CUDA Math API

API Reference Manual

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1.1. Half Precision Intrinsics

This section describes half precision intrinsic functions that are only supported in device code. To use these functions, include the header file `cuda_fp16.h` in your program.

Half Arithmetic Functions

Half2 Arithmetic Functions

Half Comparison Functions

Half2 Comparison Functions

Half Precision Conversion and Data Movement

Half Math Functions

Half2 Math Functions

1.1.1. Half Arithmetic Functions

Half Precision Intrinsics

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

__device__ __half __habs (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  absolute value of a.

Description

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

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

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

Description

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

__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].

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

half

- The

  sum of `a` and `b`, with respect to saturation.

Description

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.

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

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

Description

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

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

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

Description

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.

__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.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

c

- half. Is only being read.

Returns

half

- The

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

Description

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.

__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].

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

c

- half. Is only being read.

Returns

half

- The

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

Description

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.

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

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

Description

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

__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].

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

half

- The

  result of multiplying `a` and `b`, with respect to saturation.

Description

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

__device__ __half __hneg (const __half a)

Negates input `half` number and returns the result.

Description

Negates input `half` number and returns the result.

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

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

Description

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

__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].

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

half

- The

  result of subtraction of `b` from `a`, with respect to saturation.

Description

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

1.1.2. Half2 Arithmetic Functions

Half Precision Intrinsics

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

__device__ __half2 __h2div (const __half2 a, const __half2 b)

Performs `half2` vector division in round-to-nearest-even mode.

Description

Divides `half2` input vector `a` by input vector `b` in round-to-nearest mode.

__device__ __half2 __habs2 (const __half2 a)

Calculates the absolute value of both halves of the input `half2` number and returns the result.

Parameters

a

- half2. Is only being read.

Returns

half2

- Returns

  `a` with the absolute value of both halves.

Description

Calculates the absolute value of both halves of the input `half2` number and returns the result.

__device__ __half2 __hadd2 (const __half2 a, const __half2 b)

Performs `half2` vector addition in round-to-nearest-even mode.

Description

Performs `half2` vector add of inputs `a` and `b`, in round-to-nearest mode.

__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].

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  sum of `a` and `b`, with respect to saturation.

Description

Performs `half2` vector add of inputs `a` and `b`, in round-to-nearest mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

__device__ __half2 __hcmadd (const __half2 a, const __half2 b, const __half2 c)

Performs fast complex multiply-accumulate.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

c

- half2. Is only being read.

Returns

half2

- The

  result of complex multiply-accumulate operation on complex numbers `a`, `b`, and `c`

Description

Interprets vector `half2` input pairs `a`, `b`, and `c` as complex numbers in `half` precision and performs complex multiply-accumulate operation: a*b + c

__device__ __half2 __hfma2 (const __half2 a, const __half2 b, const __half2 c)

Performs `half2` vector fused multiply-add in round-to-nearest-even mode.

Description

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.

__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.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

c

- half2. Is only being read.

Returns

half2

- The

  result of elementwise fused multiply-add operation on vectors `a`, `b`, and `c` with relu saturation.

Description

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.

__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].

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

c

- 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.

Description

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.

__device__ __half2 __hmul2 (const __half2 a, const __half2 b)

Performs `half2` vector multiplication in round-to-nearest-even mode.

Description

Performs `half2` vector multiplication of inputs `a` and `b`, in round-to-nearest-even mode.

__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].

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  result of elementwise multiplication of vectors `a` and `b`, with respect to saturation.

Description

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.

__device__ __half2 __hneg2 (const __half2 a)

Negates both halves of the input `half2` number and returns the result.

Description

Negates both halves of the input `half2` number `a` and returns the result.

__device__ __half2 __hsub2 (const __half2 a, const __half2 b)

Performs `half2` vector subtraction in round-to-nearest-even mode.

Description

Subtracts `half2` input vector `b` from input vector `a` in round-to-nearest-even mode.

__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].

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  subtraction of vector `b` from `a`, with respect to saturation.

Description

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.

1.1.3. Half Comparison Functions

Half Precision Intrinsics

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

__device__ bool __heq (const __half a, const __half b)

Performs `half` if-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

  boolean result of if-equal comparison of `a` and `b`.

Description

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

__device__ bool __hequ (const __half a, const __half b)

Performs `half` unordered if-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

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

Description

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

__device__ bool __hge (const __half a, const __half b)

Performs `half` greater-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

  boolean result of greater-equal comparison of `a` and `b`.

Description

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

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

Performs `half` unordered greater-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

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

Description

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

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

Performs `half` greater-than comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

boolean result of greater-than comparison of `a` and `b`.

Description

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

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

Performs `half` unordered greater-than comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

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

Description

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

__device__ int __hisinf (const __half a)

Checks if the input `half` number is infinite.

Parameters

a

- half. Is only being read.

Returns

int

- -1

  iff `a` is equal to negative infinity,
- 1

  iff `a` is equal to positive infinity,
- 0

  otherwise.

Description

Checks if the input `half` number `a` is infinite.

__device__ bool __hisnan (const __half a)

Determine whether `half` argument is a NaN.

Parameters

a

- half. Is only being read.

Returns

bool

- true

  iff argument is NaN.

Description

Determine whether `half` value `a` is a NaN.

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

Performs `half` less-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

  boolean result of less-equal comparison of `a` and `b`.

Description

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

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

Performs `half` unordered less-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

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

Description

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

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

Performs `half` less-than comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

  boolean result of less-than comparison of `a` and `b`.

Description

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

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

Performs `half` unordered less-than comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

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

Description

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

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

Calculates `half` maximum of two input values.

Description

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

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

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

Description

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

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

Calculates `half` minimum of two input values.

Description

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

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

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

Description

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

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

Performs `half` not-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

  boolean result of not-equal comparison of `a` and `b`.

Description

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

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

Performs `half` unordered not-equal comparison.

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

bool

- The

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

Description

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

1.1.4. Half2 Comparison Functions

Half Precision Intrinsics

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

__device__ bool __hbeq2 (const __half2 a, const __half2 b)

Performs `half2` vector if-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbequ2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered if-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbge2 (const __half2 a, const __half2 b)

Performs `half2` vector greater-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbgeu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered greater-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbgt2 (const __half2 a, const __half2 b)

Performs `half2` vector greater-than comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbgtu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered greater-than comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hble2 (const __half2 a, const __half2 b)

Performs `half2` vector less-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbleu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered less-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hblt2 (const __half2 a, const __half2 b)

Performs `half2` vector less-than comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbltu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered less-than comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbne2 (const __half2 a, const __half2 b)

Performs `half2` vector not-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbneu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered not-equal comparison and returns boolean true iff both `half` results are true, boolean false otherwise.

Parameters

a

- half2. Is only being read.

b

- 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.

Description

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.

__device__ __half2 __heq2 (const __half2 a, const __half2 b)

Performs half2 vector if-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of if-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hequ2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered if-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of unordered if-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hge2 (const __half2 a, const __half2 b)

Performs `half2` vector greater-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of greater-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hgeu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered greater-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  `half2` vector result of unordered greater-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hgt2 (const __half2 a, const __half2 b)

Performs `half2` vector greater-than comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of greater-than comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hgtu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered greater-than comparison.

Parameters

a
: - half2. Is only being read.

b
: - half2. Is only being read.

Returns

half2

- The

  `half2` vector result of unordered greater-than comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hisnan2 (const __half2 a)

Determine whether `half2` argument is a NaN.

Parameters

a
: - half2. Is only being read.

Returns

half2

- The

  half2 with the corresponding `half` results set to 1.0 for NaN, 0.0 otherwise.

Description

Determine whether each half of input `half2` number `a` is a NaN.

__device__ __half2 __hle2 (const __half2 a, const __half2 b)

Performs `half2` vector less-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  `half2` result of less-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hleu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered less-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of unordered less-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hlt2 (const __half2 a, const __half2 b)

Performs `half2` vector less-than comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  half2 vector result of less-than comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hltu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered less-than comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of unordered less-than comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hmax2 (const __half2 a, const __half2 b)

Calculates `half2` vector maximum of two inputs.

Description

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

__device__ __half2 __hmax2_nan (const __half2 a, const __half2 b)

Calculates `half2` vector maximum of two inputs, NaNs pass through.

Description

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

__device__ __half2 __hmin2 (const __half2 a, const __half2 b)

Calculates `half2` vector minimum of two inputs.

Description

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

__device__ __half2 __hmin2_nan (const __half2 a, const __half2 b)

Calculates `half2` vector minimum of two inputs, NaNs pass through.

Description

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

__device__ __half2 __hne2 (const __half2 a, const __half2 b)

Performs `half2` vector not-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of not-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __half2 __hneu2 (const __half2 a, const __half2 b)

Performs `half2` vector unordered not-equal comparison.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  vector result of unordered not-equal comparison of vectors `a` and `b`.

Description

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.

1.1.5. Half Precision Conversion and Data Movement

Half Precision Intrinsics

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

__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.

Parameters

a

- double. Is only being read.

Returns

half

- a

  converted to half.

Description

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

__host____device__ __half2 __float22half2_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.

Parameters

a

- float2. Is only being read.

Returns

half2

- The

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

Description

Converts both components of float2 to half precision in round-to-nearest 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`.

__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.

Parameters

a

- float. Is only being read.

Returns

half

- a

  converted to half.

Description

Converts float number `a` to half precision in 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.

Parameters

a

- float. Is only being read.

Returns

half2

- The

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

Description

Converts input `a` 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.

Parameters

a

- float. Is only being read.

Returns

half

- a

  converted to half.

Description

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

__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.

Parameters

a

- float. Is only being read.

Returns

half

- a

  converted to half.

Description

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

__host____device__ __half __float2half_ru (const float a)

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

Parameters

a

- float. Is only being read.

Returns

half

- a

  converted to half.

Description

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

__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.

Parameters

a

- float. Is only being read.

Returns

half

- a

  converted to half.

Description

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

__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.

Parameters

a

- float. Is only being read.

b

- float. Is only being read.

Returns

half2

- The

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

Description

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`.

__host____device__ float2 __half22float2 (const __half2 a)

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

Parameters

a

- half2. Is only being read.

Returns

float2

- a

  converted to float2.

Description

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

__host____device__ float __half2float (const __half a)

Converts `half` number to float.

Parameters

a

- float. Is only being read.

Returns

float

- a

  converted to float.

Description

Converts half number `a` to float.

__device__ __half2 __half2half2 (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half2

- The

  vector which has both its halves equal to the input `a`.

Description

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

__device__ int __half2int_rd (const __half h)

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

Parameters

h

- half. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the half-precision floating-point value h 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.

Parameters

h

- half. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the half-precision floating-point value h 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.

Parameters

h

- half. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the half-precision floating-point value h 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.

Parameters

h

- half. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

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

__device__ unsigned int __half2uint_rd (const __half h)

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

Parameters

h

- half. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the half-precision floating-point value `h` 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.

Parameters

h

- half. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

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

__device__ short int __half_as_short (const __half h)

Reinterprets bits in a `half` as a signed short integer.

Parameters

h

- half. Is only being read.

Returns

short int

- The

  reinterpreted value.

Description

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

__device__ unsigned short int __half_as_ushort (const __half h)

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

Parameters

h

- half. Is only being read.

Returns

unsigned short int

- The

  reinterpreted value.

Description

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

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

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

Parameters

a

- half. Is only being read.

b

- half. Is only being read.

Returns

half2

- The

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

Description

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.

__host____device__ float __high2float (const __half2 a)

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

Parameters

a

- half2. Is only being read.

Returns

float

- The

  high 16 bits of `a` converted to float.

Description

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

__device__ __half __high2half (const __half2 a)

Returns high 16 bits of `half2` input.

Parameters

a

- half2. Is only being read.

Returns

half

- The

  high 16 bits of the input.

Description

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

__device__ __half2 __high2half2 (const __half2 a)

Extracts high 16 bits from `half2` input.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

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

Description

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

__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.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  high 16 bits of `a` and of `b`.

Description

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.

__device__ __half __int2half_rd (const int i)

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

Parameters

i

- int. Is only being read.

Returns

half

- i

  converted to half.

Description

Convert the signed integer value `i` to a half-precision floating-point value 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.

Parameters

i

- int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __int2half_ru (const int i)

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

Parameters

i

- int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __int2half_rz (const int i)

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

Parameters

i

- int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ldca (const __half *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half2 __ldca (const __half2 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half __ldcg (const __half *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half2 __ldcg (const __half2 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half __ldcs (const __half *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half2 __ldcs (const __half2 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half __ldcv (const __half *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half2 __ldcv (const __half2 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half __ldg (const __half *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half2 __ldg (const __half2 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

Description

defined(__CUDA_ARCH__) || (__CUDA_ARCH__ >= 300)

__device__ __half __ldlu (const __half *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half2 __ldlu (const __half2 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __half __ll2half_rd (const long long int i)

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

Parameters

i

- long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

Parameters

i

- long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ll2half_ru (const long long int i)

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

Parameters

i

- long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ll2half_rz (const long long int i)

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

Parameters

i

- long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__host____device__ float __low2float (const __half2 a)

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

Parameters

a

- half2. Is only being read.

Returns

float

- The

  low 16 bits of `a` converted to float.

Description

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

__device__ __half __low2half (const __half2 a)

Returns low 16 bits of `half2` input.

Parameters

a

- half2. Is only being read.

Returns

half

- Returns

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

Description

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

__device__ __half2 __low2half2 (const __half2 a)

Extracts low 16 bits from `half2` input.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  half2 with both halves equal to the low 16 bits of the input.

Description

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

__device__ __half2 __lowhigh2highlow (const __half2 a)

Swaps both halves of the `half2` input.

Parameters

a

- half2. Is only being read.

Returns

half2

- a

  with its halves being swapped.

Description

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

__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.

Parameters

a

- half2. Is only being read.

b

- half2. Is only being read.

Returns

half2

- The

  low 16 bits of `a` and of `b`.

Description

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.

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

Exchange a variable between threads within a warp. Copy from a thread with higher ID relative to the caller.

Parameters

mask

- unsigned int. Is only being read.

var

- half. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as half. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

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

Exchange a variable between threads within a warp. Copy from a thread with higher ID relative to the caller.

Parameters

mask
- unsigned int. Is only being read.

var
- half2. Is only being read.

delta
- int. Is only being read.

width
- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as half2. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

__device__ __half __shfl_sync (const unsigned mask, const __half var, const int delta, const int width)

Exchange a variable between threads within a warp. Direct copy from indexed thread.

Parameters

mask
- unsigned int. Is only being read.

var
- half. Is only being read.

delta
- int. Is only being read.

width
- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as half. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Returns the value of var held by the thread whose ID is given by delta. 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 delta is outside the range [0:width-1], the value returned corresponds to the value of var held by the delta 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.

__device__ __half2 __shfl_sync (const unsigned mask, const __half2 var, const int delta, const int width)

Exchange a variable between threads within a warp. Direct copy from indexed thread.

Parameters

mask
- unsigned int. Is only being read.

var
- half2. Is only being read.

delta
- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as half2. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Returns the value of var held by the thread whose ID is given by delta. 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 delta is outside the range [0:width-1], the value returned corresponds to the value of var held by the delta 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.

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

Exchange a variable between threads within a warp. Copy from a thread with lower ID relative to the caller.

Parameters

mask

- unsigned int. Is only being read.

var

- half. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as half. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

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

Exchange a variable between threads within a warp. Copy from a thread with lower ID relative to the caller.

Parameters

mask

- unsigned int. Is only being read.

var

- half2. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as half2. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

__device__ __half __shfl_xor_sync (const unsigned mask, const __half var, const int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread based on bitwise XOR of own thread ID.

Parameters

mask

- unsigned int. Is only being read.

var

- half. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as half. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with mask: 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.

__device__ __half2 __shfl_xor_sync (const unsigned mask, const __half2 var, const int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread based on bitwise XOR of own thread ID.

Parameters

mask

- unsigned int. Is only being read.

var

- half2. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as half2. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with mask: 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.

__device__ __half __short2half_rd (const short int i)

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

Parameters

i

- short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

Parameters

i

- short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __short2half_ru (const short int i)

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

Parameters

i

- short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __short2half_rz (const short int i)

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

Parameters

i

- short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __short_as_half (const short int i)

Reinterprets bits in a signed short integer as a `half`.

Parameters

i

- short int. Is only being read.

Returns

half

- The

  reinterpreted value.

Description

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

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

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

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ __half __uint2half_rd (const unsigned int i)

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

Parameters

i

- unsigned int. Is only being read.

Returns

half

- i

  converted to half.

Description

Convert the unsigned integer value `i` to a half-precision floating-point value 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.

Parameters

i

- unsigned int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __uint2half_ru (const unsigned int i)

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

Parameters

i

- unsigned int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __uint2half_rz (const unsigned int i)

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

Parameters

i

- unsigned int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ull2half_rd (const unsigned long long int i)

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

Parameters

i

- unsigned long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

Convert the unsigned 64-bit integer value `i` to a half-precision floating-point value 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.

Parameters

i

- unsigned long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ull2half_ru (const unsigned long long int i)

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

Parameters

i

- unsigned long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ull2half_rz (const unsigned long long int i)

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

Parameters

i

- unsigned long long int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ushort2half_rd (const unsigned short int i)

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

Parameters

i

- unsigned short int. Is only being read.

Returns

half

- i

  converted to half.

Description

Convert the unsigned short integer value `i` to a half-precision floating-point value 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.

Parameters

i

- unsigned short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ushort2half_ru (const unsigned short int i)

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

Parameters

i

- unsigned short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ushort2half_rz (const unsigned short int i)

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

Parameters

i

- unsigned short int. Is only being read.

Returns

half

- i

  converted to half.

Description

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

__device__ __half __ushort_as_half (const unsigned short int i)

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

Parameters

i

- unsigned short int. Is only being read.

Returns

half

- The

  reinterpreted value.

Description

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

1.1.6. Half Math Functions

Half Precision Intrinsics

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

__device__ __half hceil (const __half h)

Calculate ceiling of the input argument.

Parameters

h

- half. Is only being read.

Returns

half

- The

  smallest integer value not less than `h`.

Description

Compute the smallest integer value not less than `h`.

__device__ __half hcos (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  cosine of `a`.

Description

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

__device__ __half hexp (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  natural exponential function on `a`.

Description

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

__device__ __half hexp10 (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  decimal exponential function on `a`.

Description

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

__device__ __half hexp2 (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  binary exponential function on `a`.

Description

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

__device__ __half hfloor (const __half h)

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

Parameters

h

- half. Is only being read.

Returns

half

- The

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

Description

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

__device__ __half hlog (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  natural logarithm of `a`.

Description

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

__device__ __half hlog10 (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  decimal logarithm of `a`.

Description

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

__device__ __half hlog2 (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  binary logarithm of `a`.

Description

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

__device__ __half hrcp (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  reciprocal of `a`.

Description

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

__device__ __half hrint (const __half h)

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

Parameters

h

- half. Is only being read.

Returns

half

- The

  nearest integer to `h`.

Description

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

__device__ __half hrsqrt (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  reciprocal square root of `a`.

Description

Calculates `half` reciprocal square root of input `a` in round-to-nearest mode.

__device__ __half hsin (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  sine of `a`.

Description

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

__device__ __half hsqrt (const __half a)

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

Parameters

a

- half. Is only being read.

Returns

half

- The

  square root of `a`.

Description

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

__device__ __half htrunc (const __half h)

Truncate input argument to the integral part.

Parameters

h

- half. Is only being read.

Returns

half

- The

  truncated integer value.

Description

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

1.1.7. Half2 Math Functions

Half Precision Intrinsics

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

__device__ __half2 h2ceil (const __half2 h)

Calculate `half2` vector ceiling of the input argument.

Parameters

h

- half2. Is only being read.

Returns

half2

- The

  vector of smallest integers not less than `h`.

Description

For each component of vector `h` compute the smallest integer value not less than `h`.

__device__ __half2 h2cos (const __half2 a)

Calculates `half2` vector cosine in round-to-nearest-even mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise cosine on vector `a`.

Description

Calculates `half2` cosine of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2exp (const __half2 a)

Calculates `half2` vector exponential function in round-to-nearest mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise exponential function on vector `a`.

Description

Calculates `half2` exponential function of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2exp10 (const __half2 a)

Calculates `half2` vector decimal exponential function in round-to-nearest-even mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise decimal exponential function on vector `a`.

Description

Calculates `half2` decimal exponential function of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2exp2 (const __half2 a)

Calculates `half2` vector binary exponential function in round-to-nearest-even mode.

Parameters

a

  - half2. Is only being read.

Returns

half2

- The

  elementwise binary exponential function on vector `a`.

Description

Calculates `half2` binary exponential function of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2floor (const __half2 h)

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

Parameters

h

  - half2. Is only being read.

Returns

half2

- The

  vector of largest integers which is less than or equal to `h`.

Description

For each component of vector `h` calculate the largest integer value 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.

Parameters

a
  - half2. Is only being read.

Returns

half2

- The

  elementwise natural logarithm on vector `a`.

Description

Calculates `half2` natural logarithm of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2log10 (const __half2 a)

Calculates `half2` vector decimal logarithm in round-to-nearest-even mode.

Parameters

a
  - half2. Is only being read.

Returns

half2

- The

  elementwise decimal logarithm on vector `a`.

Description

Calculates `half2` decimal logarithm of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2log2 (const __half2 a)

Calculates `half2` vector binary logarithm in round-to-nearest-even mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise binary logarithm on vector `a`.

Description

Calculates `half2` binary logarithm of input vector `a` in round-to-nearest mode.

__device__ __half2 h2rcp (const __half2 a)

Calculates `half2` vector reciprocal in round-to-nearest-even mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise reciprocal on vector `a`.

Description

Calculates `half2` reciprocal of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2rint (const __half2 h)

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

Parameters

h

- half2. Is only being read.

Returns

half2

- The

  vector of rounded integer values.

Description

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.

__device__ __half2 h2rsqrt (const __half2 a)

Calculates `half2` vector reciprocal square root in round-to-nearest mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise reciprocal square root on vector `a`.

Description

Calculates `half2` reciprocal square root of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2sin (const __half2 a)

Calculates `half2` vector sine in round-to-nearest-even mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise sine on vector `a`.

Description

Calculates `half2` sine of input vector `a` in round-to-nearest-even mode.

__device__ __half2 h2sqrt (const __half2 a)

Calculates `half2` vector square root in round-to-nearest-even mode.

Parameters

a

- half2. Is only being read.

Returns

half2

- The

  elementwise square root on vector `a`.

Description

Calculates `half2` square root of input vector `a` in round-to-nearest mode.

__device__ __half2 h2trunc (const __half2 h)

Truncate `half2` vector input argument to the integral part.

Parameters

h

- half2. Is only being read.

Returns

half2

- The

  truncated `h`.

Description

Round each component of vector `h` to the nearest integer value that does not exceed `h` in magnitude.

1.2. Bfloat16 Precision Intrinsics

This section describes nv_bfloat16 precision intrinsic functions that are only supported in device code. To use these functions, include the header file `cuda_bf16.h` in your program.

1.2.1. Bfloat16 Arithmetic Functions

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__device__ __nv_bfloat162 __h2div (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector division in round-to-nearest-even mode.

Description

Divides `nv_bfloat162` input vector `a` by input vector `b` in round-to-nearest mode.

__device__ __nv_bfloat16 __habs (const __nv_bfloat16 a)

Calculates the absolute value of input `nv_bfloat16` number and returns the result.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  absolute value of a.

Description

Calculates the absolute value of input `nv_bfloat16` number and returns the result.

__device__ __nv_bfloat16 __hadd (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` addition in round-to-nearest-even mode.

Description

Performs `nv_bfloat16` addition of inputs `a` and `b`, in round-to-nearest-even mode.

__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].

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  sum of `a` and `b`, with respect to saturation.

Description

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.

__device__ __nv_bfloat16 __hdiv (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` division in round-to-nearest-even mode.

Description

Divides `nv_bfloat16` input `a` by input `b` in round-to-nearest 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.

Description

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.

__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.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

c

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

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

Description

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.

__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].

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

c

- 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.

Description

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.

__device__ __nv_bfloat16 __hmul (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` multiplication in round-to-nearest-even mode.

Description

Performs `nv_bfloat16` multiplication of inputs `a` and `b`, in round-to-nearest mode.

__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].

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  result of multiplying `a` and `b`, with respect to saturation.

Description

Performs `nv_bfloat16` multiplication of inputs `a` and `b`, in round-to-nearest mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

__device__ __nv_bfloat16 __hneg (const __nv_bfloat16 a)

Negates input `nv_bfloat16` number and returns the result.

Description

Negates input `nv_bfloat16` number and returns the result.

__device__ __nv_bfloat16 __hsub (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` subtraction in round-to-nearest-even mode.

Description

Subtracts `nv_bfloat16` input `b` from input `a` in round-to-nearest mode.

__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].

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  result of subtraction of `b` from `a`, with respect to saturation.

Description

Subtracts `nv_bfloat16` input `b` from input `a` in round-to-nearest mode, and clamps the result to range [0.0, 1.0]. NaN results are flushed to +0.0.

1.2.2. Bfloat162 Arithmetic Functions

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

bfloat2

- Returns

  `a` with the absolute value of both halves.

Description

Calculates the absolute value of both halves of the input `nv_bfloat162` number and returns the result.

__device__ __nv_bfloat162 __hadd2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector addition in round-to-nearest-even mode.

Description

Performs `nv_bfloat162` vector add of inputs `a` and `b`, in round-to-nearest mode.

__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].

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  sum of `a` and `b`, with respect to saturation.

Description

Performs `nv_bfloat162` vector add of inputs `a` and `b`, in round-to-nearest mode, and clamps the results to range [0.0, 1.0]. NaN results are flushed to +0.0.

__device__ __nv_bfloat162 __hcmadd (const __nv_bfloat162 a, const __nv_bfloat162 b, const __nv_bfloat162 c)

Performs fast complex multiply-accumulate.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

c

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  result of complex multiply-accumulate operation on complex numbers `a`, `b`, and `c`

Description

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

__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.

Description

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.

__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.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

c

- 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.

Description

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.

__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].

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

c

- 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.

Description

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.

__device__ __nv_bfloat162 __hmul2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector multiplication in round-to-nearest-even mode.

Description

Performs `nv_bfloat162` vector multiplication of inputs `a` and `b`, in round-to-nearest-even mode.

__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].

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  result of elementwise multiplication of vectors `a` and `b`, with respect to saturation.

Description

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.

__device__ __nv_bfloat162 __hneg2 (const __nv_bfloat162 a)

Negates both halves of the input `nv_bfloat162` number and returns the result.

Description

Negates both halves of the input `nv_bfloat162` number `a` and returns the result.

__device__ __nv_bfloat162 __hsub2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector subtraction in round-to-nearest-even mode.

Description

Subtracts `nv_bfloat162` input vector `b` from input vector `a` in round-to-nearest-even mode.

__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].

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  subtraction of vector `b` from `a`, with respect to saturation.

Description

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.

1.2.3. Bfloat16 Comparison Functions

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__device__ bool __heq (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` if-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

  boolean result of if-equal comparison of `a` and `b`.

Description

Performs `nv_bfloat16` if-equal comparison of inputs `a` and `b`. NaN inputs generate false results.

__device__ bool __hequ (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` unordered if-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

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

Description

Performs `nv_bfloat16` if-equal comparison of inputs `a` and `b`. NaN inputs generate true results.

__device__ bool __hge (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` greater-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

  boolean result of greater-equal comparison of `a` and `b`.

Description

Performs `nv_bfloat16` greater-equal comparison of inputs `a` and `b`. NaN inputs generate false results.

__device__ bool __hgeu (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` unordered greater-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

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

Description

Performs `nv_bfloat16` greater-equal comparison of inputs `a` and `b`. NaN inputs generate true results.

__device__ bool __hgt (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` greater-than comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

  boolean result of greater-than comparison of `a` and `b`.

Description

Performs `nv_bfloat16` greater-than comparison of inputs `a` and `b`. NaN inputs generate false results.

__device__ bool __hgtu (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` unordered greater-than comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

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

Description

Performs `nv_bfloat16` greater-than comparison of inputs `a` and `b`. NaN inputs generate true results.

__device__ int __hisinf (const __nv_bfloat16 a)

Checks if the input `nv_bfloat16` number is infinite.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

int

- -1

  iff `a` is equal to negative infinity,
- 1

  iff `a` is equal to positive infinity,
- 0

  otherwise.

Description

Checks if the input `nv_bfloat16` number `a` is infinite.

__device__ bool __hisnan (const __nv_bfloat16 a)

Determine whether `nv_bfloat16` argument is a NaN.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

bool

- true

  iff argument is NaN.

Description

Determine whether `nv_bfloat16` value `a` is a NaN.

__device__ bool __hle (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` less-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

  boolean result of less-equal comparison of `a` and `b`.

Description

Performs `nv_bfloat16` less-equal comparison of inputs `a` and `b`. NaN inputs generate false results.

__device__ bool __hleu (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` unordered less-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

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

Description

Performs `nv_bfloat16` less-equal comparison of inputs `a` and `b`. NaN inputs generate true results.

__device__ bool __hlt (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` less-than comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

  boolean result of less-than comparison of `a` and `b`.

Description

Performs `nv_bfloat16` less-than comparison of inputs `a` and `b`. NaN inputs generate false results.

__device__ bool __hltu (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` unordered less-than comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

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

Description

Performs `nv_bfloat16` less-than comparison of inputs `a` and `b`. NaN inputs generate true results.

__device__ __nv_bfloat16 __hmax (const __nv_bfloat16 a, const __nv_bfloat16 b)

Calculates `nv_bfloat16` maximum of two input values.

Description

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

__device__ __nv_bfloat16 __hmax_nan (const __nv_bfloat16 a, const __nv_bfloat16 b)

Calculates `nv_bfloat16` maximum of two input values, NaNs pass through.

Description

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

__device__ __nv_bfloat16 __hmin (const __nv_bfloat16 a, const __nv_bfloat16 b)

Calculates `nv_bfloat16` minimum of two input values.

Description

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

__device__ __nv_bfloat16 __hmin_nan (const __nv_bfloat16 a, const __nv_bfloat16 b)

Calculates `nv_bfloat16` minimum of two input values, NaNs pass through.

Description

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

__device__ bool __hne (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` not-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

  boolean result of not-equal comparison of `a` and `b`.

Description

Performs `nv_bfloat16` not-equal comparison of inputs `a` and `b`. NaN inputs generate false results.

__device__ bool __hneu (const __nv_bfloat16 a, const __nv_bfloat16 b)

Performs `nv_bfloat16` unordered not-equal comparison.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

bool

- The

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

Description

Performs `nv_bfloat16` not-equal comparison of inputs `a` and `b`. NaN inputs generate true results.

1.2.4. Bfloat162 Comparison Functions

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__device__ bool __hbeq2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector if-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbequ2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered if-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbge2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector greater-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbgeu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered greater-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbgt2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector greater-than comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbgtu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered greater-than comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hble2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector less-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbleu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered less-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hblt2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector less-than comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbltu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered less-than comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbne2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector not-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ bool __hbneu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered not-equal comparison and returns boolean true iff both `nv_bfloat16` results are true, boolean false otherwise.

Parameters

a

- nv_bfloat162. Is only being read.

b

- 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.

Description

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.

__device__ __nv_bfloat162 __heq2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs nv_bfloat162 vector if-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of if-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hequ2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered if-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of unordered if-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hge2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector greater-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of greater-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hgeu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered greater-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

nv_bfloat162 vector result of unordered greater-equal comparison of vectors a and b.

Description

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.

__device__ __nv_bfloat162 __hgt2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs nv_bfloat162 vector greater-than comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of greater-than comparison of vectors a and b.

Description

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.

__device__ __nv_bfloat162 __hgtu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs nv_bfloat162 vector unordered greater-than comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  `nv_bfloat162` vector result of unordered greater-than comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hisnan2 (const __nv_bfloat162 a)

Determine whether `nv_bfloat162` argument is a NaN.

Parameters

a

- 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.

Description

Determine whether each nv_bfloat16 of input `nv_bfloat162` number `a` is a NaN.

__device__ __nv_bfloat162 __hle2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector less-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

`nv_bfloat162` result of less-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hleu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered less-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of unordered less-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hlt2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector less-than comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  nv_bfloat162 vector result of less-than comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hltu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered less-than comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of unordered less-than comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hmax2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Calculates `nv_bfloat162` vector maximum of two inputs.

Description

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

__device__ __nv_bfloat162 __hmax2_nan (const __nv_bfloat162 a, const __nv_bfloat162 b)

Calculates `nv_bfloat162` vector maximum of two inputs, NaNs pass through.

Description

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

__device__ __nv_bfloat162 __hmin2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Calculates `nv_bfloat162` vector minimum of two inputs.

Description

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

__device__ __nv_bfloat162 __hmin2_nan (const __nv_bfloat162 a, const __nv_bfloat162 b)

Calculates `nv_bfloat162` vector minimum of two inputs, NaNs pass through.

Description

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

__device__ __nv_bfloat162 __hne2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector not-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of not-equal comparison of vectors `a` and `b`.

Description

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.

__device__ __nv_bfloat162 __hneu2 (const __nv_bfloat162 a, const __nv_bfloat162 b)

Performs `nv_bfloat162` vector unordered not-equal comparison.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector result of unordered not-equal comparison of vectors `a` and `b`.

Description

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.

1.2.5. Bfloat16 Precision Conversion and Data Movement

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__host____device__ float2 __bfloat1622float2 (const __nv_bfloat162 a)

Converts both halves of `nv_bfloat162` to float2 and returns the result.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

float2

- a

  converted to float2.

Description

Converts both halves of `nv_bfloat162` input `a` to float2 and returns the result.

__device__ __nv_bfloat162 __bfloat162bfloat162 (const __nv_bfloat16 a)

Returns `nv_bfloat162` with both halves equal to the input value.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat162

- The

  vector which has both its halves equal to the input `a`.

Description

Returns `nv_bfloat162` number with both halves equal to the input a `nv_bfloat16` number.

__host____device__ float __bfloat162float (const __nv_bfloat16 a)

Converts `nv_bfloat16` number to float.

Parameters

a

- float. Is only being read.

Returns

float

- a

  converted to float.

Description

Converts nv_bfloat16 number `a` to float.

__device__ int __bfloat162int_rd (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed integer in round-down mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed integer in round-down mode.

__device__ int __bfloat162int_rn (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed integer in round-to-nearest-even mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed integer in round-to-nearest-even mode.

__device__ int __bfloat162int_ru (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed integer in round-up mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed integer in round-up mode.

__host____device__ int __bfloat162int_rz (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed integer in round-towards-zero mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

int

- h

  converted to a signed integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed integer in round-towards-zero mode.

__device__ long long int __bfloat162ll_rd (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed 64-bit integer in round-down mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed 64-bit integer in round-down mode.

__device__ long long int __bfloat162ll_rn (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed 64-bit integer in round-to-nearest-even mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed 64-bit integer in round-to-nearest-even mode.

__device__ long long int __bfloat162ll_ru (const __nv_bfloat16 h)

Convert a nv_bfloat16 to a signed 64-bit integer in round-up mode.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

long long int

- h

  converted to a signed 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

short int

- h

  converted to a signed short integer.

Description

Convert the nv_bfloat16 floating-point value `h` to a signed short integer 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned int

- h

  converted to an unsigned integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned long long int

- h

  converted to an unsigned 64-bit integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the nv_bfloat16 floating-point value `h` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned short int

- h

  converted to an unsigned short integer.

Description

Convert the nv_bfloat16 floating-point value `h` to an unsigned short integer in round-towards-zero mode.

__device__ short int __bfloat16_as_short (const __nv_bfloat16 h)

Reinterprets bits in a `nv_bfloat16` as a signed short integer.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

short int

- The

  reinterpreted value.

Description

Reinterprets the bits in the nv_bfloat16 floating-point number `h` as a signed short integer.

__device__ unsigned short int __bfloat16_as_ushort (const __nv_bfloat16 h)

Reinterprets bits in a `nv_bfloat16` as an unsigned short integer.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

unsigned short int

- The

  reinterpreted value.

Description

Reinterprets the bits in the nv_bfloat16 floating-point `h` as an unsigned short number.

__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.

Parameters

a

- double. Is only being read.

Returns

nv_bfloat16

- a

  converted to nv_bfloat16.

Description

Converts double number `a` to nv_bfloat16 precision in round-to-nearest-even mode.

__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.

Parameters

a

- float2. Is only being read.

Returns

nv_bfloat162

- The

  `nv_bfloat162` which has corresponding halves equal to the converted float2 components.

Description

Converts both components of float2 to nv_bfloat16 precision in round-to-nearest 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`.

__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.

Parameters

a

- float. Is only being read.

Returns

nv_bfloat16

- a

  converted to nv_bfloat16.

Description

Converts float number `a` to nv_bfloat16 precision in 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.

Parameters

a

- float. Is only being read.

Returns

nv_bfloat162

- The

  `nv_bfloat162` value with both halves equal to the converted nv_bfloat16 precision number.

Description

Converts input `a` 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.

Parameters

a

- float. Is only being read.

Returns

nv_bfloat16

- a

  converted to nv_bfloat16.

Description

Converts float number `a` to nv_bfloat16 precision in round-down mode.

__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.

Parameters

a

- float. Is only being read.

Returns

nv_bfloat16

- a

converted to nv_bfloat16.

Description

Converts float number `a` to nv_bfloat16 precision in round-to-nearest-even mode.

__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.

Parameters

a

- float. Is only being read.

Returns

nv_bfloat16

- a

converted to nv_bfloat16.

Description

Converts float number `a` to nv_bfloat16 precision in round-up mode.

__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.

Parameters

a

- float. Is only being read.

Returns

nv_bfloat16

- a

  converted to nv_bfloat16.

Description

Converts float number `a` to nv_bfloat16 precision in round-towards-zero mode.

__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.

Parameters

a

- float. Is only being read.

b

- float. Is only being read.

Returns

nv_bfloat162

- The

  `nv_bfloat162` value with corresponding halves equal to the converted input floats.

Description

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`.

__device__ __nv_bfloat162 __halves2bfloat162 (const __nv_bfloat16 a, const __nv_bfloat16 b)

Combines two `nv_bfloat16` numbers into one `nv_bfloat162` number.

Parameters

a

- nv_bfloat16. Is only being read.

b

- nv_bfloat16. Is only being read.

Returns

nv_bfloat162

- The

  nv_bfloat162 with one nv_bfloat16 equal to `a` and the other to `b`.

Description

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.

__device__ __nv_bfloat16 __high2bfloat16 (const __nv_bfloat162 a)

Returns high 16 bits of `nv_bfloat162` input.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat16

- The

  high 16 bits of the input.

Description

Returns high 16 bits of `nv_bfloat162` input `a`.

__device__ __nv_bfloat162 __high2bfloat162 (const __nv_bfloat162 a)

Extracts high 16 bits from `nv_bfloat162` input.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  nv_bfloat162 with both halves equal to the high 16 bits of the input.

Description

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.

__host____device__ float __high2float (const __nv_bfloat162 a)

Converts high 16 bits of `nv_bfloat162` to float and returns the result.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

float

- The

  high 16 bits of `a` converted to float.

Description

Converts high 16 bits of `nv_bfloat162` input `a` to 32-bit floating-point number and returns the result.

__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.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  high 16 bits of `a` and of `b`.

Description

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.

__device__ __nv_bfloat16 __int2bfloat16_rd (const int i)

Convert a signed integer to a nv_bfloat16 in round-down mode.

Parameters

i

- int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed integer value `i` to a nv_bfloat16 floating-point value in round-towards-zero mode.

__device__ __nv_bfloat16 __ldca (const __nv_bfloat16 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat162 __ldca (const __nv_bfloat162 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat16 __ldcg (const __nv_bfloat16 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat162 __ldcg (const __nv_bfloat162 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat16 __ldcs (const __nv_bfloat16 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat162 __ldcs (const __nv_bfloat162 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat16 __ldcv (const __nv_bfloat16 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat162 __ldcv (const __nv_bfloat162 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat16 __ldg (const __nv_bfloat16 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat162 __ldg (const __nv_bfloat162 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat16 __ldlu (const __nv_bfloat16 *ptr)

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

Parameters

ptr

- memory location

Returns

The value pointed by `ptr`

__device__ __nv_bfloat162 __ldlu (const __nv_bfloat162 *ptr)

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

Parameters

ptr

- 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.

Parameters

i

- long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed 64-bit integer value `i` to a nv_bfloat16 floating-point value in round-towards-zero mode.

__device__ __nv_bfloat16 __low2bfloat16 (const __nv_bfloat162 a)

Returns low 16 bits of `nv_bfloat162` input.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat16

- Returns

  `nv_bfloat16` which contains low 16 bits of the input `a`.

Description

Returns low 16 bits of `nv_bfloat162` input `a`.

__device__ __nv_bfloat162 __low2bfloat162 (const __nv_bfloat162 a)

Extracts low 16 bits from `nv_bfloat162` input.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  nv_bfloat162 with both halves equal to the low 16 bits of the input.

Description

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.

__host____device__ float __low2float (const __nv_bfloat162 a)

Converts low 16 bits of `nv_bfloat162` to float and returns the result.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

float

- The

  low 16 bits of `a` converted to float.

Description

Converts low 16 bits of `nv_bfloat162` input `a` to 32-bit floating-point number and returns the result.

__device__ __nv_bfloat162 __lowhigh2highlow (const __nv_bfloat162 a)

Swaps both halves of the `nv_bfloat162` input.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- a

  with its halves being swapped.

Description

Swaps both halves of the `nv_bfloat162` input and returns a new `nv_bfloat162` number with swapped halves.

__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.

Parameters

a

- nv_bfloat162. Is only being read.

b

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  low 16 bits of `a` and of `b`.

Description

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.

__device__ __nv_bfloat16 __shfl_down_sync (const unsigned mask, const __nv_bfloat16 var, const unsigned int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread with higher ID relative to the caller.

Parameters

mask
- unsigned int. Is only being read.

var
- nv_bfloat16. Is only being read.

delta
- int. Is only being read.

width
- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as nv_bfloat16. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

__device__ __nv_bfloat162 __shfl_down_sync (const unsigned mask, const __nv_bfloat162 var, const unsigned int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread with higher ID relative to the caller.

Parameters

mask
- unsigned int. Is only being read.

var

- nv_bfloat162. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as nv_bfloat162. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

__device__ __nv_bfloat16 __shfl_sync (const unsigned mask, const __nv_bfloat16 var, const int delta, const int width)

Exchange a variable between threads within a warp. Direct copy from indexed thread.

Parameters

mask

- unsigned int. Is only being read.

var

- nv_bfloat16. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as nv_bfloat16. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Returns the value of var held by the thread whose ID is given by delta. 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 delta is outside the range [0:width-1], the value returned corresponds to the value of var held by the delta 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.

__device__ __nv_bfloat162 __shfl_sync (const unsigned mask, const __nv_bfloat162 var, const int delta, const int width)

Exchange a variable between threads within a warp. Direct copy from indexed thread.

Parameters

mask

- unsigned int. Is only being read.

var

- nv_bfloat162. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as nv_bfloat162. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Returns the value of var held by the thread whose ID is given by delta. 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 delta is outside the range [0:width-1], the value returned corresponds to the value of var held by the delta 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.

__device__ __nv_bfloat16 __shfl_up_sync (const unsigned mask, const __nv_bfloat16 var, const unsigned int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread with lower ID relative to the caller.

Parameters

mask
- unsigned int. Is only being read.

var
- nv_bfloat16. Is only being read.

delta
- int. Is only being read.

width
- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as nv_bfloat16. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

__device__ __nv_bfloat162 __shfl_up_sync (const unsigned mask, const __nv_bfloat162 var, const unsigned int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread with lower ID relative to the caller.

Parameters

mask
- unsigned int. Is only being read.

var
- nv_bfloat162. Is only being read.

delta
- int. Is only being read.

width
- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as nv_bfloat162. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

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.

__device__ __nv_bfloat16 __shfl_xor_sync (const unsigned mask, const __nv_bfloat16 var, const int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread based on bitwise XOR of own thread ID.

Parameters

mask
- unsigned int. Is only being read.

var
- nv_bfloat16. Is only being read.

delta
- int. Is only being read.

width
- int. Is only being read.

Returns

Returns the 2-byte word referenced by var from the source thread ID as nv_bfloat16. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with mask: 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.

__device__ __nv_bfloat162 __shfl_xor_sync (const unsigned mask, const __nv_bfloat162 var, const int delta, const int width)

Exchange a variable between threads within a warp. Copy from a thread based on bitwise XOR of own thread ID.

Parameters

mask

- unsigned int. Is only being read.

var

- nv_bfloat162. Is only being read.

delta

- int. Is only being read.

width

- int. Is only being read.

Returns

Returns the 4-byte word referenced by var from the source thread ID as nv_bfloat162. If the source thread ID is out of range or the source thread has exited, the calling thread's own var is returned.

Description

Calculates a source thread ID by performing a bitwise XOR of the caller's thread ID with mask: 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.

__device__ __nv_bfloat16 __short2bfloat16_rd (const short int i)

Convert a signed short integer to a nv_bfloat16 in round-down mode.

Parameters

i

- short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed short integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed short integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed short integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the signed short integer value `i` to a nv_bfloat16 floating-point value in round-towards-zero mode.

__device__ __nv_bfloat16 __short_as_bfloat16 (const short int i)

Reinterprets bits in a signed short integer as a `nv_bfloat16`.

Parameters

i

- short int. Is only being read.

Returns

nv_bfloat16

- The

  reinterpreted value.

Description

Reinterprets the bits in the signed short integer `i` as a nv_bfloat16 floating-point number.

__device__ void __stcg (const __nv_bfloat16 *ptr, const __nv_bfloat16 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stcg (const __nv_bfloat162 *ptr, const __nv_bfloat162 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stcs (const __nv_bfloat16 *ptr, const __nv_bfloat16 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stcs (const __nv_bfloat162 *ptr, const __nv_bfloat162 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stwb (const __nv_bfloat16 *ptr, const __nv_bfloat16 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stwb (const __nv_bfloat162 *ptr, const __nv_bfloat162 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stwt (const __nv_bfloat16 *ptr, const __nv_bfloat16 value)

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

Parameters

ptr

- memory location

value

- the value to be stored

__device__ void __stwt (const __nv_bfloat162 *ptr, const __nv_bfloat162 value)

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

Parameters

ptr

- memory location

value

- 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.

Parameters

i

- unsigned int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned long long int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned 64-bit integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned short integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned short integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned short integer value `i` to a nv_bfloat16 floating-point value 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.

Parameters

i

- unsigned short int. Is only being read.

Returns

nv_bfloat16

- i

  converted to nv_bfloat16.

Description

Convert the unsigned short integer value `i` to a nv_bfloat16 floating-point value in round-towards-zero mode.

__device__ __nv_bfloat16 __ushort_as_bfloat16 (const unsigned short int i)

Reinterprets bits in an unsigned short integer as a `nv_bfloat16`.

Parameters

i

- unsigned short int. Is only being read.

Returns

nv_bfloat16

- The

  reinterpreted value.

Description

Reinterprets the bits in the unsigned short integer `i` as a nv_bfloat16 floating-point number.

1.2.6. Bfloat16 Math Functions

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__device__ __nv_bfloat16 hceil (const __nv_bfloat16 h)

Calculate ceiling of the input argument.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  smallest integer value not less than `h`.

Description

Compute 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.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  cosine of `a`.

Description

Calculates `nv_bfloat16` cosine of input `a` in round-to-nearest-even mode.

__device__ __nv_bfloat16 hexp (const __nv_bfloat16 a)

Calculates `nv_bfloat16` natural exponential function in round-to-nearest mode.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  natural exponential function on `a`.

Description

Calculates `nv_bfloat16` natural exponential function of input `a` in round-to-nearest-even mode.

__device__ __nv_bfloat16 hexp10 (const __nv_bfloat16 a)

Calculates `nv_bfloat16` decimal exponential function in round-to-nearest mode.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  decimal exponential function on `a`.

Description

Calculates `nv_bfloat16` decimal exponential function of input `a` in round-to-nearest-even mode.

__device__ __nv_bfloat16 hexp2 (const __nv_bfloat16 a)

Calculates `nv_bfloat16` binary exponential function in round-to-nearest mode.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  binary exponential function on `a`.

Description

Calculates `nv_bfloat16` binary exponential function of input `a` in round-to-nearest-even mode.

__device__ __nv_bfloat16 hfloor (const __nv_bfloat16 h)

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

Parameters

h

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

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

Description

Calculate 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.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  natural logarithm of `a`.

Description

Calculates `nv_bfloat16` natural logarithm of input `a` 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.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  decimal logarithm of `a`.

Description

Calculates `nv_bfloat16` decimal logarithm of input `a` 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.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  binary logarithm of `a`.

Description

Calculates `nv_bfloat16` binary logarithm of input `a` in round-to-nearest-even mode.

__device__ __nv_bfloat16 hrcp (const __nv_bfloat16 a)

Calculates `nv_bfloat16` reciprocal in round-to-nearest-even mode.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  reciprocal of `a`.

Description

Calculates `nv_bfloat16` reciprocal of input `a` 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.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  nearest integer to `h`.

Description

Round `h` to the nearest integer value in nv_bfloat16 floating-point format, with bfloat16way cases rounded to the nearest even integer value.

__device__ __nv_bfloat16 hrsqrt (const __nv_bfloat16 a)

Calculates `nv_bfloat16` reciprocal square root in round-to-nearest-even mode.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  reciprocal square root of `a`.

Description

Calculates `nv_bfloat16` reciprocal square root of input `a` in round-to-nearest mode.

__device__ __nv_bfloat16 hsin (const __nv_bfloat16 a)

Calculates `nv_bfloat16` sine in round-to-nearest-even mode.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  sine of `a`.

Description

Calculates `nv_bfloat16` sine of input `a` 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.

Parameters

a

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  square root of `a`.

Description

Calculates `nv_bfloat16` square root of input `a` in round-to-nearest-even mode.

__device__ __nv_bfloat16 htrunc (const __nv_bfloat16 h)

Truncate input argument to the integral part.

Parameters

h

- nv_bfloat16. Is only being read.

Returns

nv_bfloat16

- The

  truncated integer value.

Description

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

1.2.7. Bfloat162 Math Functions

Bfloat16 Precision Intrinsics

To use these functions, include the header file `cuda_bf16.h` in your program.

__device__ __nv_bfloat162 h2ceil (const __nv_bfloat162 h)

Calculate `nv_bfloat162` vector ceiling of the input argument.

Parameters

h

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector of smallest integers not less than `h`.

Description

For each component of vector `h` compute the smallest integer value not less than `h`.

__device__ __nv_bfloat162 h2cos (const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector cosine in round-to-nearest-even mode.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise cosine on vector `a`.

Description

Calculates `nv_bfloat162` cosine of input vector `a` in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2exp (const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector exponential function in round-to-nearest mode.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise exponential function on vector `a`.

Description

Calculates `nv_bfloat162` exponential function of input vector `a` 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise decimal exponential function on vector `a`.

Description

Calculates `nv_bfloat162` decimal exponential function of input vector `a` 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise binary exponential function on vector `a`.

Description

Calculates `nv_bfloat162` binary exponential function of input vector `a` in round-to-nearest-even mode.

__device__ __nv_bfloat162 h2floor (const __nv_bfloat162 h)

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

Parameters

h

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector of largest integers which is less than or equal to `h`.

Description

For each component of vector `h` calculate the largest integer value 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise natural logarithm on vector `a`.

Description

Calculates `nv_bfloat162` natural logarithm of input vector `a` 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise decimal logarithm on vector `a`.

Description

Calculates `nv_bfloat162` decimal logarithm of input vector `a` 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise binary logarithm on vector `a`.

Description

Calculates `nv_bfloat162` binary logarithm of input vector `a` in round-to-nearest mode.

__device__ __nv_bfloat162 h2rcp (const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector reciprocal in round-to-nearest-even mode.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise reciprocal on vector `a`.

Description

Calculates `nv_bfloat162` reciprocal of input vector `a` 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.

Parameters

h

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  vector of rounded integer values.

Description

Round each component of `nv_bfloat162` vector `h` to the nearest integer value in nv_bfloat16 floating-point format, with bfloat16way cases rounded to the nearest even integer value.

__device__ __nv_bfloat162 h2rsqrt (const __nv_bfloat162 a)

Calculates `nv_bfloat162` vector reciprocal square root in round-to-nearest mode.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise reciprocal square root on vector `a`.

Description

Calculates `nv_bfloat162` reciprocal square root of input vector `a` 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise sine on vector `a`.

Description

Calculates `nv_bfloat162` sine of input vector `a` 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.

Parameters

a

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  elementwise square root on vector `a`.

Description

Calculates `nv_bfloat162` square root of input vector `a` in round-to-nearest mode.

__device__ __nv_bfloat162 h2trunc (const __nv_bfloat162 h)

Truncate `nv_bfloat162` vector input argument to the integral part.

Parameters

h

- nv_bfloat162. Is only being read.

Returns

nv_bfloat162

- The

  truncated `h`.

Description

Round each component of vector `h` to the nearest integer value that does not exceed `h` in magnitude.

1.3. Mathematical Functions

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 rhypot(), cyl_bessel_i0() are only available in device code.

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);
```

1.4. 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.

__device__ float acosf (float x)

Calculate the arc cosine of the input argument.

Returns

Result will be in radians, in the interval [0, π] for x inside [-1, +1].

- acosf(1) returns +0.
- acosf(x) returns NaN for x outside [-1, +1].

Description

Calculate the principal value of the arc cosine of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float acoshf (float x)

Calculate the nonnegative arc hyperbolic cosine of the input argument.

Returns

Result will be in the interval [0, $+\infty$].

- acoshf(1) returns 0.
- acoshf(x) returns NaN for x in the interval [$-\infty$, 1).

Description

Calculate the nonnegative arc hyperbolic cosine of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float asinf (float x)

Calculate the arc sine of the input argument.

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].

Description

Calculate the principal value of the arc sine of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float asinhf (float x)

Calculate the arc hyperbolic sine of the input argument.

Returns

- asinhf(0) returns 1.

Description

Calculate the arc hyperbolic sine of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float atan2f (float y, float x)

Calculate the arc tangent of the ratio of first and second input arguments.

Returns

Result will be in radians, in the interval [- π , + π].

- atan2f(0, 1) returns +0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float atanf (float x)

Calculate the arc tangent of the input argument.

Returns

Result will be in radians, in the interval [- $\pi/2$, + $\pi/2$].

- atanf(0) returns +0.

Description

Calculate the principal value of the arc tangent of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float atanhf (float x)

Calculate the arc hyperbolic tangent of the input argument.

Returns

- atanhf(± 0) returns ± 0.
- atanhf(± 1) returns $\pm \infty$.
- atanhf(x) returns NaN for x outside interval [-1, 1].

Description

Calculate the arc hyperbolic tangent of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float cbrtf (float x)

Calculate the cube root of the input argument.

Returns

Returns $x^{1/3}$.

- cbrtf(± 0) returns ± 0.
- cbrtf($\pm \infty$) returns $\pm \infty$.

Description

Calculate the cube root of x, $x^{1/3}$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float ceilf (float x)

Calculate ceiling of the input argument.

Returns

Returns $\lceil x \rceil$ expressed as a floating-point number.

- ceilf(± 0) returns ± 0.
- ceilf($\pm\infty$) returns $\pm\infty$.

Description

Compute the smallest integer value not less than x.

__device__ float copysignf (float x, float y)

Create value with given magnitude, copying sign of second value.

Returns

Returns a value with the magnitude of x and the sign of y.

Description

Create a floating-point value with the magnitude x and the sign of y.

__device__ float cosf (float x)

Calculate the cosine of the input argument.

Returns

- cosf(0) returns 1.
- cosf($\pm\infty$) returns NaN.

Description

Calculate the cosine of the input argument x (measured in radians).

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 for a complete list of functions affected.

__device__ float coshf (float x)

Calculate the hyperbolic cosine of the input argument.

Returns

- coshf(0) returns 1.
- coshf($\pm\infty$) returns $+\infty$.

Description

Calculate the hyperbolic cosine of the input argument `x`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float cospif (float x)

Calculate the cosine of the input argument $\times\pi$.

Returns

- cospif(± 0) returns 1.
- cospif($\pm\infty$) returns NaN.

Description

Calculate the cosine of `x` $\times\pi$ (measured in radians), where `x` is the input argument.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float cyl_bessel_i0f (float x)

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float cyl_bessel_i1f (float x)

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 1.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float erfcf (float x)

Calculate the complementary error function of the input argument.

Returns

- erfcf($-\infty$) returns 2.
- erfcf($+\infty$) returns +0.

Description

Calculate the complementary error function of the input argument x, 1 - erf(x).

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float erfcinvf (float y)

Calculate the inverse complementary error function of the input argument.

Returns

- erfcinvf(0) returns $+\infty$.
- erfcinvf(2) returns $-\infty$.

Description

Calculate the inverse complementary error function of the input argument y, for y in the interval [0, 2]. The inverse complementary error function find the value x that satisfies the equation y = erfc(x), for $0 \leq y \leq 2$, and $-\infty \leq x \leq \infty$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float erfcxf (float x)

Calculate the scaled complementary error function of the input argument.

Returns

- erfcxf($-\infty$) returns $+\infty$
- erfcxf($+\infty$) returns +0
- erfcxf(x) returns $+\infty$ if the correctly calculated value is outside the single floating-point range.

Description

Calculate the scaled complementary error function of the input argument x, $e^{x^2} \cdot \mathrm{erfc}(x)$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float erff (float x)

Calculate the error function of the input argument.

Returns

- erff(± 0) returns ± 0.
- erff($\pm \infty$) returns ± 1.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float erfinvf (float y)

Calculate the inverse error function of the input argument.

Returns

- erfinvf(1) returns $+\infty$.
- erfinvf(-1) returns $-\infty$.

Description

Calculate the inverse error function of the input argument y, for y in the interval [-1, 1]. The inverse error function finds the value x that satisfies the equation y = erf(x), for $-1 \leq y \leq 1$, and $-\infty \leq x \leq \infty$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float exp10f (float x)

Calculate the base 10 exponential of the input argument.

Returns

Returns 10^x.

Description

Calculate the base 10 exponential of the input argument `x`.

> **Note:**
>
> - For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
> - This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 for a complete list of functions affected.

__device__ float exp2f (float x)

Calculate the base 2 exponential of the input argument.

Returns

Returns 2^x.

Description

Calculate the base 2 exponential of the input argument `x`.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float expf (float x)

Calculate the base e exponential of the input argument.

Returns

Returns e^x.

Description

Calculate the base e exponential of the input argument `x`, e^x.

> **Note:**
>
> - For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
> - This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 for a complete list of functions affected.

__device__ float expm1f (float x)

Calculate the base e exponential of the input argument, minus 1.

Returns

Returns $e^x - 1$.

Description

Calculate the base e exponential of the input argument `x`, minus 1.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fabsf (float x)

Calculate the absolute value of its argument.

Returns

Returns the absolute value of its argument.

- fabs($\pm\infty$) returns $+\infty$.
- fabs(± 0) returns 0.

Description

Calculate the absolute value of the input argument `x`.

> **Note:**

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fdimf (float x, float y)

Compute the positive difference between x and y.

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 $\leq$ y.

Description

Compute the positive difference between x and y. The positive difference is x - y when x > y and +0 otherwise.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fdividef (float x, float y)

Divide two floating-point values.

Returns

Returns x / y.

Description

Compute x divided by y. If `--use_fast_math` is specified, use __fdividef() for higher performance, otherwise use normal division.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 for a complete list of functions affected.

__device__ float floorf (float x)

Calculate the largest integer less than or equal to x.

Returns

Returns $\lfloor x \rfloor$ expressed as a floating-point number.

- floorf($\pm\infty$) returns $\pm\infty$.
- floorf(± 0) returns ± 0.

Description

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

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fmaf (float x, float y, float z)

Compute $x \times y + z$ as a single operation.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.
- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$.
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$.

Description

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.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fmaxf (float x, float y)

Determine the maximum numeric value of the arguments.

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.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fminf (float x, float y)

Determine the minimum numeric value of the arguments.

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.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float fmodf (float x, float y)

Calculate the floating-point remainder of x / y.

Returns

- Returns the floating-point remainder of x / y.
- fmodf(± 0 , y) returns ± 0 if y is not zero.
- fmodf(x, $\pm \infty$) returns x if x is finite.
- fmodf(x, y) returns NaN if x is $\pm \infty$ or y is zero.
- If either argument is NaN, NaN is returned.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float frexpf (float x, int *nptr)

Extract mantissa and exponent of a floating-point value.

Returns

Returns the fractional component m.

- frexp(0, nptr) returns 0 for the fractional component and zero for the integer component.
- frexp(± 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(NaN, y) returns a NaN and stores an unspecified value in the location to which nptr points.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float hypotf (float x, float y)

Calculate the square root of the sum of squares of two arguments.

Returns

Returns the length of the hypotenuse $\sqrt{x^2 + y^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ int ilogbf (float x)

Compute the unbiased integer exponent of the argument.

Returns

- If successful, returns the unbiased exponent of the argument.
- ilogbf(0) returns `INT_MIN`.
- ilogbf(NaN) returns `INT_MIN`.
- ilogbf(x) returns `INT_MAX` if `x` is ∞ or the correct value is greater than `INT_MAX`.
- ilogbf(x) returns `INT_MIN` if the correct value is less than `INT_MIN`.
- Note: above behavior does not take into account `FP_ILOGB0` nor `FP_ILOGBNAN`.

Description

Calculates the unbiased integer exponent of the input argument `x`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ __RETURN_TYPE isfinite (float a)

Determine whether argument is finite.

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.

Description

Determine whether the floating-point value a is a finite value (zero, subnormal, or normal and not infinity or NaN).

__device__ __RETURN_TYPE isinf (float a)

Determine whether argument is infinite.

Returns

- With Visual Studio 2013 host compiler: __RETURN_TYPE is 'bool'. Returns true if and only if a is a infinite value.
- With other host compilers: __RETURN_TYPE is 'int'. Returns a nonzero value if and only if a is a infinite value.

Description

Determine whether the floating-point value a is an infinite value (positive or negative).

__device__ __RETURN_TYPE isnan (float a)

Determine whether argument 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.

Description

Determine whether the floating-point value a 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.

Returns

Returns the value of the Bessel function of the first kind of order 0.

- j0f($\pm\infty$) returns +0.
- j0f(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float j1f (float x)

Calculate the value of the Bessel function of the first kind of order 1 for the input argument.

Returns

Returns the value of the Bessel function of the first kind of order 1.

- j1f(± 0) returns ± 0.
- j1f($\pm\infty$) returns ± 0.
- j1f(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__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.

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, $+\infty$) returns +0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float ldexpf (float x, int exp)

Calculate the value of $x \cdot 2^{exp}$.

Returns

- ldexpf(x) returns $\pm\infty$ if the correctly calculated value is outside the single floating-point range.

Description

Calculate the value of $x \cdot 2^{exp}$ of the input arguments x and exp.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float lgammaf (float x)

Calculate the natural logarithm of the absolute value of the gamma function of the input argument.

Returns

- lgammaf(1) returns +0.
- lgammaf(2) returns +0.
- lgammaf(x) returns $\pm\infty$ if the correctly calculated value is outside the single floating-point range.
- lgammaf(x) returns $+\infty$ if $x \leq 0$ and x is an integer.
- lgammaf($-\infty$) returns $-\infty$.
- lgammaf($+\infty$) returns $+\infty$.

Description

Calculate the natural logarithm of the absolute value of the gamma function of the input argument x, namely the value of $log_e\left|\int_0^{\infty} e^{-t} t^{x-1} dt\right|$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ long long int llrintf (float x)

Round input to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

__device__ long long int llroundf (float x)

Round to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

> **Note:**
>
> This function may be slower than alternate rounding methods. See llrintf().

__device__ float log10f (float x)

Calculate the base 10 logarithm of the input argument.

Returns

- log10f(± 0) returns $-\infty$.
- log10f(1) returns +0.
- log10f(x) returns NaN for x < 0.
- log10f($+\infty$) returns $+\infty$.

Description

Calculate the base 10 logarithm of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float log1pf (float x)

Calculate the value of $log_e(1+x)$.

Returns

- log1pf(± 0) returns ± 0.
- log1pf(-1) returns $-\infty$.
- log1pf(x) returns NaN for x < -1.
- log1pf($+\infty$) returns $+\infty$.

Description

Calculate the value of $log_e(1+x)$ of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float log2f (float x)

Calculate the base 2 logarithm of the input argument.

Returns

- log2f(± 0) returns $-\infty$.
- log2f(1) returns +0.
- log2f(x) returns NaN for x < 0.
- log2f($+\infty$) returns $+\infty$.

Description

Calculate the base 2 logarithm of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float logbf (float x)

Calculate the floating-point representation of the exponent of the input argument.

Returns

- logbf ± 0 returns $-\infty$
- logbf $+\infty$ returns $+\infty$

Description

Calculate the floating-point representation of the exponent of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float logf (float x)

Calculate the natural logarithm of the input argument.

Returns

- logf(± 0) returns $-\infty$.
- logf(1) returns +0.
- logf(x) returns NaN for x < 0.
- logf($+\infty$) returns $+\infty$.

Description

Calculate the natural logarithm of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ long int lrintf (float x)

Round input to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

__device__ long int lroundf (float x)

Round to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

Note:

This function may be slower than alternate rounding methods. See lrintf().

__device__ float max (const float a, const float b)

Calculate the maximum value of the input `float` arguments.

Description

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.

Description

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.

Returns

- modff($\pm x$, `iptr`) returns a result with the same sign as `x`.
- modff($\pm\infty$, `iptr`) returns ± 0 and stores $\pm\infty$ in the object pointed to by `iptr`.
- modff(NaN, `iptr`) stores a NaN in the object pointed to by `iptr` and returns a NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float nanf (const char *tagp)

Returns "Not a Number" value.

Returns

- nanf(`tagp`) returns NaN.

Description

Return a representation of a quiet NaN. Argument `tagp` selects one of the possible representations.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float nearbyintf (float x)

Round the input argument to the nearest integer.

Returns

- nearbyintf(± 0) returns ± 0.
- nearbyintf($\pm\infty$) returns $\pm\infty$.

Description

Round argument `x` to an integer value in single precision floating-point format.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float nextafterf (float x, float y)

Return next representable single-precision floating-point value after argument `x` in the direction of `y`.

Returns

- nextafterf(`x`, `y`) = `y` if `x` equals `y`
- nextafterf(`x`, `y`) = `NaN` if either `x` or `y` are `NaN`

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float norm3df (float a, float b, float c)

Calculate the square root of the sum of squares of three coordinates of the argument.

Returns

Returns the length of the 3D $\sqrt{p.x^2+p.y^2+p.z^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

Calculates the length of three dimensional vector p in Euclidean space without undue overflow or underflow.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__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.

Returns

Returns the length of the 4D vector $\sqrt{p.x^2+p.y^2+p.z^2+p.t^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

Calculates the length of four dimensional vector p in Euclidean space without undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float normcdff (float y)

Calculate the standard normal cumulative distribution function.

Returns

- normcdff($+\infty$) returns 1
- normcdff($-\infty$) returns +0

Description

Calculate the cumulative distribution function of the standard normal distribution for input argument y, $\Phi(y)$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float normcdfinvf (float y)

Calculate the inverse of the standard normal cumulative distribution function.

Returns

- normcdfinvf(0) returns $-\infty$.
- normcdfinvf(1) returns $+\infty$.
- normcdfinvf(x) returns NaN if x is not in the interval [0,1].

Description

Calculate the inverse of the standard normal cumulative distribution function for input argument y, $\Phi^{-1}(y)$. The function is defined for input values in the interval $(0, 1)$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float normf (int dim, const float *a)

Calculate the square root of the sum of squares of any number of coordinates.

Returns

Returns the length of the vector $\sqrt{p.1^2 + p.2^2 + \ldots + p.dim^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

Calculates the length of a vector `p`, dimension of which is passed as an argument without undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float powf (float x, float y)

Calculate the value of first argument to the power of second argument.

Returns

- powf(± 0 , `y`) returns $\pm\infty$ for `y` an integer less than 0.
- powf(± 0 , `y`) returns ± 0 for `y` an odd integer greater than 0.
- powf(± 0 , `y`) returns +0 for `y` > 0 and not and odd integer.
- powf(-1, $\pm\infty$) 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`, $-\infty$) returns $+\infty$ for $|x| < 1$.
- powf(`x`, $-\infty$) returns +0 for $|x| > 1$.
- powf(`x`, $+\infty$) returns +0 for $|x| < 1$.
- powf(`x`, $+\infty$) returns $+\infty$ for $|x| > 1$.
- powf($-\infty$, `y`) returns -0 for `y` an odd integer less than 0.
- powf($-\infty$, `y`) returns +0 for `y` < 0 and not an odd integer.
- powf($-\infty$, `y`) returns $-\infty$ for `y` an odd integer greater than 0.
- powf($-\infty$, `y`) returns $+\infty$ for `y` > 0 and not an odd integer.
- powf($+\infty$, `y`) returns +0 for `y` < 0.

- powf($+\infty$, y) returns $+\infty$ for y > 0.

Description

Calculate the value of x to the power of y.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float rcbrtf (float x)

Calculate reciprocal cube root function.

Returns

- rcbrt(± 0) returns $\pm\infty$.
- rcbrt($\pm\infty$) returns ± 0.

Description

Calculate reciprocal cube root function of x

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float remainderf (float x, float y)

Compute single-precision floating-point remainder.

Returns

- remainderf(x, 0) returns NaN.
- remainderf($\pm\infty$, y) returns NaN.
- remainderf(x, $\pm\infty$) returns x for finite x.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float remquof (float x, float y, int *quo)

Compute single-precision floating-point remainder and part of quotient.

Returns

Returns the remainder.

- remquof(x, 0, quo) returns NaN.
- remquof($\pm\infty$, y, quo) returns NaN.
- remquof(x, $\pm\infty$, quo) returns x.

Description

Compute a double-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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float rhypotf (float x, float y)

Calculate one over the square root of the sum of squares of two arguments.

Returns

Returns one over the length of the hypotenuse $\frac{1}{\sqrt{x^2+y^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float rintf (float x)

Round input to nearest integer value in floating-point.

Returns

Returns rounded integer value.

Description

Round x to the nearest integer value in floating-point format, with halfway cases rounded to the nearest even integer value.

__device__ float rnorm3df (float a, float b, float c)

Calculate one over the square root of the sum of squares of three coordinates of the argument.

Returns

Returns one over the length of the 3D vector $\frac{1}{\sqrt{p.x^2+p.y^2+p.z^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

Calculates one over the length of three dimension vector p in Euclidean space without undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__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 of the argument.

Returns

Returns one over the length of the 3D vector $\frac{1}{\sqrt{p.x^2+p.y^2+p.z^2+p.z^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

Calculates one over the length of four dimension vector `p` in Euclidean space without undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float rnormf (int dim, const float *a)

Calculate the reciprocal of square root of the sum of squares of any number of coordinates.

Returns

Returns one over the length of the vector $\frac{1}{\sqrt{p.1^2+p.2^2+\ldots+p.dim^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float roundf (float x)

Round to nearest integer value in floating-point.

Returns

Returns rounded integer value.

Description

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().

__device__ float rsqrtf (float x)

Calculate the reciprocal of the square root of the input argument.

Returns

Returns $1/\sqrt{x}$.

- rsqrtf($+\infty$) returns +0.
- rsqrtf(± 0) returns $\pm\infty$.
- rsqrtf(x) returns NaN if x is less than 0.

Description

Calculate the reciprocal of the nonnegative square root of x, $1/\sqrt{x}$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float scalblnf (float x, long int n)

Scale floating-point input by integer power of two.

Returns

Returns $x * 2^n$.

- scalblnf(± 0 , n) returns ± 0.
- scalblnf(x, 0) returns x.
- scalblnf($\pm\infty$, n) returns $\pm\infty$.

Description

Scale x by 2^n by efficient manipulation of the floating-point exponent.

__device__ float scalbnf (float x, int n)

Scale floating-point input by integer power of two.

Returns

Returns $x * 2^n$.

- scalbnf(± 0 , n) returns ± 0.
- scalbnf(x, 0) returns x.
- scalbnf($\pm\infty$, n) returns $\pm\infty$.

Description

Scale x by 2^n by efficient manipulation of the floating-point exponent.

__device__ __RETURN_TYPE signbit (float a)

Return the sign bit of the input.

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.

Description

Determine whether the floating-point value a is negative.

__device__ void sincosf (float x, float *sptr, float *cptr)

Calculate the sine and cosine of the first input argument.

Returns

- none

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 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 $\times \pi$.

Returns

- none

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float sinf (float x)

Calculate the sine of the input argument.

Returns

- sinf(± 0) returns ± 0.
- sinf($\pm \infty$) returns NaN.

Description

Calculate the sine of the input argument `x` (measured in radians).

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 for a complete list of functions affected.

__device__ float sinhf (float x)

Calculate the hyperbolic sine of the input argument.

Returns

- sinhf(± 0) returns ± 0.
- sinhf($\pm \infty$) returns $\pm \infty$.

Description

Calculate the hyperbolic sine of the input argument `x`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float sinpif (float x)

Calculate the sine of the input argument $\times \pi$.

Returns

- sinpif(± 0) returns ± 0.
- sinpif($\pm \infty$) returns NaN.

Description

Calculate the sine of x $\times \pi$ (measured in radians), where x is the input argument.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float sqrtf (float x)

Calculate the square root of the input argument.

Returns

Returns $\sqrt{x}$.

- sqrtf(± 0) returns ± 0.
- sqrtf($+\infty$) returns $+\infty$.
- sqrtf(x) returns NaN if x is less than 0.

Description

Calculate the nonnegative square root of x, $\sqrt{x}$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float tanf (float x)

Calculate the tangent of the input argument.

Returns

- tanf(± 0) returns ± 0.
- tanf($\pm\infty$) returns NaN.

Description

Calculate the tangent of the input argument x (measured in radians).

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This function is affected by the `--use_fast_math` compiler flag. See the CUDA C++ Programming Guide, Appendix E.2, Table 8 for a complete list of functions affected.

__device__ float tanhf (float x)

Calculate the hyperbolic tangent of the input argument.

Returns

- tanhf(± 0) returns ± 0.

Description

Calculate the hyperbolic tangent of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float tgammaf (float x)

Calculate the gamma function of the input argument.

Returns

- tgammaf(± 0) returns $\pm\infty$.

- tgammaf(2) returns +1.
- tgammaf(x) returns $\pm\infty$ if the correctly calculated value is outside the single floating-point range.
- tgammaf(x) returns NaN if x < 0 and x is an integer.
- tgammaf($-\infty$) returns NaN.
- tgammaf($+\infty$) returns $+\infty$.

Description

Calculate the gamma function of the input argument x, namely the value of $\int_0^\infty e^{-t}t^{x-1}dt$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float truncf (float x)

Truncate input argument to the integral part.

Returns

Returns truncated integer value.

Description

Round x to the nearest integer value that does not exceed x in magnitude.

__device__ float y0f (float x)

Calculate the value of the Bessel function of the second kind of order 0 for the input argument.

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($+\infty$) returns +0.
- y0f(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float y1f (float x)

Calculate the value of the Bessel function of the second kind of order 1 for the input argument.

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($+\infty$) returns +0.
- y1f(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__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.

Returns

Returns the value of the Bessel function of the second kind of order n.

- ynf(n, x) returns NaN for n < 0.
- ynf(n, 0) returns $-\infty$.
- ynf(n, x) returns NaN for x < 0.
- ynf(n, $+\infty$) returns +0.
- ynf(n, NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

1.5. 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.

__device__ double acos (double x)

Calculate the arc cosine of the input argument.

Returns

Result will be in radians, in the interval [0, π] for `x` inside [-1, +1].

- acos(1) returns +0.
- acos(`x`) returns NaN for `x` outside [-1, +1].

Description

Calculate the principal value of the arc cosine of the input argument `x`.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double acosh (double x)

Calculate the nonnegative arc hyperbolic cosine of the input argument.

Returns

Result will be in the interval [0, $+\infty$].

- acosh(1) returns 0.
- acosh(x) returns NaN for x in the interval [$-\infty$, 1).

Description

Calculate the nonnegative arc hyperbolic cosine of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double asin (double x)

Calculate the arc sine of the input argument.

Returns

Result will be in radians, in the interval [- π /2, + π /2] for x inside [-1, +1].

- asin(0) returns +0.
- asin(x) returns NaN for x outside [-1, +1].

Description

Calculate the principal value of the arc sine of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double asinh (double x)

Calculate the arc hyperbolic sine of the input argument.

Returns

- asinh(0) returns 1.

Description

Calculate the arc hyperbolic sine of the input argument x.

> **Note:**

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double atan (double x)

Calculate the arc tangent of the input argument.

Returns

Result will be in radians, in the interval [- π /2, + π /2].

- atan(0) returns +0.

Description

Calculate the principal value of the arc tangent of the input argument `x`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double atan2 (double y, double x)

Calculate the arc tangent of the ratio of first and second input arguments.

Returns

Result will be in radians, in the interval [- π /, + π].

- atan2(0, 1) returns +0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double atanh (double x)

Calculate the arc hyperbolic tangent of the input argument.

Returns

- atanh(± 0) returns ± 0.
- atanh(± 1) returns $\pm \infty$.
- atanh(x) returns NaN for x outside interval [-1, 1].

Description

Calculate the arc hyperbolic tangent of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double cbrt (double x)

Calculate the cube root of the input argument.

Returns

Returns $x^{1/3}$.

- cbrt(± 0) returns ± 0.
- cbrt($\pm \infty$) returns $\pm \infty$.

Description

Calculate the cube root of x, $x^{1/3}$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double ceil (double x)

Calculate ceiling of the input argument.

Returns

Returns $\lceil x \rceil$ expressed as a floating-point number.

- ceil(± 0) returns ± 0.
- ceil($\pm\infty$) returns $\pm\infty$.

Description

Compute the smallest integer value not less than x.

__device__ double copysign (double x, double y)

Create value with given magnitude, copying sign of second value.

Returns

Returns a value with the magnitude of x and the sign of y.

Description

Create a floating-point value with the magnitude x and the sign of y.

__device__ double cos (double x)

Calculate the cosine of the input argument.

Returns

- cos(± 0) returns 1.
- cos($\pm\infty$) returns NaN.

Description

Calculate the cosine of the input argument x (measured in radians).

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double cosh (double x)

Calculate the hyperbolic cosine of the input argument.

Returns

- cosh(0) returns 1.
- cosh($\pm\infty$) returns $+\infty$.

Description

Calculate the hyperbolic cosine of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double cospi (double x)

Calculate the cosine of the input argument $\times \pi$.

Returns

- cospi(± 0) returns 1.
- cospi($\pm \infty$) returns NaN.

Description

Calculate the cosine of x $\times \pi$ (measured in radians), where x is the input argument.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double cyl_bessel_i0 (double x)

Calculate the value of the regular modified cylindrical Bessel function of order 0 for the input argument.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double cyl_bessel_i1 (double x)

Calculate the value of the regular modified cylindrical Bessel function of order 1 for the input argument.

Returns

Returns the value of the regular modified cylindrical Bessel function of order 1.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double erf (double x)

Calculate the error function of the input argument.

Returns

- erf(± 0) returns ± 0.
- erf($\pm \infty$) returns ± 1.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double erfc (double x)

Calculate the complementary error function of the input argument.

Returns

- erfc($-\infty$) returns 2.
- erfc($+\infty$) returns +0.

Description

Calculate the complementary error function of the input argument `x`, 1 - erf(`x`).

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double erfcinv (double y)

Calculate the inverse complementary error function of the input argument.

Returns

- erfcinv(0) returns $+\infty$.
- erfcinv(2) returns $-\infty$.

Description

Calculate the inverse complementary error function of the input argument `y`, for `y` in the interval [0, 2]. The inverse complementary error function find the value `x` that satisfies the equation `y` = erfc(`x`), for $0 \le y \le 2$, and $-\infty \le x \le \infty$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double erfcx (double x)

Calculate the scaled complementary error function of the input argument.

Returns

- erfcx($-\infty$) returns $+\infty$

- erfcx($+\infty$) returns +0
- erfcx(x) returns $+\infty$ if the correctly calculated value is outside the double floating-point range.

Description

Calculate the scaled complementary error function of the input argument x, $e^{x^2} \cdot \mathrm{erfc}(x)$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double erfinv (double y)

Calculate the inverse error function of the input argument.

Returns

- erfinv(1) returns $+\infty$.
- erfinv(-1) returns $-\infty$.

Description

Calculate the inverse error function of the input argument y, for y in the interval [-1, 1]. The inverse error function finds the value x that satisfies the equation y = erf(x), for $-1 \leq y \leq 1$, and $-\infty \leq x \leq \infty$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double exp (double x)

Calculate the base e exponential of the input argument.

Returns

Returns e^x.

Description

Calculate the base e exponential of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double exp10 (double x)

Calculate the base 10 exponential of the input argument.

Returns

Returns 10^x.

Description

Calculate the base 10 exponential of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double exp2 (double x)

Calculate the base 2 exponential of the input argument.

Returns

Returns 2^x.

Description

Calculate the base 2 exponential of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double expm1 (double x)

Calculate the base e exponential of the input argument, minus 1.

Returns

Returns $e^x - 1$.

Description

Calculate the base e exponential of the input argument x, minus 1.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double fabs (double x)

Calculate the absolute value of the input argument.

Returns

Returns the absolute value of the input argument.

- fabs($\pm\infty$) returns $+\infty$.
- fabs(± 0) returns 0.

Description

Calculate the absolute value of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double fdim (double x, double y)

Compute the positive difference between x and y.

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.

Description

Compute the positive difference between x and y. The positive difference is x - y when x > y and +0 otherwise.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ double floor (double x)

Calculate the largest integer less than or equal to x.

Returns

Returns $\lfloor x \rfloor$ expressed as a floating-point number.

- floor($\pm\infty$) returns $\pm\infty$.
- floor(± 0) returns ± 0.

Description

Calculates the largest integer value which is less than or equal to x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double fma (double x, double y, double z)

Compute $x \times y + z$ as a single operation.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fma($\pm\infty$, ± 0 , z) returns NaN.
- fma(± 0 , $\pm\infty$, z) returns NaN.
- fma(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$.
- fma(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$.

Description

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.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double fmax (double, double)

Determine the maximum numeric value of the arguments.

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.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double fmin (double x, double y)

Determine the minimum numeric value of the arguments.

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.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double fmod (double x, double y)

Calculate the double-precision floating-point remainder of x / y.

Returns

- Returns the floating-point remainder of x / y.
- fmod(± 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.

Description

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*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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double frexp (double x, int *nptr)

Extract mantissa and exponent of a floating-point value.

Returns

Returns the fractional component m.

- frexp(0, nptr) returns 0 for the fractional component and zero for the integer component.
- frexp(± 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(NaN, y) returns a NaN and stores an unspecified value in the location to which nptr points.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double hypot (double x, double y)

Calculate the square root of the sum of squares of two arguments.

Returns

Returns the length of the hypotenuse $\sqrt{x^2 + y^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ int ilogb (double x)

Compute the unbiased integer exponent of the argument.

Returns

- If successful, returns the unbiased exponent of the argument.
- ilogb(0) returns `INT_MIN`.
- ilogb(NaN) returns `INT_MIN`.
- ilogb(`x`) returns `INT_MAX` if `x` is ∞ or the correct value is greater than `INT_MAX`.
- ilogb(`x`) returns `INT_MIN` if the correct value is less than `INT_MIN`.
- Note: above behavior does not take into account `FP_ILOGB0` nor `FP_ILOGBNAN`.

Description

Calculates the unbiased integer exponent of the input argument `x`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ __RETURN_TYPE isfinite (double a)

Determine whether argument is finite.

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.

Description

Determine whether the floating-point value a is a finite value (zero, subnormal, or normal and not infinity or NaN).

__device__ __RETURN_TYPE isinf (double a)

Determine whether argument is infinite.

Returns

- With Visual Studio 2013 host compiler: Returns true if and only if a is a infinite value.
- With other host compilers: Returns a nonzero value if and only if a is a infinite value.

Description

Determine whether the floating-point value a is an infinite value (positive or negative).

__device__ __RETURN_TYPE isnan (double a)

Determine whether argument 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.

Description

Determine whether the floating-point value a 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.

Returns

Returns the value of the Bessel function of the first kind of order 0.

- j0($\pm\infty$) returns +0.
- j0(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double j1 (double x)

Calculate the value of the Bessel function of the first kind of order 1 for the input argument.

Returns

Returns the value of the Bessel function of the first kind of order 1.

- j1(± 0) returns ± 0.
- j1($\pm\infty$) returns ± 0.
- j1(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__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.

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.
- jn(n, $+\infty$) returns +0.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double ldexp (double x, int exp)

Calculate the value of $x \cdot 2^{exp}$.

Returns

- ldexp(x) returns $\pm\infty$ if the correctly calculated value is outside the double floating-point range.

Description

Calculate the value of $x \cdot 2^{exp}$ of the input arguments x and exp.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double lgamma (double x)

Calculate the natural logarithm of the absolute value of the gamma function of the input argument.

Returns

- lgamma(1) returns +0.
- lgamma(2) returns +0.
- lgamma(x) returns $\pm\infty$ if the correctly calculated value is outside the double floating-point range.
- lgamma(x) returns $+\infty$ if x $\leq$ 0 and x is an integer.
- lgamma($-\infty$) returns $-\infty$.
- lgamma($+\infty$) returns $+\infty$.

Description

Calculate the natural logarithm of the absolute value of the gamma function of the input argument x, namely the value of $\log_e\left|\int_0^\infty e^{-t}t^{x-1}dt\right|$

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ long long int llrint (double x)

Round input to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

__device__ long long int llround (double x)

Round to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

Note:

This function may be slower than alternate rounding methods. See llrint().

__device__ double log (double x)

Calculate the base e logarithm of the input argument.

Returns

- log(± 0) returns $-\infty$.
- log(1) returns +0.
- log(x) returns NaN for x < 0.
- log($+\infty$) returns $+\infty$

Description

Calculate the base e logarithm of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double log10 (double x)

Calculate the base 10 logarithm of the input argument.

Returns

- log10(± 0) returns $-\infty$.
- log10(1) returns +0.
- log10(x) returns NaN for x < 0.
- log10($+\infty$) returns $+\infty$.

Description

Calculate the base 10 logarithm of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double log1p (double x)

Calculate the value of $log_e(1+x)$.

Returns

- log1p(± 0) returns ± 0 .
- log1p(-1) returns $-\infty$.
- log1p(x) returns NaN for x < -1.
- log1p($+\infty$) returns $+\infty$.

Description

Calculate the value of $log_e(1+x)$ of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double log2 (double x)

Calculate the base 2 logarithm of the input argument.

Returns

- log2(± 0) returns $-\infty$.
- log2(1) returns +0.
- log2(x) returns NaN for x < 0.
- log2($+\infty$) returns $+\infty$.

Description

Calculate the base 2 logarithm of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double logb (double x)

Calculate the floating-point representation of the exponent of the input argument.

Returns

- logb ± 0 returns $-\infty$
- logb $\pm\infty$ returns $+\infty$

Description

Calculate the floating-point representation of the exponent of the input argument x.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ long int lrint (double x)

Round input to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

__device__ long int lround (double x)

Round to nearest integer value.

Returns

Returns rounded integer value.

Description

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 result is undefined.

Note:

This function may be slower than alternate rounding methods. See lrint().

__device__ double max (const double a, const float b)

Calculate the maximum value of the input `double` and `float` arguments.

Description

Convert `float` argument `b` to `double`, followed by fmax().

Note, this is different from `std::` specification

__device__ double max (const float a, const double b)

Calculate the maximum value of the input `float` and `double` arguments.

Description

Convert `float` argument `a` 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.

Description

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 double a, const float b)

Calculate the minimum value of the input `double` and `float` arguments.

Description

Convert `float` argument `b` to `double`, followed by fmin().

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.

Description

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.

Description

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 modf (double x, double *iptr)

Break down the input argument into fractional and integral parts.

Returns

- modf($\pm x$, `iptr`) returns a result with the same sign as `x`.
- modf($\pm\infty$, `iptr`) returns ± 0 and stores $\pm\infty$ in the object pointed to by `iptr`.
- modf(NaN, `iptr`) stores a NaN in the object pointed to by `iptr` and returns a NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double nan (const char *tagp)

Returns "Not a Number" value.

Returns

- nan(`tagp`) returns NaN.

Description

Return a representation of a quiet NaN. Argument `tagp` selects one of the possible representations.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double nearbyint (double x)

Round the input argument to the nearest integer.

Returns

- nearbyint(± 0) returns ± 0.
- nearbyint($\pm\infty$) returns $\pm\infty$.

Description

Round argument `x` to an integer value in double precision floating-point format.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double nextafter (double x, double y)

Return next representable double-precision floating-point value after argument `x` in the direction of `y`.

Returns

- nextafter(`x`, `y`) = `y` if `x` equals `y`
- nextafter(`x`, `y`) = `NaN` if either `x` or `y` are `NaN`

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double norm (int dim, const double *t)

Calculate the square root of the sum of squares of any number of coordinates.

Returns

Returns the length of the dim-D vector $\sqrt{p.1^2 + p.2^2 + \ldots + p.dim^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0. If two of the input arguments is 0, returns remaining argument

Description

Calculate the length of a vector p, dimension of which is passed as an argument `without` undue overflow or underflow.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double norm3d (double a, double b, double c)

Calculate the square root of the sum of squares of three coordinates of the argument.

Returns

Returns the length of 3D vector $\sqrt{p.x^2 + p.y^2 + p.z^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

Calculate the length of three dimensional vector p in Euclidean space without undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__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.

Returns

Returns the length of 4D vector $\sqrt{p.x^2 + p.y^2 + p.z^2 + p.t^2}$. If the correct value would overflow, returns $+\infty$. If the correct value would underflow, returns 0.

Description

Calculate the length of four dimensional vector p in Euclidean space without undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double normcdf (double y)

Calculate the standard normal cumulative distribution function.

Returns

- normcdf($+\infty$) returns 1
- normcdf($-\infty$) returns +0

Description

Calculate the cumulative distribution function of the standard normal distribution for input argument y, $\Phi(y)$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double normcdfinv (double y)

Calculate the inverse of the standard normal cumulative distribution function.

Returns

- normcdfinv(0) returns $-\infty$.
- normcdfinv(1) returns $+\infty$.
- normcdfinv(x) returns NaN if x is not in the interval [0,1].

Description

Calculate the inverse of the standard normal cumulative distribution function for input argument y, $\Phi^{-1}(y)$. The function is defined for input values in the interval $(0, 1)$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double pow (double x, double y)

Calculate the value of first argument to the power of second argument.

Returns

- pow(± 0 , y) returns $\pm\infty$ for y an integer less than 0.
- pow(± 0 , y) returns ± 0 for y an odd integer greater than 0.
- pow(± 0 , y) returns +0 for y > 0 and not and 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.

Description

Calculate the value of x to the power of y

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double rcbrt (double x)

Calculate reciprocal cube root function.

Returns

- rcbrt(± 0) returns $\pm\infty$.
- rcbrt($\pm\infty$) returns ± 0.

Description

Calculate reciprocal cube root function of x

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double remainder (double x, double y)

Compute double-precision floating-point remainder.

Returns

- remainder(x, 0) returns NaN.
- remainder($\pm\infty$, y) returns NaN.

- remainder(x, $\pm\infty$) returns x for finite x.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double remquo (double x, double y, int *quo)

Compute double-precision floating-point remainder and part of quotient.

Returns

Returns the remainder.

- remquo(x, 0, quo) returns NaN.
- remquo($\pm\infty$, y, quo) returns NaN.
- remquo(x, $\pm\infty$, quo) returns x.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double rhypot (double x, double y)

Calculate one over the square root of the sum of squares of two arguments.

Returns

Returns one over the length of the hypotenuse $\frac{1}{\sqrt{x^2+y^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double rint (double x)

Round to nearest integer value in floating-point.

Returns

Returns rounded integer value.

Description

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

__device__ double rnorm (int dim, const double *t)

Calculate the reciprocal of square root of the sum of squares of any number of coordinates.

Returns

Returns one over the length of the vector $\frac{1}{\sqrt{\mathrm{p.1}^2+\mathrm{p.2}^2+\ \ldots\ +\mathrm{p.dim}^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double rnorm3d (double a, double b, double c)

Calculate one over the square root of the sum of squares of three coordinates of the argument.

Returns

Returns one over the length of the 3D vector $\frac{1}{\sqrt{p.x^2+p.y^2+p.z^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

Calculate one over the length of three dimensional vector `p` in Euclidean space undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__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 of the argument.

Returns

Returns one over the length of the 3D vector $\frac{1}{\sqrt{p.x^2+p.y^2+p.z^2+p.t^2}}$. If the square root would overflow, returns 0. If the square root would underflow, returns $+\infty$.

Description

Calculate one over the length of four dimensional vector `p` in Euclidean space undue overflow or underflow.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double round (double x)

Round to nearest integer value in floating-point.

Returns

Returns rounded integer value.

Description

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().

__device__ double rsqrt (double x)

Calculate the reciprocal of the square root of the input argument.

Returns

Returns $1/\sqrt{x}$.

- rsqrt($+\infty$) returns +0.
- rsqrt(± 0) returns $\pm\infty$.
- rsqrt(x) returns NaN if x is less than 0.

Description

Calculate the reciprocal of the nonnegative square root of x, $1/\sqrt{x}$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double scalbln (double x, long int n)

Scale floating-point input by integer power of two.

Returns

Returns x * 2^n.

- scalbln(± 0 , n) returns ± 0.
- scalbln(x, 0) returns x.
- scalbln($\pm \infty$, n) returns $\pm \infty$.

Description

Scale x by 2^n by efficient manipulation of the floating-point exponent.

__device__ double scalbn (double x, int n)

Scale floating-point input by integer power of two.

Returns

Returns x * 2^n.

- scalbn(± 0 , n) returns ± 0.
- scalbn(x, 0) returns x.
- scalbn($\pm \infty$, n) returns $\pm \infty$.

Description

Scale x by 2^n by efficient manipulation of the floating-point exponent.

__device__ __RETURN_TYPE signbit (double a)

Return the sign bit of the input.

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.

Description

Determine whether the floating-point value a is negative.

__device__ double sin (double x)

Calculate the sine of the input argument.

Returns

- sin(± 0) returns ± 0.
- sin($\pm \infty$) returns NaN.

Description

Calculate the sine of the input argument `x` (measured in radians).

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ void sincos (double x, double *sptr, double *cptr)

Calculate the sine and cosine of the first input argument.

Returns

- none

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ void sincospi (double x, double *sptr, double *cptr)

Calculate the sine and cosine of the first input argument $\times \pi$.

Returns

- none

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double sinh (double x)

Calculate the hyperbolic sine of the input argument.

Returns

- sinh(± 0) returns ± 0.
- sinh($\pm \infty$) returns $\pm \infty$.

Description

Calculate the hyperbolic sine of the input argument `x`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double sinpi (double x)

Calculate the sine of the input argument $\times \pi$.

Returns

- sinpi(± 0) returns ± 0.
- sinpi($\pm \infty$) returns NaN.

Description

Calculate the sine of x $\times \pi$ (measured in radians), where x is the input argument.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double sqrt (double x)

Calculate the square root of the input argument.

Returns

Returns $\sqrt{x}$.

- sqrt(± 0) returns ± 0.
- sqrt($+\infty$) returns $+\infty$.
- sqrt(x) returns NaN if x is less than 0.

Description

Calculate the nonnegative square root of x, $\sqrt{x}$.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double tan (double x)

Calculate the tangent of the input argument.

Returns

- tan(± 0) returns ± 0.
- tan($\pm \infty$) returns NaN.

Description

Calculate the tangent of the input argument x (measured in radians).

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double tanh (double x)

Calculate the hyperbolic tangent of the input argument.

Returns

- tanh(± 0) returns ± 0.

Description

Calculate the hyperbolic tangent of the input argument x.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double tgamma (double x)

Calculate the gamma function of the input argument.

Returns

- tgamma(± 0) returns $\pm \infty$.
- tgamma(2) returns +1.
- tgamma(x) returns $\pm \infty$ if the correctly calculated value is outside the double floating-point range.

- tgamma(x) returns NaN if x < 0 and x is an integer.
- tgamma($-\infty$) returns NaN.
- tgamma($+\infty$) returns $+\infty$.

Description

Calculate the gamma function of the input argument x, namely the value of $\int_0^{\infty} e^{-t} t^{x-1} dt$.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double trunc (double x)

Truncate input argument to the integral part.

Returns

Returns truncated integer value.

Description

Round x to the nearest integer value that does not exceed x in magnitude.

__device__ double y0 (double x)

Calculate the value of the Bessel function of the second kind of order 0 for the input argument.

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($+\infty$) returns +0.
- y0(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double y1 (double x)

Calculate the value of the Bessel function of the second kind of order 1 for the input argument.

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($+\infty$) returns +0.
- y1(NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__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.

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, $+\infty$) returns +0.
- yn(n, NaN) returns NaN.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

1.6. 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.

__device__ int abs (int a)

Calculate the absolute value of the input `int` argument.

Description

Calculate the absolute value of the input argument `a`.

__device__ long int labs (long int a)

Calculate the absolute value of the input `long int` argument.

Description

Calculate the absolute value of the input argument `a`.

__device__ long long int llabs (long long int a)

Calculate the absolute value of the input `long long int` argument.

Description

Calculate the absolute value of the input argument `a`.

__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.

Description

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.

Description

Calculate the minimum 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.

Description

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.

Description

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.

Description

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.

Description

Calculate the maximum value of the arguments `a` and `b`.

__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.

Description

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

__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.

Description

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.

Description

Calculate the maximum value of the arguments `a` and `b`.

__device__ long int max (const long int a, const long int b)

Calculate the maximum value of the input `long int` arguments.

Description

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.

Description

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

__device__ unsigned int max (const int a, const unsigned int b)

Calculate the maximum value of the input `int` and `unsigned int` arguments.

Description

Calculate the maximum value of the arguments `a` and `b`, perform integer promotion first.

__device__ unsigned int max (const unsigned int a, const unsigned int b)

Calculate the maximum value of the input `unsigned int` arguments.

Description

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.

Description

Calculate the maximum 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.

Description

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.

Description

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.

Description

Calculate the minimum value of the arguments `a` and `b`.

__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.

Description

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.

Description

Calculate the minimum 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.

Description

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.

Description

Calculate the minimum value of the arguments `a` and `b`.

__device__ long int min (const long int a, const long int b)

Calculate the minimum value of the input `long int` arguments.

Description

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.

Description

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

__device__ unsigned int min (const int a, const unsigned int b)

Calculate the minimum value of the input `int` and `unsigned int` arguments.

Description

Calculate the minimum value of the arguments `a` and `b`, perform integer promotion first.

__device__ unsigned int min (const unsigned int a, const unsigned int b)

Calculate the minimum value of the input `unsigned int` arguments.

Description

Calculate the minimum value of the arguments `a` and `b`.

__device__ int min (const int a, const int b)

Calculate the minimum value of the input `int` arguments.

Description

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.

Description

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.

Description

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.

Description

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.

Description

Calculate the minimum value of the arguments `a` and `b`.

1.7. 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.

__device__ float __cosf (float x)

Calculate the fast approximate cosine of the input argument.

Returns

Returns the approximate cosine of `x`.

Description

Calculate the fast approximate cosine of the input argument `x`, measured in radians.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Input and output in the denormal range is flushed to sign preserving 0.0.

__device__ float __exp10f (float x)

Calculate the fast approximate base 10 exponential of the input argument.

Returns

Returns an approximation to 10^x.

Description

Calculate the fast approximate base 10 exponential of the input argument `x`, 10^x.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Most input and output values around denormal range are flushed to sign preserving 0.0.

__device__ float __expf (float x)

Calculate the fast approximate base e exponential of the input argument.

Returns

Returns an approximation to e^x.

Description

Calculate the fast approximate base e exponential of the input argument x, e^x.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Most input and output values around denormal range are flushed to sign preserving 0.0.

__device__ float __fadd_rd (float x, float y)

Add two floating-point values in round-down mode.

Returns

Returns x + y.

Description

Compute the sum of x and y in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fadd_rn (float x, float y)

Add two floating-point values in round-to-nearest-even mode.

Returns

Returns x + y.

Description

Compute the sum of x and y in round-to-nearest-even rounding mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fadd_ru (float x, float y)

Add two floating-point values in round-up mode.

Returns

Returns x + y.

Description

Compute the sum of x and y in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fadd_rz (float x, float y)

Add two floating-point values in round-towards-zero mode.

Returns

Returns x + y.

Description

Compute the sum of x and y in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fdiv_rd (float x, float y)

Divide two floating-point values in round-down mode.

Returns

Returns x / y.

Description

Divide two floating-point values x by y in round-down (to negative infinity) mode.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fdiv_rn (float x, float y)

Divide two floating-point values in round-to-nearest-even mode.

Returns

Returns x / y.

Description

Divide two floating-point values x by y in round-to-nearest-even mode.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fdiv_ru (float x, float y)

Divide two floating-point values in round-up mode.

Returns

Returns x / y.

Description

Divide two floating-point values x by y in round-up (to positive infinity) mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fdiv_rz (float x, float y)

Divide two floating-point values in round-towards-zero mode.

Returns

Returns x / y.

Description

Divide two floating-point values x by y in round-towards-zero mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fdividef (float x, float y)

Calculate the fast approximate division of the input arguments.

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.

Description

Calculate the fast approximate division of `x` by `y`.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.

__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.

Description

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.

Description

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.

Description

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.

Description

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.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , `z`) returns NaN.
- fmaf(± 0 , $\pm\infty$, `z`) returns NaN.
- fmaf(`x`, `y`, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$.
- fmaf(`x`, `y`, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__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.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , `z`) returns NaN.
- fmaf(± 0 , $\pm\infty$, `z`) returns NaN.
- fmaf(`x`, `y`, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$.
- fmaf(`x`, `y`, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fmaf_ru (float x, float y, float z)

Compute $x \times y + z$ as a single operation, in round-up mode.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.
- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$.
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fmaf_rz (float x, float y, float z)

Compute $x \times y + z$ as a single operation, in round-towards-zero mode.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.
- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$.
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fmul_rd (float x, float y)

Multiply two floating-point values in round-down mode.

Returns

Returns `x` * `y`.

Description

Compute the product of `x` and `y` in round-down (to negative infinity) mode.

> **Note:**
>
> - For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
> - This operation will never be merged into a single multiply-add instruction.

__device__ float __fmul_rn (float x, float y)

Multiply two floating-point values in round-to-nearest-even mode.

Returns

Returns `x` * `y`.

Description

Compute the product of `x` and `y` in round-to-nearest-even mode.

> **Note:**
>
> - For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

- This operation will never be merged into a single multiply-add instruction.

__device__ float __fmul_ru (float x, float y)

Multiply two floating-point values in round-up mode.

Returns

Returns x * y.

Description

Compute the product of x and y in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fmul_rz (float x, float y)

Multiply two floating-point values in round-towards-zero mode.

Returns

Returns x * y.

Description

Compute the product of x and y in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __frcp_rd (float x)

Compute $\frac{1}{x}$ in round-down mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-down (to negative infinity) mode.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __frcp_rn (float x)

Compute $\frac{1}{x}$ in round-to-nearest-even mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-to-nearest-even mode.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __frcp_ru (float x)

Compute $\frac{1}{x}$ in round-up mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-up (to positive infinity) mode.

Note:

For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __frcp_rz (float x)

Compute $\frac{1}{x}$ in round-towards-zero mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-towards-zero mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __frsqrt_rn (float x)

Compute $1/\sqrt{x}$ in round-to-nearest-even mode.

Returns

Returns $1/\sqrt{x}$.

Description

Compute the reciprocal square root of x in round-to-nearest-even mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fsqrt_rd (float x)

Compute $\sqrt{x}$ in round-down mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of `x` in round-down (to negative infinity) mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fsqrt_rn (float x)

Compute $\sqrt{x}$ in round-to-nearest-even mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of `x` in round-to-nearest-even mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fsqrt_ru (float x)

Compute $\sqrt{x}$ in round-up mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of `x` in round-up (to positive infinity) mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fsqrt_rz (float x)

Compute $\sqrt{x}$ in round-towards-zero mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of x in round-towards-zero mode.

> **Note:**
>
> For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.

__device__ float __fsub_rd (float x, float y)

Subtract two floating-point values in round-down mode.

Returns

Returns x - y.

Description

Compute the difference of x and y in round-down (to negative infinity) mode.

> **Note:**
>
> - For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
> - This operation will never be merged into a single multiply-add instruction.

__device__ float __fsub_rn (float x, float y)

Subtract two floating-point values in round-to-nearest-even mode.

Returns

Returns x - y.

Description

Compute the difference of x and y in round-to-nearest-even rounding mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fsub_ru (float x, float y)

Subtract two floating-point values in round-up mode.

Returns

Returns `x - y`.

Description

Compute the difference of `x` and `y` in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __fsub_rz (float x, float y)

Subtract two floating-point values in round-towards-zero mode.

Returns

Returns `x - y`.

Description

Compute the difference of `x` and `y` in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 6.
- This operation will never be merged into a single multiply-add instruction.

__device__ float __log10f (float x)

Calculate the fast approximate base 10 logarithm of the input argument.

Returns

Returns an approximation to $\log_{10}(x)$.

Description

Calculate the fast approximate base 10 logarithm of the input argument x.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Most input and output values around denormal range are flushed to sign preserving 0.0.

__device__ float __log2f (float x)

Calculate the fast approximate base 2 logarithm of the input argument.

Returns

Returns an approximation to $\log_2(x)$.

Description

Calculate the fast approximate base 2 logarithm of the input argument x.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Input and output in the denormal range is flushed to sign preserving 0.0.

__device__ float __logf (float x)

Calculate the fast approximate base e logarithm of the input argument.

Returns

Returns an approximation to $\log_e(x)$.

Description

Calculate the fast approximate base e logarithm of the input argument `x`.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Most input and output values around denormal range are flushed to sign preserving 0.0.

__device__ float __powf (float x, float y)

Calculate the fast approximate of x^y.

Returns

Returns an approximation to x^y.

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Most input and output values around denormal range are flushed to sign preserving 0.0.

__device__ float __saturatef (float x)

Clamp the input argument to [+0.0, 1.0].

Returns

- __saturatef(`x`) returns 0 if `x` < 0.
- __saturatef(`x`) returns 1 if `x` > 1.
- __saturatef(`x`) returns `x` if $0 \leq x \leq 1$.
- __saturatef(NaN) returns 0.

Description

Clamp the input argument `x` to be within the interval [+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.

Returns

- none

Description

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`.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Denorm input/output is flushed to sign preserving 0.0.

__device__ float __sinf (float x)

Calculate the fast approximate sine of the input argument.

Returns

Returns the approximate sine of `x`.

Description

Calculate the fast approximate sine of the input argument `x`, measured in radians.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- Input and output in the denormal range is flushed to sign preserving 0.0.

__device__ float __tanf (float x)

Calculate the fast approximate tangent of the input argument.

Returns

Returns the approximate tangent of `x`.

Description

Calculate the fast approximate tangent of the input argument `x`, measured in radians.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.2, Table 9.
- The result is computed as the fast divide of __sinf() by __cosf(). Denormal input and output are flushed to sign-preserving 0.0 at each step of the computation.

1.8. 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.

__device__ double __dadd_rd (double x, double y)

Add two floating-point values in round-down mode.

Returns

Returns `x + y`.

Description

Adds two floating-point values `x` and `y` in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dadd_rn (double x, double y)

Add two floating-point values in round-to-nearest-even mode.

Returns

Returns `x + y`.

Description

Adds two floating-point values `x` and `y` in round-to-nearest-even mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dadd_ru (double x, double y)

Add two floating-point values in round-up mode.

Returns

Returns `x + y`.

Description

Adds two floating-point values `x` and `y` in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dadd_rz (double x, double y)

Add two floating-point values in round-towards-zero mode.

Returns

Returns `x + y`.

Description

Adds two floating-point values x and y in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __ddiv_rd (double x, double y)

Divide two floating-point values in round-down mode.

Returns

Returns x / y.

Description

Divides two floating-point values x by y in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __ddiv_rn (double x, double y)

Divide two floating-point values in round-to-nearest-even mode.

Returns

Returns x / y.

Description

Divides two floating-point values x by y in round-to-nearest-even mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

- Requires compute capability >= 2.0.

__device__ double __ddiv_ru (double x, double y)

Divide two floating-point values in round-up mode.

Returns

Returns x / y.

Description

Divides two floating-point values x by y in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __ddiv_rz (double x, double y)

Divide two floating-point values in round-towards-zero mode.

Returns

Returns x / y.

Description

Divides two floating-point values x by y in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __dmul_rd (double x, double y)

Multiply two floating-point values in round-down mode.

Returns

Returns x * y.

Description

Multiplies two floating-point values x and y in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dmul_rn (double x, double y)

Multiply two floating-point values in round-to-nearest-even mode.

Returns

Returns x * y.

Description

Multiplies two floating-point values x and y in round-to-nearest-even mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dmul_ru (double x, double y)

Multiply two floating-point values in round-up mode.

Returns

Returns x * y.

Description

Multiplies two floating-point values x and y in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

- This operation will never be merged into a single multiply-add instruction.

__device__ double __dmul_rz (double x, double y)

Multiply two floating-point values in round-towards-zero mode.

Returns

Returns x * y.

Description

Multiplies two floating-point values x and y in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __drcp_rd (double x)

Compute $\frac{1}{x}$ in round-down mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __drcp_rn (double x)

Compute $\frac{1}{x}$ in round-to-nearest-even mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-to-nearest-even mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __drcp_ru (double x)

Compute $\frac{1}{x}$ in round-up mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __drcp_rz (double x)

Compute $\frac{1}{x}$ in round-towards-zero mode.

Returns

Returns $\frac{1}{x}$.

Description

Compute the reciprocal of x in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __dsqrt_rd (double x)

Compute $\sqrt{x}$ in round-down mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of x in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __dsqrt_rn (double x)

Compute $\sqrt{x}$ in round-to-nearest-even mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of x in round-to-nearest-even mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __dsqrt_ru (double x)

Compute $\sqrt{x}$ in round-up mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of x in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __dsqrt_rz (double x)

Compute $\sqrt{x}$ in round-towards-zero mode.

Returns

Returns $\sqrt{x}$.

Description

Compute the square root of x in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- Requires compute capability >= 2.0.

__device__ double __dsub_rd (double x, double y)

Subtract two floating-point values in round-down mode.

Returns

Returns `x - y`.

Description

Subtracts two floating-point values `x` and `y` in round-down (to negative infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dsub_rn (double x, double y)

Subtract two floating-point values in round-to-nearest-even mode.

Returns

Returns `x - y`.

Description

Subtracts two floating-point values `x` and `y` in round-to-nearest-even mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dsub_ru (double x, double y)

Subtract two floating-point values in round-up mode.

Returns

Returns `x - y`.

Description

Subtracts two floating-point values x and y in round-up (to positive infinity) mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __dsub_rz (double x, double y)

Subtract two floating-point values in round-towards-zero mode.

Returns

Returns x - y.

Description

Subtracts two floating-point values x and y in round-towards-zero mode.

Note:

- For accuracy information for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.
- This operation will never be merged into a single multiply-add instruction.

__device__ double __fma_rd (double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-down mode.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.
- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__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.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.
- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double __fma_ru (double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-up mode.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.

- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

__device__ double __fma_rz (double x, double y, double z)

Compute $x \times y + z$ as a single operation in round-towards-zero mode.

Returns

Returns the rounded value of $x \times y + z$ as a single operation.

- fmaf($\pm\infty$, ± 0 , z) returns NaN.
- fmaf(± 0 , $\pm\infty$, z) returns NaN.
- fmaf(x, y, $-\infty$) returns NaN if $x \times y$ is an exact $+\infty$
- fmaf(x, y, $+\infty$) returns NaN if $x \times y$ is an exact $-\infty$

Description

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 for this function see the CUDA C++ Programming Guide, Appendix E.1, Table 7.

1.9. 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.

__device__ unsigned int __brev (unsigned int x)

Reverse the bit order of a 32-bit unsigned integer.

Returns

Returns the bit-reversed value of `x`. i.e. bit N of the return value corresponds to bit 31-N of `x`.

Description

Reverses the bit order of the 32-bit unsigned integer `x`.

__device__ unsigned long long int __brevll (unsigned long long int x)

Reverse the bit order of a 64-bit unsigned integer.

Returns

Returns the bit-reversed value of `x`. i.e. bit N of the return value corresponds to bit 63-N of `x`.

Description

Reverses the bit order of the 64-bit unsigned integer `x`.

__device__ unsigned int __byte_perm (unsigned int x, unsigned int y, unsigned int s)

Return selected bytes from two 32-bit unsigned integers.

Returns

The returned value r is computed to be: `result[n] := input[selector[n]]` where `result[n]` is the nth byte of r.

Description

byte_perm(x,y,s) 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`.

The input bytes are indexed as follows: input[0] = x<7:0> input[1] = x<15:8> input[2] = x<23:16> input[3] = x<31:24> input[4] = y<7:0> input[5] = y<15:8> input[6] = y<23:16> input[7] = y<31:24> The selector indices are as follows (the upper 16-bits of the selector are not used): selector[0] = s<2:0> selector[1] = s<6:4> selector[2] = s<10:8> selector[3] = s<14:12>

__device__ int __clz (int x)

Return the number of consecutive high-order zero bits in a 32-bit integer.

Returns

Returns a value between 0 and 32 inclusive representing the number of zero bits.

Description

Count the number of consecutive leading zero bits, starting at the most significant bit (bit 31) of x.

__device__ int __clzll (long long int x)

Count the number of consecutive high-order zero bits in a 64-bit integer.

Returns

Returns a value between 0 and 64 inclusive representing the number of zero bits.

Description

Count the number of consecutive leading zero bits, starting at the most significant bit (bit 63) of x.

__device__ int __ffs (int x)

Find the position of the least significant bit set to 1 in a 32-bit integer.

Returns

Returns a value between 0 and 32 inclusive representing the position of the first bit set.

- __ffs(0) returns 0.

Description

Find the position of the first (least significant) bit set to 1 in x, where the least significant bit position is 1.

__device__ int __ffsll (long long int x)

Find the position of the least significant bit set to 1 in a 64-bit integer.

Returns

Returns a value between 0 and 64 inclusive representing the position of the first bit set.

- __ffsll(0) returns 0.

Description

Find the position of the first (least significant) bit set to 1 in `x`, where the least significant bit position is 1.

__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.

Returns

Returns the most significant 32 bits of the shifted 64-bit value.

Description

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.

__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.

Returns

Returns the most significant 32 bits of the shifted 64-bit value.

Description

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(`shift`, 32)). The most significant 32-bits of the result are returned.

__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.

Returns

Returns the least significant 32 bits of the shifted 64-bit value.

Description

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` (`shift` & 31). The least significant 32-bits of the result are returned.

__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.

Returns

Returns the least significant 32 bits of the shifted 64-bit value.

Description

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(`shift`, 32)). The least significant 32-bits of the result are returned.

__device__ int __hadd (int, int)

Compute average of signed input arguments, avoiding overflow in the intermediate sum.

Returns

Returns a signed integer value representing the signed average value of the two inputs.

Description

Compute average of signed input arguments `x` and `y` as (`x` + `y`) >> 1, 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.

Returns

Returns the least significant 32 bits of the product `x` * `y`.

Description

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.

__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.

Returns

Returns the most significant 64 bits of the product x * y.

Description

Calculate the most significant 64 bits of the 128-bit product x * y, where x and y are 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.

Returns

Returns the most significant 32 bits of the product x * y.

Description

Calculate the most significant 32 bits of the 64-bit product x * y, where x and y are 32-bit integers.

__device__ int __popc (unsigned int x)

Count the number of bits that are set to 1 in a 32-bit integer.

Returns

Returns a value between 0 and 32 inclusive representing the number of set bits.

Description

Count the number of bits that are set to 1 in x.

__device__ int __popcll (unsigned long long int x)

Count the number of bits that are set to 1 in a 64-bit integer.

Returns

Returns a value between 0 and 64 inclusive representing the number of set bits.

Description

Count the number of bits that are set to 1 in x.

__device__ int __rhadd (int, int)

Compute rounded average of signed input arguments, avoiding overflow in the intermediate sum.

Returns

Returns a signed integer value representing the signed rounded average value of the two inputs.

Description

Compute average of signed input arguments x and y as (x + y + 1) >> 1, 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.

Returns

Returns $|x-y|+z$.

Description

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.

__device__ unsigned int __uhadd (unsigned int, unsigned int)

Compute average of unsigned input arguments, avoiding overflow in the intermediate sum.

Returns

Returns an unsigned integer value representing the unsigned average value of the two inputs.

Description

Compute average of unsigned input arguments `x` and `y` as (`x` + `y`) >> 1, 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.

Returns

Returns the least significant 32 bits of the product `x` * `y`.

Description

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.

__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.

Returns

Returns the most significant 64 bits of the product `x` * `y`.

Description

Calculate the most significant 64 bits of the 128-bit product `x` * `y`, where `x` and `y` are 64-bit unsigned 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.

Returns

Returns the most significant 32 bits of the product `x * y`.

Description

Calculate the most significant 32 bits of the 64-bit product `x * y`, where `x` and `y` are 32-bit unsigned integers.

__device__ unsigned int __urhadd (unsigned int, unsigned int)

Compute rounded average of unsigned input arguments, avoiding overflow in the intermediate sum.

Returns

Returns an unsigned integer value representing the unsigned rounded average value of the two inputs.

Description

Compute average of unsigned input arguments `x` and `y` as (`x` + `y` + 1) >> 1, 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.

Returns

Returns $|x-y|+z$.

Description

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.

1.10. Type Casting Intrinsics

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.

__device__ float __double2float_rd (double x)

Convert a double to a float in round-down mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a single-precision floating-point value in round-down (to negative infinity) mode.

__device__ float __double2float_rn (double x)

Convert a double to a float in round-to-nearest-even mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a single-precision floating-point value in round-to-nearest-even mode.

__device__ float __double2float_ru (double x)

Convert a double to a float in round-up mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a single-precision floating-point value in round-up (to positive infinity) mode.

__device__ float __double2float_rz (double x)

Convert a double to a float in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a single-precision floating-point value in round-towards-zero mode.

__device__ int __double2hiint (double x)

Reinterpret high 32 bits in a double as a signed integer.

Returns

Returns reinterpreted value.

Description

Reinterpret the high 32 bits in the double-precision floating-point value x as a signed integer.

__device__ int __double2int_rd (double x)

Convert a double to a signed int in round-down mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed integer value in round-down (to negative infinity) mode.

__device__ int __double2int_rn (double x)

Convert a double to a signed int in round-to-nearest-even mode.

Returns

Returns converted value.

Description

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

__device__ int __double2int_ru (double x)

Convert a double to a signed int in round-up mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed integer value in round-up (to positive infinity) mode.

__device__ int __double2int_rz (double)

Convert a double to a signed int in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed integer value 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.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed 64-bit integer value in round-down (to negative infinity) mode.

__device__ long long int __double2ll_rn (double x)

Convert a double to a signed 64-bit int in round-to-nearest-even mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed 64-bit integer value 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.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed 64-bit integer value in round-up (to positive infinity) mode.

__device__ long long int __double2ll_rz (double)

Convert a double to a signed 64-bit int in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to a signed 64-bit integer value in round-towards-zero mode.

__device__ int __double2loint (double x)

Reinterpret low 32 bits in a double as a signed integer.

Returns

Returns reinterpreted value.

Description

Reinterpret the low 32 bits in the double-precision floating-point value x as a signed integer.

__device__ unsigned int __double2uint_rd (double x)

Convert a double to an unsigned int in round-down mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to an unsigned integer value in round-down (to negative infinity) mode.

__device__ unsigned int __double2uint_rn (double x)

Convert a double to an unsigned int in round-to-nearest-even mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to an unsigned integer value in round-to-nearest-even mode.

__device__ unsigned int __double2uint_ru (double x)

Convert a double to an unsigned int in round-up mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to an unsigned integer value in round-up (to positive infinity) mode.

__device__ unsigned int __double2uint_rz (double)

Convert a double to an unsigned int in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to an unsigned integer value 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.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to an unsigned 64-bit integer value in round-down (to negative infinity) 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.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value x to an unsigned 64-bit integer value 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.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value `x` to an unsigned 64-bit integer value in round-up (to positive infinity) mode.

__device__ unsigned long long int __double2ull_rz (double)

Convert a double to an unsigned 64-bit int in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the double-precision floating-point value `x` to an unsigned 64-bit integer value 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.

Returns

Returns reinterpreted value.

Description

Reinterpret the bits in the double-precision floating-point value `x` as a signed 64-bit integer.

__device__ int __float2int_rd (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to a signed integer in round-down (to negative infinity) mode.

__device__ int __float2int_rn (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to a signed integer in round-up (to positive infinity) mode.

__device__ int __float2int_rz (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to a signed 64-bit integer in round-down (to negative infinity) mode.

__device__ long long int __float2ll_rn (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to a signed 64-bit integer in round-up (to positive infinity) mode.

__device__ long long int __float2ll_rz (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value `x` 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value `x` to an unsigned integer in round-down (to negative infinity) mode.

__device__ unsigned int __float2uint_rn (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value `x` 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to an unsigned integer in round-up (to positive infinity) mode.

__device__ unsigned int __float2uint_rz (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to an unsigned 64-bit integer in round-down (to negative infinity) 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x 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.

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x to an unsigned 64-bit integer in round-up (to positive infinity) mode.

__device__ unsigned long long int __float2ull_rz (float x)

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

Returns

Returns converted value.

Description

Convert the single-precision floating-point value x 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.

Returns

Returns reinterpreted value.

Description

Reinterpret the bits in the single-precision floating-point value x as a signed integer.

__device__ unsigned int __float_as_uint (float x)

Reinterpret bits in a float as a unsigned integer.

Returns

Returns reinterpreted value.

Description

Reinterpret the bits in the single-precision floating-point value `x` as a unsigned integer.

__device__ double __hiloint2double (int hi, int lo)

Reinterpret high and low 32-bit integer values as a double.

Returns

Returns reinterpreted value.

Description

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.

__device__ double __int2double_rn (int x)

Convert a signed int to a double.

Returns

Returns converted value.

Description

Convert the signed integer value `x` to a double-precision floating-point value.

__device__ float __int2float_rd (int x)

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

Returns

Returns converted value.

Description

Convert the signed integer value `x` to a single-precision floating-point value in round-down (to negative infinity) mode.

__device__ float __int2float_rn (int x)

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

Returns

Returns converted value.

Description

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

__device__ float __int2float_ru (int x)

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

Returns

Returns converted value.

Description

Convert the signed integer value x to a single-precision floating-point value in round-up (to positive infinity) mode.

__device__ float __int2float_rz (int x)

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

Returns

Returns converted value.

Description

Convert the signed integer value x to a single-precision floating-point value in round-towards-zero mode.

__device__ float __int_as_float (int x)

Reinterpret bits in an integer as a float.

Returns

Returns reinterpreted value.

Description

Reinterpret the bits in the signed integer value x as a single-precision floating-point value.

__device__ double __ll2double_rd (long long int x)

Convert a signed 64-bit int to a double in round-down mode.

Returns

Returns converted value.

Description

Convert the signed 64-bit integer value x to a double-precision floating-point value in round-down (to negative infinity) mode.

__device__ double __ll2double_rn (long long int x)

Convert a signed 64-bit int to a double in round-to-nearest-even mode.

Returns

Returns converted value.

Description

Convert the signed 64-bit integer value x to a double-precision floating-point value 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.

Returns

Returns converted value.

Description

Convert the signed 64-bit integer value x to a double-precision floating-point value in round-up (to positive infinity) mode.

__device__ double __ll2double_rz (long long int x)

Convert a signed 64-bit int to a double in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the signed 64-bit integer value x to a double-precision floating-point value in round-towards-zero mode.

__device__ float __ll2float_rd (long long int x)

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

Returns

Returns converted value.

Description

Convert the signed integer value x to a single-precision floating-point value in round-down (to negative infinity) mode.

__device__ float __ll2float_rn (long long int x)

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

Returns

Returns converted value.

Description

Convert the signed 64-bit integer value x to a single-precision floating-point value 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.

Returns

Returns converted value.

Description

Convert the signed integer value x to a single-precision floating-point value in round-up (to positive infinity) mode.

__device__ float __ll2float_rz (long long int x)

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

Returns

Returns converted value.

Description

Convert the signed integer value x to a single-precision floating-point value 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.

Returns

Returns reinterpreted value.

Description

Reinterpret the bits in the 64-bit signed integer value x as a double-precision floating-point value.

__device__ double __uint2double_rn (unsigned int x)

Convert an unsigned int to a double.

Returns

Returns converted value.

Description

Convert the unsigned integer value x to a double-precision floating-point value.

__device__ float __uint2float_rd (unsigned int x)

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

Returns

Returns converted value.

Description

Convert the unsigned integer value `x` to a single-precision floating-point value in round-down (to negative infinity) mode.

__device__ float __uint2float_rn (unsigned int x)

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

Returns

Returns converted value.

Description

Convert the unsigned integer value `x` to a single-precision floating-point value in round-to-nearest-even mode.

__device__ float __uint2float_ru (unsigned int x)

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

Returns

Returns converted value.

Description

Convert the unsigned integer value `x` to a single-precision floating-point value in round-up (to positive infinity) mode.

__device__ float __uint2float_rz (unsigned int x)

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

Returns

Returns converted value.

Description

Convert the unsigned integer value x to a single-precision floating-point value in round-towards-zero mode.

__device__ float __uint_as_float (unsigned int x)

Reinterpret bits in an unsigned integer as a float.

Returns

Returns reinterpreted value.

Description

Reinterpret the bits in the unsigned integer value x as a single-precision floating-point value.

__device__ double __ull2double_rd (unsigned long long int x)

Convert an unsigned 64-bit int to a double in round-down mode.

Returns

Returns converted value.

Description

Convert the unsigned 64-bit integer value x to a double-precision floating-point value in round-down (to negative infinity) 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.

Returns

Returns converted value.

Description

Convert the unsigned 64-bit integer value x to a double-precision floating-point value 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.

Returns

Returns converted value.

Description

Convert the unsigned 64-bit integer value x to a double-precision floating-point value in round-up (to positive infinity) mode.

__device__ double __ull2double_rz (unsigned long long int x)

Convert an unsigned 64-bit int to a double in round-towards-zero mode.

Returns

Returns converted value.

Description

Convert the unsigned 64-bit integer value x to a double-precision floating-point value 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.

Returns

Returns converted value.

Description

Convert the unsigned integer value x to a single-precision floating-point value in round-down (to negative infinity) mode.

__device__ float __ull2float_rn (unsigned long long int x)

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

Returns

Returns converted value.

Description

Convert the unsigned integer value x to a single-precision floating-point value 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.

Returns

Returns converted value.

Description

Convert the unsigned integer value x to a single-precision floating-point value in round-up (to positive infinity) mode.

__device__ float __ull2float_rz (unsigned long long int x)

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

Returns

Returns converted value.

Description

Convert the unsigned integer value x to a single-precision floating-point value in round-towards-zero mode.

1.11. 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.

__device__ unsigned int __vabs2 (unsigned int a)

Computes per-halfword absolute value.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vabs4 (unsigned int a)

Computes per-byte absolute value.

Returns

Returns computed value.

Description

Splits argument by bytes. Computes absolute value of each byte. Partial results are recombined and returned as unsigned int.

__device__ unsigned int __vabsdiffs2 (unsigned int a, unsigned int b)

Computes per-halfword sum of absolute difference of signed integer.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vabsdiffs4 (unsigned int a, unsigned int b)

Computes per-byte absolute difference of signed integer.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vabsdiffu2 (unsigned int a, unsigned int b)

Performs per-halfword absolute difference of unsigned integer computation: |a - b|.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vabsdiffu4 (unsigned int a, unsigned int b)

Computes per-byte absolute difference of unsigned integer.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vabsss2 (unsigned int a)

Computes per-halfword absolute value with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vabsss4 (unsigned int a)

Computes per-byte absolute value with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vadd2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed addition, with wrap-around: a + b.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vadd4 (unsigned int a, unsigned int b)

Performs per-byte (un)signed addition.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vaddss2 (unsigned int a, unsigned int b)

Performs per-halfword addition with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vaddss4 (unsigned int a, unsigned int b)

Performs per-byte addition with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vaddus2 (unsigned int a, unsigned int b)

Performs per-halfword addition with unsigned saturation.

Returns

Returns computed value.

Description

Splits 4 bytes of each argument into 2 parts, each consisting of 2 bytes, then performs addition with unsigned saturation on corresponding parts.

__device__ unsigned int __vaddus4 (unsigned int a, unsigned int b)

Performs per-byte addition with unsigned saturation.

Returns

Returns computed value.

Description

Splits 4 bytes of each argument into 4 parts, each consisting of 1 byte, then performs addition with unsigned saturation on corresponding parts.

__device__ unsigned int __vavgs2 (unsigned int a, unsigned int b)

Performs per-halfword signed rounded average computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vavgs4 (unsigned int a, unsigned int b)

Computes per-byte signed rounded average.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vavgu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned rounded average computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vavgu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned rounded average.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vcmpeq2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed comparison.

Returns

Returns 0xffff computed value.

Description

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.

__device__ unsigned int __vcmpeq4 (unsigned int a, unsigned int b)

Performs per-byte (un)signed comparison.

Returns

Returns 0xff if a = b, else returns 0.

Description

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.

__device__ unsigned int __vcmpges2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison: a >= b ? 0xffff : 0.

Returns

Returns 0xffff if a >= b, else returns 0.

Description

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.

__device__ unsigned int __vcmpges4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 0xff if a >= b, else returns 0.

Description

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.

__device__ unsigned int __vcmpgeu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned comparison: a >= b ? 0xffff : 0.

Returns

Returns 0xffff if a >= b, else returns 0.

Description

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 __vcmpgeu2(0x1234aba5, 0x1234aba6) returns 0xffff0000.

__device__ unsigned int __vcmpgeu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 0xff if a = b, else returns 0.

Description

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 __vcmpgeu4(0x1234aba5, 0x1234aba6) returns 0xffffff00.

__device__ unsigned int __vcmpgts2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison: a > b ? 0xffff : 0.

Returns

Returns 0xffff if a > b, else returns 0.

Description

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.

__device__ unsigned int __vcmpgts4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 0xff if a > b, else returns 0.

Description

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.

__device__ unsigned int __vcmpgtu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned comparison: a > b ? 0xffff : 0.

Returns

Returns 0xffff if a > b, else returns 0.

Description

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.

__device__ unsigned int __vcmpgtu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 0xff if a > b, else returns 0.

Description

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.

__device__ unsigned int __vcmples2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison: a <= b ? 0xffff : 0.

Returns

Returns 0xffff if a <= b, else returns 0.

Description

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 __vcmples2(0x1234aba5, 0x1234aba6) returns 0xffffffff.

__device__ unsigned int __vcmples4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 0xff if a <= b, else returns 0.

Description

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 __vcmples4(0x1234aba5, 0x1234aba6) returns 0xffffffff.

__device__ unsigned int __vcmpleu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned comparison: a <= b ? 0xffff : 0.

Returns

Returns 0xffff if a <= b, else returns 0.

Description

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 __vcmpleu2(0x1234aba5, 0x1234aba6) returns 0xffffffff.

__device__ unsigned int __vcmpleu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 0xff if a <= b, else returns 0.

Description

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 __vcmpleu4(0x1234aba5, 0x1234aba6) returns 0xffffffff.

__device__ unsigned int __vcmplts2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison: a < b ? 0xffff : 0.

Returns

Returns 0xffff if a < b, else returns 0.

Description

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.

__device__ unsigned int __vcmplts4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 0xff if a < b, else returns 0.

Description

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.

__device__ unsigned int __vcmpltu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned comparison: a < b ? 0xffff : 0.

Returns

Returns 0xffff if a < b, else returns 0.

Description

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 __vcmpltu2(0x1234aba5, 0x1234aba6) returns 0x0000ffff.

__device__ unsigned int __vcmpltu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 0xff if a < b, else returns 0.

Description

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 __vcmpltu4(0x1234aba5, 0x1234aba6) returns 0x000000ff.

__device__ unsigned int __vcmpne2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed comparison: a != b ? 0xffff : 0.

Returns

Returns 0xffff if a != b, else returns 0.

Description

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.

__device__ unsigned int __vcmpne4 (unsigned int a, unsigned int b)

Performs per-byte (un)signed comparison.

Returns

Returns 0xff if a != b, else returns 0.

Description

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.

__device__ unsigned int __vhaddu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned average computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vhaddu4 (unsigned int a, unsigned int b)

Computes per-byte unsigned average.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vmaxs2 (unsigned int a, unsigned int b)

Performs per-halfword signed maximum computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vmaxs4 (unsigned int a, unsigned int b)

Computes per-byte signed maximum.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vmaxu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned maximum computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vmaxu4 (unsigned int a, unsigned int b)

Computes per-byte unsigned maximum.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vmins2 (unsigned int a, unsigned int b)

Performs per-halfword signed minimum computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vmins4 (unsigned int a, unsigned int b)

Computes per-byte signed minimum.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vminu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned minimum computation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vminu4 (unsigned int a, unsigned int b)

Computes per-byte unsigned minimum.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vneg2 (unsigned int a)

Computes per-halfword negation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vneg4 (unsigned int a)

Performs per-byte negation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vnegss2 (unsigned int a)

Computes per-halfword negation with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vnegss4 (unsigned int a)

Performs per-byte negation with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsads2 (unsigned int a, unsigned int b)

Performs per-halfword sum of absolute difference of signed.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsads4 (unsigned int a, unsigned int b)

Computes per-byte sum of abs difference of signed.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsadu2 (unsigned int a, unsigned int b)

Computes per-halfword sum of abs diff of unsigned.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsadu4 (unsigned int a, unsigned int b)

Computes per-byte sum of abs difference of unsigned.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vseteq2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed comparison.

Returns

Returns 1 if a = b, else returns 0.

Description

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.

__device__ unsigned int __vseteq4 (unsigned int a, unsigned int b)

Performs per-byte (un)signed comparison.

Returns

Returns 1 if a = b, else returns 0.

Description

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.

__device__ unsigned int __vsetges2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison.

Returns

Returns 1 if a >= b, else returns 0.

Description

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.

__device__ unsigned int __vsetges4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 1 if a >= b, else returns 0.

Description

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.

__device__ unsigned int __vsetgeu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned minimum unsigned comparison.

Returns

Returns 1 if a >= b, else returns 0.

Description

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.

__device__ unsigned int __vsetgeu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 1 if a >= b, else returns 0.

Description

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.

__device__ unsigned int __vsetgts2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison.

Returns

Returns 1 if a > b, else returns 0.

Description

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.

__device__ unsigned int __vsetgts4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 1 if a > b, else returns 0.

Description

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.

__device__ unsigned int __vsetgtu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned comparison.

Returns

Returns 1 if a > b, else returns 0.

Description

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.

__device__ unsigned int __vsetgtu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 1 if a > b, else returns 0.

Description

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.

__device__ unsigned int __vsetles2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned minimum computation.

Returns

Returns 1 if a <= b, else returns 0.

Description

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.

__device__ unsigned int __vsetles4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 1 if a <= b, else returns 0.

Description

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.

__device__ unsigned int __vsetleu2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison.

Returns

Returns 1 if a <= b, else returns 0.

Description

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.

__device__ unsigned int __vsetleu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 1 if a <= b, else returns 0.

Description

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.

__device__ unsigned int __vsetlts2 (unsigned int a, unsigned int b)

Performs per-halfword signed comparison.

Returns

Returns 1 if a < b, else returns 0.

Description

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.

__device__ unsigned int __vsetlts4 (unsigned int a, unsigned int b)

Performs per-byte signed comparison.

Returns

Returns 1 if a < b, else returns 0.

Description

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.

__device__ unsigned int __vsetltu2 (unsigned int a, unsigned int b)

Performs per-halfword unsigned comparison.

Returns

Returns 1 if a < b, else returns 0.

Description

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.

__device__ unsigned int __vsetltu4 (unsigned int a, unsigned int b)

Performs per-byte unsigned comparison.

Returns

Returns 1 if a < b, else returns 0.

Description

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.

__device__ unsigned int __vsetne2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed comparison.

Returns

Returns 1 if a != b, else returns 0.

Description

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.

__device__ unsigned int __vsetne4 (unsigned int a, unsigned int b)

Performs per-byte (un)signed comparison.

Returns

Returns 1 if a != b, else returns 0.

Description

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.

__device__ unsigned int __vsub2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed subtraction, with wrap-around.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsub4 (unsigned int a, unsigned int b)

Performs per-byte subtraction.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsubss2 (unsigned int a, unsigned int b)

Performs per-halfword (un)signed subtraction, with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsubss4 (unsigned int a, unsigned int b)

Performs per-byte subtraction with signed saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsubus2 (unsigned int a, unsigned int b)

Performs per-halfword subtraction with unsigned saturation.

Returns

Returns computed value.

Description

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.

__device__ unsigned int __vsubus4 (unsigned int a, unsigned int b)

Performs per-byte subtraction with unsigned saturation.

Returns

Returns computed value.

Description

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.

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