2(unsigned int a, unsigned int b)
 Performs per-halfword subtraction with unsigned saturation.

__device__ unsigned int __vsubus4(unsigned int a, unsigned int b)
 Performs per-byte subtraction with unsigned saturation.

11.1. Functions

__device__ unsigned int __vabs2(unsigned int a)
 Computes per-halfword absolute value.

Splits 4 bytes of argument into 2 parts, each consisting of 2 bytes, then computes absolute value for each of parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

__device__ unsigned int __vabs4(unsigned int a)
 Computes per-byte absolute value.

Splits argument by bytes. Computes absolute value of each byte. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

__device__ unsigned int __vabsdiffs2(unsigned int a, unsigned int b)
 Computes per-halfword sum of absolute difference of signed integer.

Splits 4 bytes of each into 2 parts, each consisting of 2 bytes. For corresponding parts function computes absolute difference. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vabsdiffs4(unsigned int a, unsigned int b)`

Computes per-byte absolute difference of signed integer.

Splits 4 bytes of each into 4 parts, each consisting of 1 byte. For corresponding parts function computes absolute difference. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vabsdiffu2(unsigned int a, unsigned int b)`

Performs per-halfword absolute difference of unsigned integer computation: $|a - b|$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes absolute difference. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vabsdiffu4(unsigned int a, unsigned int b)`

Computes per-byte absolute difference of unsigned integer.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes absolute difference. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vabsss2(unsigned int a)`

Computes per-halfword absolute value with signed saturation.

Splits 4 bytes of argument into 2 parts, each consisting of 2 bytes, then computes absolute value with signed saturation for each of parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vabsss4(unsigned int a)`

Computes per-byte absolute value with signed saturation.

Splits 4 bytes of argument into 4 parts, each consisting of 1 byte, then computes absolute value with signed saturation for each of parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vadd2(unsigned int a, unsigned int b)`

Performs per-halfword (un)signed addition, with wrap-around: $a + b$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then performs unsigned addition on corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vadd4(unsigned int a, unsigned int b)`

Performs per-byte (un)signed addition.

Splits 'a' into 4 bytes, then performs unsigned addition on each of these bytes with the corresponding byte from 'b', ignoring overflow. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vaddss2(unsigned int a, unsigned int b)`

Performs per-halfword addition with signed saturation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then performs addition with signed saturation on corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vaddss4(unsigned int a, unsigned int b)`

Performs per-byte addition with signed saturation.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte, then performs addition with signed saturation on corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vaddus2(unsigned int a, unsigned int b)`

Performs per-halfword addition with unsigned saturation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then performs addition with unsigned saturation on corresponding parts.

Returns

Returns computed value.

`__device__ unsigned int __vaddus4(unsigned int a, unsigned int b)`

Performs per-byte addition with unsigned saturation.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte, then performs addition with unsigned saturation on corresponding parts.

Returns

Returns computed value.

`__device__ unsigned int __vavgs2(unsigned int a, unsigned int b)`

Performs per-halfword signed rounded average computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then computes signed rounded average of corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vavgs4(unsigned int a, unsigned int b)`

Computes per-byte signed rounded average.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. then computes signed rounded average of corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vavgu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned rounded average computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then computes unsigned rounded average of corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vavgu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned rounded average.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. then computes unsigned rounded average of corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vcmpeq2(unsigned int a, unsigned int b)`

Performs per-halfword (un)signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is ffff if they are equal, and 0000 otherwise. For example `__vcmpeq2(0x1234aba5, 0x1234aba6)` returns `0xffff0000`.

Returns

Returns `0xffff` computed value.

`__device__ unsigned int __vcmpeq4(unsigned int a, unsigned int b)`

Performs per-byte (un)signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is ff if they are equal, and 00 otherwise. For example `__vcmpeq4(0x1234aba5, 0x1234aba6)` returns `0xffffff00`.

Returns

Returns `0xff` if `a = b`, else returns `0`.

`__device__ unsigned int __vcmpges2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison: `a >= b ? 0xffff : 0`.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is ffff if 'a' part `>=` 'b' part, and 0000 otherwise. For example `__vcmpges2(0x1234aba5, 0x1234aba6)` returns `0xffff0000`.

Returns

Returns `0xffff` if `a >= b`, else returns `0`.

`__device__ unsigned int __vcmpges4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is ff if 'a' part `>=` 'b' part, and 00 otherwise. For example `__vcmpges4(0x1234aba5, 0x1234aba6)` returns `0xffffff00`.

Returns

Returns `0xff` if `a >= b`, else returns `0`.

`__device__ unsigned int __vcmpgeu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned comparison: $a \geq b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part \geq 'b' part, and `0000` otherwise. For example `__vcmpgeu2(0x1234aba5, 0x1234aba6)` returns `0xffff0000`.

Returns

Returns `0xffff` if $a \geq b$, else returns `0`.

`__device__ unsigned int __vcmpgeu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part \geq 'b' part, and `00` otherwise. For example `__vcmpgeu4(0x1234aba5, 0x1234aba6)` returns `0xffffff00`.

Returns

Returns `0xff` if $a \geq b$, else returns `0`.

`__device__ unsigned int __vcmpgts2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison: $a > b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part $>$ 'b' part, and `0000` otherwise. For example `__vcmpgts2(0x1234aba5, 0x1234aba6)` returns `0x00000000`.

Returns

Returns `0xffff` if $a > b$, else returns `0`.

`__device__ unsigned int __vcmpgts4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part $>$ 'b' part, and `00` otherwise. For example `__vcmpgts4(0x1234aba5, 0x1234aba6)` returns `0x00000000`.

Returns

Returns `0xff` if $a > b$, else returns `0`.

`__device__ unsigned int __vcmpgtu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned comparison: $a > b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part $>$ 'b' part, and `0000` otherwise. For example `__vcmpgtu2(0x1234aba5, 0x1234aba6)` returns `0x00000000`.

Returns

Returns `0xffff` if $a > b$, else returns `0`.

`__device__ unsigned int __vcmpgtu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part $>$ 'b' part, and `00` otherwise. For example `__vcmpgtu4(0x1234aba5, 0x1234aba6)` returns `0x00000000`.

Returns

Returns `0xff` if $a > b$, else returns `0`.

`__device__ unsigned int __vcmples2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison: $a \leq b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part \leq 'b' part, and `0000` otherwise. For example `__vcmples2(0x1234aba5, 0x1234aba6)` returns `0xffffffff`.

Returns

Returns `0xffff` if $a \leq b$, else returns `0`.

`__device__ unsigned int __vcmples4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part \leq 'b' part, and `00` otherwise. For example `__vcmples4(0x1234aba5, 0x1234aba6)` returns `0xffffffff`.

Returns

Returns `0xff` if $a \leq b$, else returns `0`.

`__device__ unsigned int __vcmpleu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned comparison: $a \leq b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part \leq 'b' part, and `0000` otherwise. For example `__vcmpleu2(0x1234aba5, 0x1234aba6)` returns `0xffffffff`.

Returns

Returns `0xffff` if $a \leq b$, else returns `0`.

`__device__ unsigned int __vcmpleu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part \leq 'b' part, and `00` otherwise. For example `__vcmpleu4(0x1234aba5, 0x1234aba6)` returns `0xffffffff`.

Returns

Returns `0xff` if $a \leq b$, else returns `0`.

`__device__ unsigned int __vcmplts2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison: $a < b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part $<$ 'b' part, and `0000` otherwise. For example `__vcmplts2(0x1234aba5, 0x1234aba6)` returns `0x0000ffff`.

Returns

Returns `0xffff` if $a < b$, else returns `0`.

`__device__ unsigned int __vcmplts4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part $<$ 'b' part, and `00` otherwise. For example `__vcmplts4(0x1234aba5, 0x1234aba6)` returns `0x000000ff`.

Returns

Returns `0xff` if $a < b$, else returns `0`.

`__device__ unsigned int __vcmp1tu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned comparison: $a < b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part < 'b' part, and `0000` otherwise. For example `__vcmp1tu2(0x1234aba5, 0x1234aba6)` returns `0x0000ffff`.

Returns

Returns `0xffff` if $a < b$, else returns `0`.

`__device__ unsigned int __vcmp1tu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part < 'b' part, and `00` otherwise. For example `__vcmp1tu4(0x1234aba5, 0x1234aba6)` returns `0x000000ff`.

Returns

Returns `0xff` if $a < b$, else returns `0`.

`__device__ unsigned int __vcmpne2(unsigned int a, unsigned int b)`

Performs per-halfword (un)signed comparison: $a != b ? 0xffff : 0$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts result is `ffff` if 'a' part != 'b' part, and `0000` otherwise. For example `__vcmpne2(0x1234aba5, 0x1234aba6)` returns `0x0000ffff`.

Returns

Returns `0xffff` if $a != b$, else returns `0`.

`__device__ unsigned int __vcmpne4(unsigned int a, unsigned int b)`

Performs per-byte (un)signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts result is `ff` if 'a' part != 'b' part, and `00` otherwise. For example `__vcmpne4(0x1234aba5, 0x1234aba6)` returns `0x000000ff`.

Returns

Returns `0xff` if $a != b$, else returns `0`.

`__device__ unsigned int __vhaddu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned average computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then computes unsigned average of corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vhaddu4(unsigned int a, unsigned int b)`

Computes per-byte unsigned average.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. then computes unsigned average of corresponding parts. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmax_s16x2(const unsigned int a, const unsigned int b, const unsigned int c)`

Performs per-halfword $\max(a + b, c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs an add and compare: $\max(a_part + b_part), c_part$) Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmax_s16x2_relu(const unsigned int a, const unsigned int b, const unsigned int c)`

Performs per-halfword $\max(\max(a + b, c), 0)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs an add, followed by a max with relu: $\max(\max(a_part + b_part), c_part), 0$) Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ int __viaddmax_s32(const int a, const int b, const int c)`

Computes $\max(a + b, c)$

Calculates the sum of signed integers a and b and takes the max with c.

Returns

Returns computed value.

`__host__ __device__ int __viaddmax_s32_relu(const int a, const int b, const int c)`

Computes $\max(\max(a + b, c), 0)$

Calculates the sum of signed integers a and b and takes the max with c. If the result is less than 0 then 0 is returned.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmax_u16x2(const unsigned int a, const unsigned int b, const unsigned int c)`

Performs per-halfword $\max(a + b, c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as unsigned shorts. For corresponding parts function performs an add and compare: $\max(a_part + b_part), c_part$) Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmax_u32(const unsigned int a, const unsigned int b, const unsigned int c)`

Computes $\max(a + b, c)$

Calculates the sum of unsigned integers a and b and takes the max with c.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmin_s16x2`(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\min(a + b, c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs an add and compare: $\min(a_part + b_part), c_part$) Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmin_s16x2_relu`(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\max(\min(a + b, c), 0)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs an add, followed by a min with relu: $\max(\min(a_part + b_part), c_part), 0$) Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ int __viaddmin_s32`(const int a, const int b, const int c)

Computes $\min(a + b, c)$

Calculates the sum of signed integers a and b and takes the min with c.

Returns

Returns computed value.

`__host__ __device__ int __viaddmin_s32_relu`(const int a, const int b, const int c)

Computes $\max(\min(a + b, c), 0)$

Calculates the sum of signed integers a and b and takes the min with c. If the result is less than 0 then 0 is returned.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmin_u16x2`(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\min(a + b, c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as unsigned shorts. For corresponding parts function performs an add and compare: $\min(a_part + b_part), c_part$) Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __viaddmin_u32`(const unsigned int a, const unsigned int b, const unsigned int c)

Computes $\min(a + b, c)$

Calculates the sum of unsigned integers a and b and takes the min with c.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vibmax_s16x2`(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)

Performs per-halfword $\max(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \geq b)$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a maximum ($= \max(a_part, b_part)$). Partial results are recombined and returned as unsigned int. Sets the value pointed to by `pred_hi` to the value $(a_high_part \geq b_high_part)$. Sets the value pointed to by `pred_lo` to the value $(a_low_part \geq b_low_part)$.

Returns

Returns computed values.

`__host__ __device__ int __vibmax_s32`(const int a, const int b, bool *const pred)

Computes $\max(a, b)$, also sets the value pointed to by `pred` to $(a \geq b)$.

Calculates the maximum of a and b of two signed ints. Also sets the value pointed to by `pred` to the value $(a \geq b)$.

Returns

Returns computed values.

`__host__ __device__ unsigned int __vibmax_u16x2`(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)

Performs per-halfword $\max(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \geq b)$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as unsigned shorts. For corresponding parts function performs a maximum ($= \max(a_part, b_part)$). Partial results are recombined and returned as unsigned int. Sets the value pointed to by `pred_hi` to the value $(a_high_part \geq b_high_part)$. Sets the value pointed to by `pred_lo` to the value $(a_low_part \geq b_low_part)$.

Returns

Returns computed values.

`__host__ __device__ unsigned int __vibmax_u32`(const unsigned int a, const unsigned int b, bool *const pred)

Computes $\max(a, b)$, also sets the value pointed to by `pred` to $(a \geq b)$.

Calculates the maximum of a and b of two unsigned ints. Also sets the value pointed to by `pred` to the value $(a \geq b)$.

Returns

Returns computed values.

`__host__ __device__ unsigned int __vibmin_s16x2`(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)

Performs per-halfword $\min(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \leq b)$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a maximum ($= \max(a_part, b_part)$). Partial results are recombined and returned as unsigned int. Sets the value pointed to by `pred_hi` to the value $(a_high_part \leq b_high_part)$. Sets the value pointed to by `pred_lo` to the value $(a_low_part \leq b_low_part)$.

Returns

Returns computed values.

`__host__ __device__ int __vibmin_s32(const int a, const int b, bool *const pred)`

Computes $\min(a, b)$, also sets the value pointed to by `pred` to $(a \leq b)$.

Calculates the minimum of `a` and `b` of two signed ints. Also sets the value pointed to by `pred` to the value $(a \leq b)$.

Returns

Returns computed values.

`__host__ __device__ unsigned int __vibmin_u16x2(const unsigned int a, const unsigned int b, bool *const pred_hi, bool *const pred_lo)`

Performs per-halfword $\min(a, b)$, also sets the value pointed to by `pred_hi` and `pred_lo` to the per-halfword result of $(a \leq b)$.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as unsigned shorts. For corresponding parts function performs a maximum ($= \max(a_part, b_part)$). Partial results are recombined and returned as unsigned int. Sets the value pointed to by `pred_hi` to the value $(a_high_part \leq b_high_part)$. Sets the value pointed to by `pred_lo` to the value $(a_low_part \leq b_low_part)$.

Returns

Returns computed values.

`__host__ __device__ unsigned int __vibmin_u32(const unsigned int a, const unsigned int b, bool *const pred)`

Computes $\min(a, b)$, also sets the value pointed to by `pred` to $(a \leq b)$.

Calculates the minimum of `a` and `b` of two unsigned ints. Also sets the value pointed to by `pred` to the value $(a \leq b)$.

Returns

Returns computed values.

`__host__ __device__ unsigned int __vimax3_s16x2(const unsigned int a, const unsigned int b, const unsigned int c)`

Performs per-halfword $\max(\max(a, b), c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a 3-way max ($= \max(\max(a_part, b_part), c_part)$). Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vimax3_s16x2_relu(const unsigned int a, const unsigned int b, const unsigned int c)`

Performs per-halfword $\max(\max(\max(a, b), c), 0)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a three-way max with `relu` ($= \max(a_part, b_part, c_part, 0)$). Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ int __vimax3_s32(const int a, const int b, const int c)`

Computes $\max(\max(a, b), c)$

Calculates the 3-way max of signed integers `a`, `b` and `c`.

Returns

Returns computed value.

`__host__ __device__ int __vimax3_s32_relu(const int a, const int b, const int c)`

Computes $\max(\max(\max(a, b), c), 0)$

Calculates the maximum of three signed ints, if this is less than 0 then 0 is returned.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vimax3_u16x2(const unsigned int a, const unsigned int b,
const unsigned int c)`

Performs per-halfword $\max(\max(a, b), c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as unsigned shorts. For corresponding parts function performs a 3-way max (= $\max(\max(a_part, b_part), c_part)$). Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vimax3_u32(const unsigned int a, const unsigned int b, const
unsigned int c)`

Computes $\max(\max(a, b), c)$

Calculates the 3-way max of unsigned integers a, b and c.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vimax_s16x2_relu(const unsigned int a, const unsigned int
b)`

Performs per-halfword $\max(\max(a, b), 0)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a max with relu (= $\max(a_part, b_part, 0)$). Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ int __vimax_s32_relu(const int a, const int b)`

Computes $\max(\max(a, b), 0)$

Calculates the maximum of a and b of two signed ints, if this is less than 0 then 0 is returned.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vimin3_s16x2(const unsigned int a, const unsigned int b,
const unsigned int c)`

Performs per-halfword $\min(\min(a, b), c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a 3-way min (= $\min(\min(a_part, b_part), c_part)$). Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vmin3_s16x2_relu`(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\max(\min(\min(a, b), c), 0)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a three-way min with $\text{relu} (= \max(\min(a_part, b_part, c_part), 0))$. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ int __vmin3_s32`(const int a, const int b, const int c)

Computes $\min(\min(a, b), c)$

Calculates the 3-way min of signed integers a, b and c.

Returns

Returns computed value.

`__host__ __device__ int __vmin3_s32_relu`(const int a, const int b, const int c)

Computes $\max(\min(\min(a, b), c), 0)$

Calculates the minimum of three signed ints, if this is less than 0 then 0 is returned.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vmin3_u16x2`(const unsigned int a, const unsigned int b, const unsigned int c)

Performs per-halfword $\min(\min(a, b), c)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as unsigned shorts. For corresponding parts function performs a 3-way min ($= \min(\min(a_part, b_part), c_part)$). Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vmin3_u32`(const unsigned int a, const unsigned int b, const unsigned int c)

Computes $\min(\min(a, b), c)$

Calculates the 3-way min of unsigned integers a, b and c.

Returns

Returns computed value.

`__host__ __device__ unsigned int __vmin_s16x2_relu`(const unsigned int a, const unsigned int b)

Performs per-halfword $\max(\min(a, b), 0)$

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. These 2 byte parts are interpreted as signed shorts. For corresponding parts function performs a min with $\text{relu} (= \max(\min(a_part, b_part), 0))$. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__host__ __device__ int __vmin_s32_relu(const int a, const int b)`

Computes $\max(\min(a, b), 0)$

Calculates the minimum of a and b of two signed ints, if this is less than 0 then 0 is returned.

Returns

Returns computed value.

`__device__ unsigned int __vmaxs2(unsigned int a, unsigned int b)`

Performs per-halfword signed maximum computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes signed maximum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vmaxs4(unsigned int a, unsigned int b)`

Computes per-byte signed maximum.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes signed maximum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vmaxu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned maximum computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes unsigned maximum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vmaxu4(unsigned int a, unsigned int b)`

Computes per-byte unsigned maximum.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes unsigned maximum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vmins2(unsigned int a, unsigned int b)`

Performs per-halfword signed minimum computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes signed minimum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vmins4(unsigned int a, unsigned int b)`

Computes per-byte signed minimum.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes signed minimum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vminu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned minimum computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes unsigned minimum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vminu4(unsigned int a, unsigned int b)`

Computes per-byte unsigned minimum.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes unsigned minimum. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vneg2(unsigned int a)`

Computes per-halfword negation.

Splits 4 bytes of argument into 2 parts, each consisting of 2 bytes. For each part function computes negation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vneg4(unsigned int a)`

Performs per-byte negation.

Splits 4 bytes of argument into 4 parts, each consisting of 1 byte. For each part function computes negation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vnegss2(unsigned int a)`

Computes per-halfword negation with signed saturation.

Splits 4 bytes of argument into 2 parts, each consisting of 2 bytes. For each part function computes negation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vnegss4(unsigned int a)`

Performs per-byte negation with signed saturation.

Splits 4 bytes of argument into 4 parts, each consisting of 1 byte. For each part function computes negation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsads2(unsigned int a, unsigned int b)`

Performs per-halfword sum of absolute difference of signed.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes absolute difference and sum it up. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsads4(unsigned int a, unsigned int b)`

Computes per-byte sum of abs difference of signed.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes absolute difference and sum it up. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsadu2(unsigned int a, unsigned int b)`

Computes per-halfword sum of abs diff of unsigned.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function computes absolute differences and returns sum of those differences.

Returns

Returns computed value.

`__device__ unsigned int __vsadu4(unsigned int a, unsigned int b)`

Computes per-byte sum of abs difference of unsigned.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function computes absolute differences and returns sum of those differences.

Returns

Returns computed value.

`__device__ unsigned int __vseteq2(unsigned int a, unsigned int b)`

Performs per-halfword (un)signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part == 'b' part. If both equalities are satisfied, function returns 1.

Returns

Returns 1 if a = b, else returns 0.

`__device__ unsigned int __vseteq4(unsigned int a, unsigned int b)`

Performs per-byte (un)signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part == 'b' part. If both equalities are satisfied, function returns 1.

Returns

Returns 1 if a = b, else returns 0.

`__device__ unsigned int __vsetges2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part >= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a >= b, else returns 0.

`__device__ unsigned int __vsetges4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part >= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a >= b, else returns 0.

`__device__ unsigned int __vsetgeu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned minimum unsigned comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part >= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a >= b, else returns 0.

`__device__ unsigned int __vsetgeu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part >= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a >= b, else returns 0.

`__device__ unsigned int __vsetgts2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part > 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a > b, else returns 0.

`__device__ unsigned int __vsetgts4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part > 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a > b, else returns 0.

`__device__ unsigned int __vsetgtu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part > 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a > b, else returns 0.

`__device__ unsigned int __vsetgtu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part > 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a > b, else returns 0.

`__device__ unsigned int __vsetles2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned minimum computation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a <= b, else returns 0.

`__device__ unsigned int __vsetles4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a <= b, else returns 0.

`__device__ unsigned int __vsetleu2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a <= b, else returns 0.

`__device__ unsigned int __vsetleu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 part, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a <= b, else returns 0.

`__device__ unsigned int __vsetlts2(unsigned int a, unsigned int b)`

Performs per-halfword signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a < b, else returns 0.

`__device__ unsigned int __vset1ts4(unsigned int a, unsigned int b)`

Performs per-byte signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a < b, else returns 0.

`__device__ unsigned int __vset1tu2(unsigned int a, unsigned int b)`

Performs per-halfword unsigned comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a < b, else returns 0.

`__device__ unsigned int __vset1tu4(unsigned int a, unsigned int b)`

Performs per-byte unsigned comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part <= 'b' part. If both inequalities are satisfied, function returns 1.

Returns

Returns 1 if a < b, else returns 0.

`__device__ unsigned int __vsetne2(unsigned int a, unsigned int b)`

Performs per-halfword (un)signed comparison.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs comparison 'a' part != 'b' part. If both conditions are satisfied, function returns 1.

Returns

Returns 1 if a != b, else returns 0.

`__device__ unsigned int __vsetne4(unsigned int a, unsigned int b)`

Performs per-byte (un)signed comparison.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs comparison 'a' part != 'b' part. If both conditions are satisfied, function returns 1.

Returns

Returns 1 if a != b, else returns 0.

`__device__ unsigned int __vsub2(unsigned int a, unsigned int b)`

Performs per-halfword (un)signed subtraction, with wrap-around.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs subtraction. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsub4`(unsigned int a, unsigned int b)

Performs per-byte subtraction.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs subtraction. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsubss2`(unsigned int a, unsigned int b)

Performs per-halfword (un)signed subtraction, with signed saturation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs subtraction with signed saturation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsubss4`(unsigned int a, unsigned int b)

Performs per-byte subtraction with signed saturation.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs subtraction with signed saturation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsubus2`(unsigned int a, unsigned int b)

Performs per-halfword subtraction with unsigned saturation.

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes. For corresponding parts function performs subtraction with unsigned saturation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

`__device__ unsigned int __vsubus4`(unsigned int a, unsigned int b)

Performs per-byte subtraction with unsigned saturation.

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte. For corresponding parts function performs subtraction with unsigned saturation. Partial results are recombined and returned as unsigned int.

Returns

Returns computed value.

Chapter 12. Structs

12.1. `__half`

struct `__half`

`__half` data type

This structure implements the datatype for storing half-precision floating-point numbers. The structure implements assignment, arithmetic and comparison operators, and type conversions. 16 bits are being used in total: 1 sign bit, 5 bits for the exponent, and the significand is being stored in 10 bits. The total precision is 11 bits. There are 15361 representable numbers within the interval [0.0, 1.0], endpoints included. On average we have $\log_{10}(2^{11}) \sim 3.311$ decimal digits.

The objective here is to provide IEEE754-compliant implementation of `binary16` type and arithmetic with limitations due to device HW not supporting floating-point exceptions.

Public Functions

`__half()` = default

Constructor by default.

Empty default constructor, result is uninitialized.

`__host__ __device__ inline constexpr __half(const __half_raw &hr)`

Constructor from `__half_raw`.

`__host__ __device__ explicit __half(const __nv_bfloat16 f)`

Construct `__half` from `__nv_bfloat16` input using default round-to-nearest-even rounding mode.

Need to include the header file `cuda_bf16.h`

`__host__ __device__ inline __half(const double f)`

Construct `__half` from `double` input using default round-to-nearest-even rounding mode.

See also:

`__double2half(double)` for further details.

`__host__ __device__ inline __half(const float f)`

Construct `__half` from `float` input using default round-to-nearest-even rounding mode.

See also:

[__float2half\(float\)](#) for further details.

`__host__ __device__ inline __half(const int val)`

Construct `__half` from `int` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const long long val)`

Construct `__half` from `long long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const long val)`

Construct `__half` from `long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const short val)`

Construct `__half` from `short` integer input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const unsigned int val)`

Construct `__half` from `unsigned int` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const unsigned long long val)`

Construct `__half` from `unsigned long long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const unsigned long val)`

Construct `__half` from `unsigned long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __half(const unsigned short val)`

Construct `__half` from `unsigned short` integer input using default round-to-nearest-even rounding mode.

`__host__ __device__ operator __half_raw() const`

Type cast to `__half_raw` operator.

`__host__ __device__ operator __half_raw() volatile const`

Type cast to `__half_raw` operator with volatile input.

`__host__ __device__ inline constexpr operator bool() const`

Conversion operator to `bool` data type.

+0 and -0 inputs convert to `false`. Non-zero inputs convert to `true`.

`__host__ __device__ operator char() const`

Conversion operator to an implementation defined `char` data type.

Using round-toward-zero rounding mode.

Detects signedness of the `char` type and proceeds accordingly, see further details in [__half2char_rz\(__half\)](#) and [__half2uchar_rz\(__half\)](#).

`__host__ __device__ operator float() const`

Type cast to `float` operator.

`__host__ __device__ operator int()` const
Conversion operator to `int` data type.
Using round-toward-zero rounding mode.

See also:

[`__half2int_rz\(__half\)`](#) for further details.

`__host__ __device__ operator long()` const
Conversion operator to `long` data type.
Using round-toward-zero rounding mode.

Detects size of the `long` type and proceeds accordingly, see further details in [`__half2int_rz\(__half\)`](#) and [`__half2ll_rz\(__half\)`](#).

`__host__ __device__ operator long long()` const
Conversion operator to `long long` data type.
Using round-toward-zero rounding mode.

See also:

[`__half2ll_rz\(__half\)`](#) for further details.

`__host__ __device__ operator short()` const
Conversion operator to `short` data type.
Using round-toward-zero rounding mode.

See also:

[`__half2short_rz\(__half\)`](#) for further details.

`__host__ __device__ operator signed char()` const
Conversion operator to `signed char` data type.
Using round-toward-zero rounding mode.

See also:

[`__half2char_rz\(__half\)`](#) for further details.

`__host__ __device__ operator unsigned char()` const
Conversion operator to `unsigned char` data type.
Using round-toward-zero rounding mode.

See also:

[`__half2uchar_rz\(__half\)`](#) for further details.

`__host__ __device__ operator unsigned int()` const
 Conversion operator to unsigned int data type.
 Using round-toward-zero rounding mode.

See also:

[`__half2uint_rz\(__half\)`](#) for further details.

`__host__ __device__ operator unsigned long()` const
 Conversion operator to unsigned long data type.
 Using round-toward-zero rounding mode.

Detects size of the unsigned long type and proceeds accordingly, see further details in [`__half2uint_rz\(__half\)`](#) and [`__half2ull_rz\(__half\)`](#).

`__host__ __device__ operator unsigned long long()` const
 Conversion operator to unsigned long long data type.
 Using round-toward-zero rounding mode.

See also:

[`__half2ull_rz\(__half\)`](#) for further details.

`__host__ __device__ operator unsigned short()` const
 Conversion operator to unsigned short data type.
 Using round-toward-zero rounding mode.

See also:

[`__half2ushort_rz\(__half\)`](#) for further details.

`__host__ __device__ __half &operator=(const __half_raw &hr)`
 Assignment operator from [`__half_raw`](#).

`__host__ __device__ volatile __half &operator=(const __half_raw &hr) volatile`
 Assignment operator from [`__half_raw`](#) to volatile [`__half`](#).

`__host__ __device__ __half &operator=(const double f)`
 Type cast to [`__half`](#) assignment operator from double input using default round-to-nearest-even rounding mode.

See also:

[`__double2half\(double\)`](#) for further details.

`__host__ __device__ __half &operator=(const float f)`

Type cast to [`__half`](#) assignment operator from float input using default round-to-nearest-even rounding mode.

See also:

[`__float2half\(float\)`](#) for further details.

- `__host__ __device__ __half &operator=(const int val)`
Type cast from `int` assignment operator, using default round-to-nearest-even rounding mode.
- `__host__ __device__ __half &operator=(const long long val)`
Type cast from `long long` assignment operator, using default round-to-nearest-even rounding mode.
- `__host__ __device__ __half &operator=(const short val)`
Type cast from `short` assignment operator, using default round-to-nearest-even rounding mode.
- `__host__ __device__ __half &operator=(const unsigned int val)`
Type cast from `unsigned int` assignment operator, using default round-to-nearest-even rounding mode.
- `__host__ __device__ __half &operator=(const unsigned long long val)`
Type cast from `unsigned long long` assignment operator, using default round-to-nearest-even rounding mode.
- `__host__ __device__ __half &operator=(const unsigned short val)`
Type cast from `unsigned short` assignment operator, using default round-to-nearest-even rounding mode.
- `__host__ __device__ volatile __half &operator=(volatile const __half_raw &hr) volatile`
Assignment operator from volatile `__half_raw` to volatile `__half`.

12.2. `__half2`

struct `__half2`

`__half2` data type

This structure implements the datatype for storing two half-precision floating-point numbers. The structure implements assignment, arithmetic and comparison operators, and type conversions.

- NOTE: `__half2` is visible to non-nvcc host compilers

Public Functions

`__half2()` = default

Constructor by default.

Empty default constructor, result is uninitialized.

`__host__ __device__ inline constexpr __half2(const __half &a, const __half &b)`

Constructor from two `__half` variables.

`__host__ __device__ inline __half2(const __half2 &&src)`

Move constructor, available for C++11 and later dialects.

```
__host__ __device__ inline __half2(const __half2 &src)
    Copy constructor.

__host__ __device__ inline __half2(const __half2_raw &h2r)
    Constructor from __half2_raw.

__host__ __device__ operator __half2_raw() const
    Conversion operator to __half2_raw.

__host__ __device__ __half2 &operator=(const __half2 &&src)
    Move assignment operator, available for C++11 and later dialects.

__host__ __device__ __half2 &operator=(const __half2 &src)
    Copy assignment operator.

__host__ __device__ __half2 &operator=(const __half2_raw &h2r)
    Assignment operator from __half2_raw.
```

Public Members

```
__half x
    Storage field holding lower __half part.

__half y
    Storage field holding upper __half part.
```

12.3. __half2_raw

```
struct __half2_raw
    __half2_raw data type
    Type allows static initialization of half2 until it becomes a builtin type.
```

- ▶ Note: this initialization is as a bit-field representation of half2, and not a conversion from short2 to half2. Such representation will be deprecated in a future version of CUDA.
- ▶ Note: this is visible to non-nvcc compilers, including C-only compilations

Public Members

```
unsigned short x
    Storage field contains bits of the lower half part.

unsigned short y
    Storage field contains bits of the upper half part.
```


12.4. `__half_raw`

struct `__half_raw`

`__half_raw` data type

Type allows static initialization of `half` until it becomes a builtin type.

- ▶ Note: this initialization is as a bit-field representation of `half`, and not a conversion from `short` to `half`. Such representation will be deprecated in a future version of CUDA.
- ▶ Note: this is visible to non-nvcc compilers, including C-only compilations

Public Members

unsigned short `x`

Storage field contains bits representation of the `half` floating-point number.

12.5. `__nv_bfloat16`

struct `__nv_bfloat16`

`nv_bfloat16` datatype

This structure implements the datatype for storing `nv_bfloat16` floating-point numbers. The structure implements assignment operators and type conversions. 16 bits are being used in total: 1 sign bit, 8 bits for the exponent, and the significand is being stored in 7 bits. The total precision is 8 bits.

Public Functions

`__nv_bfloat16()` = default

Constructor by default.

Empty default constructor, result is uninitialized.

`__host__ __device__ inline explicit __nv_bfloat16(const __half f)`

Construct `__nv_bfloat16` from `__half` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline constexpr __nv_bfloat16(const __nv_bfloat16_raw &hr)`

Constructor from `__nv_bfloat16_raw`.

`__host__ __device__ inline __nv_bfloat16(const double f)`

Construct `__nv_bfloat16` from `double` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(const float f)`
 Construct `__nv_bfloat16` from `float` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(const long val)`
 Construct `__nv_bfloat16` from `long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(const unsigned long val)`
 Construct `__nv_bfloat16` from unsigned `long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(int val)`
 Construct `__nv_bfloat16` from `int` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(long long val)`
 Construct `__nv_bfloat16` from `long long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(short val)`
 Construct `__nv_bfloat16` from `short` integer input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(unsigned int val)`
 Construct `__nv_bfloat16` from unsigned `int` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(unsigned long long val)`
 Construct `__nv_bfloat16` from unsigned `long long` input using default round-to-nearest-even rounding mode.

`__host__ __device__ inline __nv_bfloat16(unsigned short val)`
 Construct `__nv_bfloat16` from unsigned `short` integer input using default round-to-nearest-even rounding mode.

`__host__ __device__ operator __nv_bfloat16_raw() const`
 Type cast to `__nv_bfloat16_raw` operator.

`__host__ __device__ operator __nv_bfloat16_raw() volatile const`
 Type cast to `__nv_bfloat16_raw` operator with `volatile` input.

`__host__ __device__ inline constexpr operator bool() const`
 Conversion operator to `bool` data type.
 +0 and -0 inputs convert to `false`. Non-zero inputs convert to `true`.

`__host__ __device__ operator char() const`
 Conversion operator to an implementation defined `char` data type.
 Using round-toward-zero rounding mode.
 Detects signedness of the `char` type and proceeds accordingly, see further details in signed and unsigned `char` operators.

`__host__ __device__ operator float() const`
 Type cast to `float` operator.

`__host__ __device__ operator int() const`
 Conversion operator to int data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162int_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator long() const`
 Conversion operator to long data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162ll_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator long long() const`
 Conversion operator to long long data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162ll_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator short() const`
 Conversion operator to short data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162short_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator signed char() const`
 Conversion operator to signed char data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162char_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator unsigned char() const`
 Conversion operator to unsigned char data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162uchar_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator unsigned int() const`
 Conversion operator to unsigned int data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162uint_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator unsigned long() const`
 Conversion operator to unsigned long data type.
 Using round-toward-zero rounding mode.

`__host__ __device__ operator unsigned long long() const`
 Conversion operator to unsigned long long data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162ull_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ operator unsigned short() const`
 Conversion operator to unsigned short data type.
 Using round-toward-zero rounding mode.
 See [__bfloat162ushort_rz\(__nv_bfloat16\)](#) for further details

`__host__ __device__ __nv_bfloat16 &operator=(const __nv_bfloat16_raw &hr)`
 Assignment operator from `__nv_bfloat16_raw`.

`__host__ __device__ volatile __nv_bfloat16 &operator=(const __nv_bfloat16_raw &hr) volatile`
 Assignment operator from `__nv_bfloat16_raw` to volatile `__nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 &operator=(const double f)`
 Type cast to `__nv_bfloat16` assignment operator from double input using default round-to-nearest-even rounding mode.

`__host__ __device__ __nv_bfloat16 &operator=(const float f)`
 Type cast to `__nv_bfloat16` assignment operator from float input using default round-to-nearest-even rounding mode.

`__host__ __device__ volatile __nv_bfloat16 &operator=(volatile const __nv_bfloat16_raw &hr) volatile`
 Assignment operator from volatile `__nv_bfloat16_raw` to volatile `__nv_bfloat16`.

`__host__ __device__ __nv_bfloat16 &operator=(int val)`
 Type cast from `int` assignment operator, using default round-to-nearest-even rounding mode.

`__host__ __device__ __nv_bfloat16 &operator=(long long val)`
 Type cast from `long long` assignment operator, using default round-to-nearest-even rounding mode.

`__host__ __device__ __nv_bfloat16 &operator=(short val)`
 Type cast from `short` assignment operator, using default round-to-nearest-even rounding mode.

`__host__ __device__ __nv_bfloat16 &operator=(unsigned int val)`
 Type cast from `unsigned int` assignment operator, using default round-to-nearest-even rounding mode.

`__host__ __device__ __nv_bfloat16 &operator=(unsigned long long val)`
 Type cast from `unsigned long long` assignment operator, using default round-to-nearest-even rounding mode.

`__host__ __device__ __nv_bfloat16 &operator=(unsigned short val)`
 Type cast from `unsigned short` assignment operator, using default round-to-nearest-even rounding mode.

12.6. `__nv_bfloat162`

`struct __nv_bfloat162`

`nv_bfloat162` datatype

This structure implements the datatype for storing two `nv_bfloat16` floating-point numbers. The structure implements assignment, arithmetic and comparison operators, and type conversions.

► NOTE: `__nv_bfloat162` is visible to non-nvcc host compilers

Public Functions

`__nv_bfloat162()` = default

Constructor by default.

Empty default constructor, result is uninitialized.

`__host__ __device__ __nv_bfloat162(__nv_bfloat162 &&src)`

Move constructor, available for C++11 and later dialects.

`__host__ __device__ inline constexpr __nv_bfloat162(const __nv_bfloat16 &a, const __nv_bfloat16 &b)`

Constructor from two `__nv_bfloat16` variables.

`__host__ __device__ __nv_bfloat162(const __nv_bfloat162 &src)`

Copy constructor.

`__host__ __device__ __nv_bfloat162(const __nv_bfloat162_raw &h2r)`

Constructor from `__nv_bfloat162_raw`.

`__host__ __device__ operator __nv_bfloat162_raw() const`

Conversion operator to `__nv_bfloat162_raw`.

`__host__ __device__ __nv_bfloat162 &operator=(__nv_bfloat162 &&src)`

Move assignment operator, available for C++11 and later dialects.

`__host__ __device__ __nv_bfloat162 &operator=(const __nv_bfloat162 &src)`

Copy assignment operator.

`__host__ __device__ __nv_bfloat162 &operator=(const __nv_bfloat162_raw &h2r)`

Assignment operator from `__nv_bfloat162_raw`.

Public Members

`__nv_bfloat16 x`

Storage field holding lower `__nv_bfloat16` part.

`__nv_bfloat16 y`

Storage field holding upper `__nv_bfloat16` part.

12.7. `__nv_bfloat162_raw`

struct `__nv_bfloat162_raw`

`__nv_bfloat162_raw` data type

Type allows static initialization of `nv_bfloat162` until it becomes a builtin type.

- Note: this initialization is as a bit-field representation of `nv_bfloat162`, and not a conversion from `short2` to `nv_bfloat162`. Such representation will be deprecated in a future version of CUDA.

- ▶ Note: this is visible to non-nvcc compilers, including C-only compilations

Public Members

unsigned short **x**

Storage field contains bits of the lower `nv_bfloat16` part.

unsigned short **y**

Storage field contains bits of the upper `nv_bfloat16` part.

12.8. `__nv_bfloat16_raw`

struct `__nv_bfloat16_raw`

`__nv_bfloat16_raw` data type

Type allows static initialization of `nv_bfloat16` until it becomes a builtin type.

- ▶ Note: this initialization is as a bit-field representation of `nv_bfloat16`, and not a conversion from short to `nv_bfloat16`. Such representation will be deprecated in a future version of CUDA.
- ▶ Note: this is visible to non-nvcc compilers, including C-only compilations

Public Members

unsigned short **x**

Storage field contains bits representation of the `nv_bfloat16` floating-point number.

12.9. `__nv_fp8_e4m3`

struct `__nv_fp8_e4m3`

`__nv_fp8_e4m3` datatype

This structure implements the datatype for storing fp8 floating-point numbers of e4m3 kind: with 1 sign, 4 exponent, 1 implicit and 3 explicit mantissa bits. The encoding doesn't support Infinity. NaNs are limited to 0x7F and 0xFF values.

The structure implements converting constructors and operators.

Public Functions

`__nv_fp8_e4m3()` = default

Constructor by default.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const __half f)`

Constructor from `__half` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const __nv_bfloat16 f)`

Constructor from `__nv_bfloat16` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const double f)`

Constructor from `double` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const float f)`

Constructor from `float` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const int val)`

Constructor from `int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const long int val)`

Constructor from `long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const long long int val)`

Constructor from `long long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const short int val)`

Constructor from `short int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const unsigned int val)`

Constructor from `unsigned int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const unsigned long int val)`

Constructor from `unsigned long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const unsigned long long int val)`

Constructor from `unsigned long long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e4m3(const unsigned short int val)`

Constructor from `unsigned short int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit operator __half()` const

Conversion operator to `__half` data type.

`__host__ __device__ inline explicit operator __nv_bfloat16() const`

Conversion operator to `__nv_bfloat16` data type.

`__host__ __device__ inline explicit operator bool() const`

Conversion operator to `bool` data type.

+0 and -0 inputs convert to `false`. Non-zero inputs convert to `true`.

`__host__ __device__ inline explicit operator char() const`

Conversion operator to an implementation defined `char` data type.

Detects signedness of the `char` type and proceeds accordingly, see further details in signed and unsigned `char` operators.

Clamps inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator double() const`

Conversion operator to `double` data type.

`__host__ __device__ inline explicit operator float() const`

Conversion operator to `float` data type.

`__host__ __device__ inline explicit operator int() const`

Conversion operator to `int` data type.

NaN inputs convert to zero.

`__host__ __device__ inline explicit operator long int() const`

Conversion operator to `long int` data type.

Clamps too large inputs to the output range. NaN inputs convert to zero if output type is 32-bit. NaN inputs convert to `0x8000000000000000ULL` if output type is 64-bit.

`__host__ __device__ inline explicit operator long long int() const`

Conversion operator to `long long int` data type.

NaN inputs convert to `0x8000000000000000LL`.

`__host__ __device__ inline explicit operator short int() const`

Conversion operator to `short int` data type.

NaN inputs convert to zero.

`__host__ __device__ inline explicit operator signed char() const`

Conversion operator to `signed char` data type.

Clamps too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator unsigned char() const`

Conversion operator to `unsigned char` data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator unsigned int() const`

Conversion operator to `unsigned int` data type.

Clamps negative inputs to zero. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator unsigned long int() const`

Conversion operator to unsigned long int data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to zero if output type is 32-bit. NaN inputs convert to `0x8000000000000000ULL` if output type is 64-bit.

`__host__ __device__ inline explicit operator unsigned long long int() const`

Conversion operator to unsigned long long int data type.

Clamps negative inputs to zero. NaN inputs convert to `0x8000000000000000ULL`.

`__host__ __device__ inline explicit operator unsigned short int() const`

Conversion operator to unsigned short int data type.

Clamps negative inputs to zero. NaN inputs convert to zero.

Public Members

`__nv_fp8_storage_t __x`

Storage variable contains the fp8 floating-point data.

12.10. `__nv_fp8_e5m2`

struct `__nv_fp8_e5m2`

`__nv_fp8_e5m2` datatype

This structure implements the datatype for handling fp8 floating-point numbers of e5m2 kind: with 1 sign, 5 exponent, 1 implicit and 2 explicit mantissa bits.

The structure implements converting constructors and operators.

Public Functions

`__nv_fp8_e5m2()` = default

Constructor by default.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const __half f)`

Constructor from `__half` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const __nv_bfloat16 f)`

Constructor from `__nv_bfloat16` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const double f)`

Constructor from `double` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const float f)`
 Constructor from `float` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const int val)`
 Constructor from `int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const long int val)`
 Constructor from `long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const long long int val)`
 Constructor from `long long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const short int val)`
 Constructor from `short int` data type.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const unsigned int val)`
 Constructor from `unsigned int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const unsigned long int val)`
 Constructor from `unsigned long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const unsigned long long int val)`
 Constructor from `unsigned long long int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8_e5m2(const unsigned short int val)`
 Constructor from `unsigned short int` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit operator __half() const`
 Conversion operator to `__half` data type.

`__host__ __device__ inline explicit operator __nv_bfloat16() const`
 Conversion operator to `__nv_bfloat16` data type.

`__host__ __device__ inline explicit operator bool() const`
 Conversion operator to `bool` data type.
 +0 and -0 inputs convert to `false`. Non-zero inputs convert to `true`.

`__host__ __device__ inline explicit operator char() const`
 Conversion operator to an implementation defined `char` data type.
 Detects signedness of the `char` type and proceeds accordingly, see further details in signed and unsigned char operators.
 Clamps inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator double() const`
 Conversion operator to `double` data type.

`__host__ __device__ inline explicit operator float() const`
 Conversion operator to `float` data type.

`__host__ __device__ inline explicit operator int() const`

Conversion operator to `int` data type.

Clamps too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator long int() const`

Conversion operator to `long int` data type.

Clamps too large inputs to the output range. NaN inputs convert to zero if output type is 32-bit. NaN inputs convert to `0x8000000000000000ULL` if output type is 64-bit.

`__host__ __device__ inline explicit operator long long int() const`

Conversion operator to `long long int` data type.

Clamps too large inputs to the output range. NaN inputs convert to `0x8000000000000000LL`.

`__host__ __device__ inline explicit operator short int() const`

Conversion operator to `short int` data type.

Clamps too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator signed char() const`

Conversion operator to `signed char` data type.

Clamps too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator unsigned char() const`

Conversion operator to `unsigned char` data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator unsigned int() const`

Conversion operator to `unsigned int` data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to zero.

`__host__ __device__ inline explicit operator unsigned long int() const`

Conversion operator to `unsigned long int` data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to zero if output type is 32-bit. NaN inputs convert to `0x8000000000000000ULL` if output type is 64-bit.

`__host__ __device__ inline explicit operator unsigned long long int() const`

Conversion operator to `unsigned long long int` data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to `0x8000000000000000ULL`.

`__host__ __device__ inline explicit operator unsigned short int() const`

Conversion operator to `unsigned short int` data type.

Clamps negative and too large inputs to the output range. NaN inputs convert to zero.

Public Members

`__nv_fp8_storage_t __x`

Storage variable contains the fp8 floating-point data.

12.11. `__nv_fp8x2_e4m3`

struct `__nv_fp8x2_e4m3`

`__nv_fp8x2_e4m3` datatype

This structure implements the datatype for storage and operations on the vector of two fp8 values of e4m3 kind each: with 1 sign, 4 exponent, 1 implicit and 3 explicit mantissa bits. The encoding doesn't support Infinity. NaNs are limited to 0x7F and 0xFF values.

Public Functions

`__nv_fp8x2_e4m3()` = default

Constructor by default.

`__host__ __device__ inline explicit __nv_fp8x2_e4m3(const __half2 f)`

Constructor from `__half2` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x2_e4m3(const __nv_bfloat162 f)`

Constructor from `__nv_bfloat162` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x2_e4m3(const double2 f)`

Constructor from `double2` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x2_e4m3(const float2 f)`

Constructor from `float2` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit operator __half2() const`

Conversion operator to `__half2` data type.

`__host__ __device__ inline explicit operator float2() const`

Conversion operator to `float2` data type.

Public Members

`__nv_fp8x2_storage_t __x`

Storage variable contains the vector of two fp8 floating-point data values.

12.12. `__nv_fp8x2_e5m2`

struct `__nv_fp8x2_e5m2`

`__nv_fp8x2_e5m2` datatype

This structure implements the datatype for handling two fp8 floating-point numbers of e5m2 kind each: with 1 sign, 5 exponent, 1 implicit and 2 explicit mantissa bits.

The structure implements converting constructors and operators.

Public Functions

`__nv_fp8x2_e5m2()` = default

Constructor by default.

`__host__ __device__ inline explicit __nv_fp8x2_e5m2(const __half2 f)`

Constructor from `__half2` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x2_e5m2(const __nv_bfloat162 f)`

Constructor from `__nv_bfloat162` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x2_e5m2(const double2 f)`

Constructor from `double2` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x2_e5m2(const float2 f)`

Constructor from `float2` data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit operator __half2() const`

Conversion operator to `__half2` data type.

`__host__ __device__ inline explicit operator float2() const`

Conversion operator to `float2` data type.

Public Members

`__nv_fp8x2_storage_t __x`

Storage variable contains the vector of two fp8 floating-point data values.

12.13. `__nv_fp8x4_e4m3`

struct `__nv_fp8x4_e4m3`

`__nv_fp8x4_e4m3` datatype

This structure implements the datatype for storage and operations on the vector of four fp8 values of e4m3 kind each: with 1 sign, 4 exponent, 1 implicit and 3 explicit mantissa bits. The encoding doesn't support Infinity. NaNs are limited to 0x7F and 0xFF values.

Public Functions

`__nv_fp8x4_e4m3()` = default

Constructor by default.

`__host__ __device__ inline explicit __nv_fp8x4_e4m3(const __half2 flo, const __half2 fhi)`

Constructor from a pair of `__half2` data type values, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x4_e4m3(const __nv_bfloat162 flo, const __nv_bfloat162 fhi)`

Constructor from a pair of `__nv_bfloat162` data type values, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x4_e4m3(const double4 f)`

Constructor from `double4` vector data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x4_e4m3(const float4 f)`

Constructor from `float4` vector data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit operator float4() const`

Conversion operator to `float4` vector data type.

Public Members

`__nv_fp8x4_storage_t __x`

Storage variable contains the vector of four fp8 floating-point data values.

12.14. `__nv_fp8x4_e5m2`

struct `__nv_fp8x4_e5m2`

`__nv_fp8x4_e5m2` datatype

This structure implements the datatype for handling four fp8 floating-point numbers of e5m2 kind each: with 1 sign, 5 exponent, 1 implicit and 2 explicit mantissa bits.

The structure implements converting constructors and operators.

Public Functions

`__nv_fp8x4_e5m2()` = default

Constructor by default.

`__host__ __device__ inline explicit __nv_fp8x4_e5m2(const __half2 flo, const __half2 fhi)`

Constructor from a pair of `__half2` data type values, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x4_e5m2(const __nv_bfloat162 flo, const __nv_bfloat162 fhi)`

Constructor from a pair of `__nv_bfloat162` data type values, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x4_e5m2(const double4 f)`

Constructor from `double4` vector data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit __nv_fp8x4_e5m2(const float4 f)`

Constructor from `float4` vector data type, relies on `__NV_SATFINITE` behavior for out-of-range values.

`__host__ __device__ inline explicit operator float4()` const

Conversion operator to `float4` vector data type.

Public Members

`__nv_fp8x4_storage_t __x`

Storage variable contains the vector of four fp8 floating-point data values.

`__half`

`__half` data type

`__half2`

`__half2` data type

`__half2_raw`

`__half2_raw` data type

`__half_raw`

`__half_raw` data type

__nv_bfloat16
 nv_bfloat16 datatype

__nv_bfloat162
 nv_bfloat162 datatype

__nv_bfloat162_raw
 __nv_bfloat162_raw data type

__nv_bfloat16_raw
 __nv_bfloat16_raw data type

__nv_fp8_e4m3
 __nv_fp8_e4m3 datatype

__nv_fp8_e5m2
 __nv_fp8_e5m2 datatype

__nv_fp8x2_e4m3
 __nv_fp8x2_e4m3 datatype

__nv_fp8x2_e5m2
 __nv_fp8x2_e5m2 datatype

__nv_fp8x4_e4m3
 __nv_fp8x4_e4m3 datatype

__nv_fp8x4_e5m2
 __nv_fp8x4_e5m2 datatype

Chapter 13. Notices

13.1. Notice

This document is provided for information purposes only and shall not be regarded as a warranty of a certain functionality, condition, or quality of a product. NVIDIA Corporation (“NVIDIA”) makes no representations or warranties, expressed or implied, as to the accuracy or completeness of the information contained in this document and assumes no responsibility for any errors contained herein. NVIDIA shall have no liability for the consequences or use of such information or for any infringement of patents or other rights of third parties that may result from its use. This document is not a commitment to develop, release, or deliver any Material (defined below), code, or functionality.

NVIDIA reserves the right to make corrections, modifications, enhancements, improvements, and any other changes to this document, at any time without notice.

Customer should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

NVIDIA products are sold subject to the NVIDIA standard terms and conditions of sale supplied at the time of order acknowledgement, unless otherwise agreed in an individual sales agreement signed by authorized representatives of NVIDIA and customer (“Terms of Sale”). NVIDIA hereby expressly objects to applying any customer general terms and conditions with regards to the purchase of the NVIDIA product referenced in this document. No contractual obligations are formed either directly or indirectly by this document.

NVIDIA products are not designed, authorized, or warranted to be suitable for use in medical, military, aircraft, space, or life support equipment, nor in applications where failure or malfunction of the NVIDIA product can reasonably be expected to result in personal injury, death, or property or environmental damage. NVIDIA accepts no liability for inclusion and/or use of NVIDIA products in such equipment or applications and therefore such inclusion and/or use is at customer’s own risk.

NVIDIA makes no representation or warranty that products based on this document will be suitable for any specified use. Testing of all parameters of each product is not necessarily performed by NVIDIA. It is customer’s sole responsibility to evaluate and determine the applicability of any information contained in this document, ensure the product is suitable and fit for the application planned by customer, and perform the necessary testing for the application in order to avoid a default of the application or the product. Weaknesses in customer’s product designs may affect the quality and reliability of the NVIDIA product and may result in additional or different conditions and/or requirements beyond those contained in this document. NVIDIA accepts no liability related to any default, damage, costs, or problem which may be based on or attributable to: (i) the use of the NVIDIA product in any manner that is contrary to this document or (ii) customer product designs.

No license, either expressed or implied, is granted under any NVIDIA patent right, copyright, or other NVIDIA intellectual property right under this document. Information published by NVIDIA regarding third-party products or services does not constitute a license from NVIDIA to use such products or

services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property rights of the third party, or a license from NVIDIA under the patents or other intellectual property rights of NVIDIA.

Reproduction of information in this document is permissible only if approved in advance by NVIDIA in writing, reproduced without alteration and in full compliance with all applicable export laws and regulations, and accompanied by all associated conditions, limitations, and notices.

THIS DOCUMENT AND ALL NVIDIA DESIGN SPECIFICATIONS, REFERENCE BOARDS, FILES, DRAWINGS, DIAGNOSTICS, LISTS, AND OTHER DOCUMENTS (TOGETHER AND SEPARATELY, "MATERIALS") ARE BEING PROVIDED "AS IS." NVIDIA MAKES NO WARRANTIES, EXPRESSED, IMPLIED, STATUTORY, OR OTHERWISE WITH RESPECT TO THE MATERIALS, AND EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES OF NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. TO THE EXTENT NOT PROHIBITED BY LAW, IN NO EVENT WILL NVIDIA BE LIABLE FOR ANY DAMAGES, INCLUDING WITHOUT LIMITATION ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY, ARISING OUT OF ANY USE OF THIS DOCUMENT, EVEN IF NVIDIA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Notwithstanding any damages that customer might incur for any reason whatsoever, NVIDIA's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms of Sale for the product.

13.2. OpenCL

OpenCL is a trademark of Apple Inc. used under license to the Khronos Group Inc.

13.3. Trademarks

NVIDIA and the NVIDIA logo are trademarks or registered trademarks of NVIDIA Corporation in the U.S. and other countries. Other company and product names may be trademarks of the respective companies with which they are associated.

Copyright

©2007-2024, NVIDIA Corporation & affiliates. All rights reserved