



# CUDA RUNTIME API

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## API Reference Manual



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# Chapter 1.

## API SYNCHRONIZATION BEHAVIOR

The API provides memcpy/memset functions in both synchronous and asynchronous forms, the latter having an "Async" suffix. This is a misnomer as each function may exhibit synchronous or asynchronous behavior depending on the arguments passed to the function. In the reference documentation, each memcpy function is categorized as synchronous or asynchronous, corresponding to the definitions below.

### **Memcpy**

The API provides memcpy/memset functions in both synchronous and asynchronous forms, the latter having an "Async" suffix. This is a misnomer as each function may exhibit synchronous or asynchronous behavior depending on the arguments passed to the function. In the reference documentation, each memcpy function is categorized as synchronous or asynchronous, corresponding to the definitions below.

### **Synchronous**

1. For transfers from pageable host memory to device memory, a stream sync is performed before the copy is initiated. The function will return once the pageable buffer has been copied to the staging memory for DMA transfer to device memory, but the DMA to final destination may not have completed.
2. For transfers from pinned host memory to device memory, the function is synchronous with respect to the host.
3. For transfers from device to either pageable or pinned host memory, the function returns only once the copy has completed.
4. For transfers from device memory to device memory, no host-side synchronization is performed.
5. For transfers from any host memory to any host memory, the function is fully synchronous with respect to the host.

### **Asynchronous**

1. For transfers from pageable host memory to device memory, host memory is copied to a staging buffer immediately (no device synchronization is performed). The function will return once the pageable buffer has been copied to the staging memory. The DMA transfer to final destination may not have completed.
2. For transfers between pinned host memory and device memory, the function is fully asynchronous.
3. For transfers from device memory to pageable host memory, the function will return only once the copy has completed.
4. For all other transfers, the function is fully asynchronous. If pageable memory must first be staged to pinned memory, this will be handled asynchronously with a worker thread.
5. For transfers from any host memory to any host memory, the function is fully synchronous with respect to the host.

### **Memset**

The `cudaMemset` functions are asynchronous with respect to the host except when the target memory is pinned host memory. The Async versions are always asynchronous with respect to the host.

### **Kernel Launches**

Kernel launches are asynchronous with respect to the host. Details of concurrent kernel execution and data transfers can be found in the CUDA Programmers Guide.



# Chapter 2.

## MODULES

Here is a list of all modules:

- ▶ Device Management
- ▶ Thread Management [DEPRECATED]
- ▶ Error Handling
- ▶ Stream Management
- ▶ Event Management
- ▶ Execution Control
- ▶ Memory Management
- ▶ Unified Addressing
- ▶ Peer Device Memory Access
- ▶ OpenGL Interoperability
- ▶ OpenGL Interoperability [DEPRECATED]
- ▶ Direct3D 9 Interoperability
- ▶ Direct3D 9 Interoperability [DEPRECATED]
- ▶ Direct3D 10 Interoperability
- ▶ Direct3D 10 Interoperability [DEPRECATED]
- ▶ Direct3D 11 Interoperability
- ▶ Direct3D 11 Interoperability [DEPRECATED]
- ▶ VDPAU Interoperability
- ▶ Graphics Interoperability
- ▶ Texture Reference Management
- ▶ Surface Reference Management
- ▶ Texture Object Management
- ▶ Surface Object Management
- ▶ Version Management
- ▶ C++ API Routines
- ▶ Interactions with the CUDA Driver API

- ▶ Profiler Control
- ▶ Data types used by CUDA Runtime

## 2.1. Device Management

This section describes the device management functions of the CUDA runtime application programming interface.

### `cudaError_t cudaChooseDevice (int *device, const cudaDeviceProp *prop)`

Select compute-device which best matches criteria.

#### Parameters

##### **device**

- Device with best match

##### **prop**

- Desired device properties

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

#### Description

Returns in `*device` the device which has properties that best match `*prop`.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaGetDeviceCount`, `cudaGetDevice`, `cudaSetDevice`, `cudaGetDeviceProperties`

### `cudaError_t cudaDeviceGetAttribute (int *value, cudaDeviceAttr attr, int device)`

Returns information about the device.

#### Parameters

##### **value**

- Returned device attribute value

**attr**

- Device attribute to query

**device**

- Device number to query

**Returns**

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`

**Description**

Returns in `*value` the integer value of the attribute `attr` on device `device`. The supported attributes are:

- ▶ `cudaDevAttrMaxThreadsPerBlock`: Maximum number of threads per block;
- ▶ `cudaDevAttrMaxBlockDimX`: Maximum x-dimension of a block;
- ▶ `cudaDevAttrMaxBlockDimY`: Maximum y-dimension of a block;
- ▶ `cudaDevAttrMaxBlockDimZ`: Maximum z-dimension of a block;
- ▶ `cudaDevAttrMaxGridDimX`: Maximum x-dimension of a grid;
- ▶ `cudaDevAttrMaxGridDimY`: Maximum y-dimension of a grid;
- ▶ `cudaDevAttrMaxGridDimZ`: Maximum z-dimension of a grid;
- ▶ `cudaDevAttrMaxSharedMemoryPerBlock`: Maximum amount of shared memory available to a thread block in bytes; this amount is shared by all thread blocks simultaneously resident on a multiprocessor;
- ▶ `cudaDevAttrTotalConstantMemory`: Memory available on device for `__constant__` variables in a CUDA C kernel in bytes;
- ▶ `cudaDevAttrWarpSize`: Warp size in threads;
- ▶ `cudaDevAttrMaxPitch`: Maximum pitch in bytes allowed by the memory copy functions that involve memory regions allocated through `cudaMallocPitch()`;
- ▶ `cudaDevAttrMaxTexture1DWidth`: Maximum 1D texture width;
- ▶ `cudaDevAttrMaxTexture1DLinearWidth`: Maximum width for a 1D texture bound to linear memory;
- ▶ `cudaDevAttrMaxTexture1DMipmappedWidth`: Maximum mipmapped 1D texture width;
- ▶ `cudaDevAttrMaxTexture2DWidth`: Maximum 2D texture width;
- ▶ `cudaDevAttrMaxTexture2DHeight`: Maximum 2D texture height;
- ▶ `cudaDevAttrMaxTexture2DLinearWidth`: Maximum width for a 2D texture bound to linear memory;
- ▶ `cudaDevAttrMaxTexture2DLinearHeight`: Maximum height for a 2D texture bound to linear memory;
- ▶ `cudaDevAttrMaxTexture2DLinearPitch`: Maximum pitch in bytes for a 2D texture bound to linear memory;

- ▶ `cudaDevAttrMaxTexture2DMipmappedWidth`: Maximum mipmapped 2D texture width;
- ▶ `cudaDevAttrMaxTexture2DMipmappedHeight`: Maximum mipmapped 2D texture height;
- ▶ `cudaDevAttrMaxTexture3DWidth`: Maximum 3D texture width;
- ▶ `cudaDevAttrMaxTexture3DHeight`: Maximum 3D texture height;
- ▶ `cudaDevAttrMaxTexture3DDepth`: Maximum 3D texture depth;
- ▶ `cudaDevAttrMaxTexture3DWidthAlt`: Alternate maximum 3D texture width, 0 if no alternate maximum 3D texture size is supported;
- ▶ `cudaDevAttrMaxTexture3DHeightAlt`: Alternate maximum 3D texture height, 0 if no alternate maximum 3D texture size is supported;
- ▶ `cudaDevAttrMaxTexture3DDepthAlt`: Alternate maximum 3D texture depth, 0 if no alternate maximum 3D texture size is supported;
- ▶ `cudaDevAttrMaxTextureCubemapWidth`: Maximum cubemap texture width or height;
- ▶ `cudaDevAttrMaxTexture1DLayeredWidth`: Maximum 1D layered texture width;
- ▶ `cudaDevAttrMaxTexture1DLayeredLayers`: Maximum layers in a 1D layered texture;
- ▶ `cudaDevAttrMaxTexture2DLayeredWidth`: Maximum 2D layered texture width;
- ▶ `cudaDevAttrMaxTexture2DLayeredHeight`: Maximum 2D layered texture height;
- ▶ `cudaDevAttrMaxTexture2DLayeredLayers`: Maximum layers in a 2D layered texture;
- ▶ `cudaDevAttrMaxTextureCubemapLayeredWidth`: Maximum cubemap layered texture width or height;
- ▶ `cudaDevAttrMaxTextureCubemapLayeredLayers`: Maximum layers in a cubemap layered texture;
- ▶ `cudaDevAttrMaxSurface1DWidth`: Maximum 1D surface width;
- ▶ `cudaDevAttrMaxSurface2DWidth`: Maximum 2D surface width;
- ▶ `cudaDevAttrMaxSurface2DHeight`: Maximum 2D surface height;
- ▶ `cudaDevAttrMaxSurface3DWidth`: Maximum 3D surface width;
- ▶ `cudaDevAttrMaxSurface3DHeight`: Maximum 3D surface height;
- ▶ `cudaDevAttrMaxSurface3DDepth`: Maximum 3D surface depth;
- ▶ `cudaDevAttrMaxSurface1DLayeredWidth`: Maximum 1D layered surface width;
- ▶ `cudaDevAttrMaxSurface1DLayeredLayers`: Maximum layers in a 1D layered surface;
- ▶ `cudaDevAttrMaxSurface2DLayeredWidth`: Maximum 2D layered surface width;
- ▶ `cudaDevAttrMaxSurface2DLayeredHeight`: Maximum 2D layered surface height;
- ▶ `cudaDevAttrMaxSurface2DLayeredLayers`: Maximum layers in a 2D layered surface;
- ▶ `cudaDevAttrMaxSurfaceCubemapWidth`: Maximum cubemap surface width;

- ▶ `cudaDevAttrMaxSurfaceCubemapLayeredWidth`: Maximum cubemap layered surface width;
- ▶ `cudaDevAttrMaxSurfaceCubemapLayeredLayers`: Maximum layers in a cubemap layered surface;
- ▶ `cudaDevAttrMaxRegistersPerBlock`: Maximum number of 32-bit registers available to a thread block; this number is shared by all thread blocks simultaneously resident on a multiprocessor;
- ▶ `cudaDevAttrClockRate`: Peak clock frequency in kilohertz;
- ▶ `cudaDevAttrTextureAlignment`: Alignment requirement; texture base addresses aligned to textureAlign bytes do not need an offset applied to texture fetches;
- ▶ `cudaDevAttrTexturePitchAlignment`: Pitch alignment requirement for 2D texture references bound to pitched memory;
- ▶ `cudaDevAttrGpuOverlap`: 1 if the device can concurrently copy memory between host and device while executing a kernel, or 0 if not;
- ▶ `cudaDevAttrMultiProcessorCount`: Number of multiprocessors on the device;
- ▶ `cudaDevAttrKernelExecTimeout`: 1 if there is a run time limit for kernels executed on the device, or 0 if not;
- ▶ `cudaDevAttrIntegrated`: 1 if the device is integrated with the memory subsystem, or 0 if not;
- ▶ `cudaDevAttrCanMapHostMemory`: 1 if the device can map host memory into the CUDA address space, or 0 if not;
- ▶ `cudaDevAttrComputeMode`: Compute mode is the compute mode that the device is currently in. Available modes are as follows:
  - ▶ `cudaComputeModeDefault`: Default mode - Device is not restricted and multiple threads can use `cudaSetDevice()` with this device.
  - ▶ `cudaComputeModeExclusive`: Compute-exclusive mode - Only one thread will be able to use `cudaSetDevice()` with this device.
  - ▶ `cudaComputeModeProhibited`: Compute-prohibited mode - No threads can use `cudaSetDevice()` with this device.
  - ▶ `cudaComputeModeExclusiveProcess`: Compute-exclusive-process mode - Many threads in one process will be able to use `cudaSetDevice()` with this device.
- ▶ `cudaDevAttrConcurrentKernels`: 1 if the device supports executing multiple kernels within the same context simultaneously, or 0 if not. It is not guaranteed that multiple kernels will be resident on the device concurrently so this feature should not be relied upon for correctness;
- ▶ `cudaDevAttrEccEnabled`: 1 if error correction is enabled on the device, 0 if error correction is disabled or not supported by the device;
- ▶ `cudaDevAttrPciBusId`: PCI bus identifier of the device;
- ▶ `cudaDevAttrPciDeviceId`: PCI device (also known as slot) identifier of the device;
- ▶ `cudaDevAttrTccDriver`: 1 if the device is using a TCC driver. TCC is only available on Tesla hardware running Windows Vista or later;

- ▶ `cudaDevAttrMemoryClockRate`: Peak memory clock frequency in kilohertz;
- ▶ `cudaDevAttrGlobalMemoryBusWidth`: Global memory bus width in bits;
- ▶ `cudaDevAttrL2CacheSize`: Size of L2 cache in bytes. 0 if the device doesn't have L2 cache;
- ▶ `cudaDevAttrMaxThreadsPerMultiProcessor`: Maximum resident threads per multiprocessor;
- ▶ `cudaDevAttrUnifiedAddressing`: 1 if the device shares a unified address space with the host, or 0 if not;
- ▶ `cudaDevAttrComputeCapabilityMajor`: Major compute capability version number;
- ▶ `cudaDevAttrComputeCapabilityMinor`: Minor compute capability version number;
- ▶ `cudaDevAttrStreamPrioritiesSupported`: 1 if the device supports stream priorities, or 0 if not;



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaGetDeviceCount`, `cudaGetDevice`, `cudaSetDevice`, `cudaChooseDevice`, `cudaGetDeviceProperties`

## `cudaError_t cudaDeviceGetByPCIBusId (int *device, char *pciBusId)`

Returns a handle to a compute device.

#### Parameters

##### `device`

- Returned device ordinal

##### `pciBusId`

- String in one of the following forms: [domain]:[bus]:[device].[function] [domain]:[bus]:[device] [bus]:[device].[function] where domain, bus, device, and function are all hexadecimal values

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevice`

#### Description

Returns in `*device` a device ordinal given a PCI bus ID string.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceGetPCIBusId](#)

## **cudaError\_t cudaDeviceGetCacheConfig (cudaFuncCache \*pCacheConfig)**

Returns the preferred cache configuration for the current device.

### Parameters

#### **pCacheConfig**

- Returned cache configuration

### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#)

### Description

On devices where the L1 cache and shared memory use the same hardware resources, this returns through `pCacheConfig` the preferred cache configuration for the current device. This is only a preference. The runtime will use the requested configuration if possible, but it is free to choose a different configuration if required to execute functions.

This will return a `pCacheConfig` of [cudaFuncCachePreferNone](#) on devices where the size of the L1 cache and shared memory are fixed.

The supported cache configurations are:

- ▶ [cudaFuncCachePreferNone](#): no preference for shared memory or L1 (default)
- ▶ [cudaFuncCachePreferShared](#): prefer larger shared memory and smaller L1 cache
- ▶ [cudaFuncCachePreferL1](#): prefer larger L1 cache and smaller shared memory
- ▶ [cudaFuncCachePreferEqual](#): prefer equal size L1 cache and shared memory



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceSetCacheConfig](#), [cudaFuncSetCacheConfig](#) ( C API),  
[cudaFuncSetCacheConfig](#) (C++ API)

## `cudaError_t cudaDeviceGetLimit (size_t *pValue, cudaLimit limit)`

Returns resource limits.

### Parameters

#### **pValue**

- Returned size of the limit

#### **limit**

- Limit to query

### Returns

`cudaSuccess`, `cudaErrorUnsupportedLimit`, `cudaErrorInvalidValue`

### Description

Returns in \*pValue the current size of limit. The supported `cudaLimit` values are:

- ▶ `cudaLimitStackSize`: stack size in bytes of each GPU thread;
- ▶ `cudaLimitPrintfFifoSize`: size in bytes of the shared FIFO used by the `printf()` and `fprintf()` device system calls.
- ▶ `cudaLimitMallocHeapSize`: size in bytes of the heap used by the `malloc()` and `free()` device system calls;
- ▶ `cudaLimitDevRuntimeSyncDepth`: maximum grid depth at which a thread can issue the device runtime call `cudaDeviceSynchronize()` to wait on child grid launches to complete.
- ▶ `cudaLimitDevRuntimePendingLaunchCount`: maximum number of outstanding device runtime launches.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaDeviceSetLimit`



## cudaError\_t cudaDeviceGetPCIBusId (char \*pciBusId, int len, int device)

Returns a PCI Bus Id string for the device.

### Parameters

#### pciBusId

- Returned identifier string for the device in the following format [domain]:[bus]:[device].[function] where `domain`, `bus`, `device`, and `function` are all hexadecimal values. `pciBusId` should be large enough to store 13 characters including the NULL-terminator.

#### len

- Maximum length of string to store in name

#### device

- Device to get identifier string for

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevice](#)

### Description

Returns an ASCII string identifying the device `dev` in the NULL-terminated string pointed to by `pciBusId`. `len` specifies the maximum length of the string that may be returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaDeviceGetByPCIBusId](#)

## cudaError\_t cudaDeviceGetSharedMemConfig (cudaSharedMemConfig \*pConfig)

Returns the shared memory configuration for the current device.

### Parameters

#### pConfig

- Returned cache configuration

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInitializationError](#)

**Description**

This function will return in `pConfig` the current size of shared memory banks on the current device. On devices with configurable shared memory banks, [cudaDeviceSetSharedMemConfig](#) can be used to change this setting, so that all subsequent kernel launches will by default use the new bank size. When [cudaDeviceGetSharedMemConfig](#) is called on devices without configurable shared memory, it will return the fixed bank size of the hardware.

The returned bank configurations can be either:

- ▶ `cudaSharedMemBankSizeFourByte` - shared memory bank width is four bytes.
- ▶ `cudaSharedMemBankSizeEightByte` - shared memory bank width is eight bytes.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cudaDeviceSetCacheConfig](#), [cudaDeviceGetCacheConfig](#),  
[cudaDeviceSetSharedMemConfig](#), [cudaFuncSetCacheConfig](#)

## `cudaError_t cudaDeviceGetStreamPriorityRange (int *leastPriority, int *greatestPriority)`

Returns numerical values that correspond to the least and greatest stream priorities.

**Parameters****leastPriority**

- Pointer to an int in which the numerical value for least stream priority is returned

**greatestPriority**

- Pointer to an int in which the numerical value for greatest stream priority is returned

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#)

**Description**

Returns in `*leastPriority` and `*greatestPriority` the numerical values that correspond to the least and greatest stream priorities respectively. Stream priorities

follow a convention where lower numbers imply greater priorities. The range of meaningful stream priorities is given by [`*greatestPriority`, `*leastPriority`]. If the user attempts to create a stream with a priority value that is outside the meaningful range as specified by this API, the priority is automatically clamped down or up to either `*leastPriority` or `*greatestPriority` respectively. See [cudaStreamCreateWithPriority](#) for details on creating a priority stream. A NULL may be passed in for `*leastPriority` or `*greatestPriority` if the value is not desired.

This function will return '0' in both `*leastPriority` and `*greatestPriority` if the current context's device does not support stream priorities (see [cudaDeviceGetAttribute](#)).



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaStreamCreateWithPriority](#), [cudaStreamGetPriority](#)

## `cudaError_t cudaDeviceReset (void)`

Destroy all allocations and reset all state on the current device in the current process.

### Returns

[cudaSuccess](#)

### Description

Explicitly destroys and cleans up all resources associated with the current device in the current process. Any subsequent API call to this device will reinitialize the device.

Note that this function will reset the device immediately. It is the caller's responsibility to ensure that the device is not being accessed by any other host threads from the process when this function is called.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceSynchronize](#)

## cudaError\_t cudaDeviceSetCacheConfig (cudaFuncCache cacheConfig)

Sets the preferred cache configuration for the current device.

### Parameters

#### cacheConfig

- Requested cache configuration

### Returns

cudaSuccess, cudaErrorInitializationError

### Description

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `cacheConfig` the preferred cache configuration for the current device. This is only a preference. The runtime will use the requested configuration if possible, but it is free to choose a different configuration if required to execute the function. Any function preference set via `cudaFuncSetCacheConfig` (C API) or `cudaFuncSetCacheConfig` (C++ API) will be preferred over this device-wide setting. Setting the device-wide cache configuration to `cudaFuncCachePreferNone` will cause subsequent kernel launches to prefer to not change the cache configuration unless required to launch the kernel.

This setting does nothing on devices where the size of the L1 cache and shared memory are fixed.

Launching a kernel with a different preference than the most recent preference setting may insert a device-side synchronization point.

The supported cache configurations are:

- ▶ `cudaFuncCachePreferNone`: no preference for shared memory or L1 (default)
- ▶ `cudaFuncCachePreferShared`: prefer larger shared memory and smaller L1 cache
- ▶ `cudaFuncCachePreferL1`: prefer larger L1 cache and smaller shared memory
- ▶ `cudaFuncCachePreferEqual`: prefer equal size L1 cache and shared memory



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaDeviceGetCacheConfig`, `cudaFuncSetCacheConfig` (C API),  
`cudaFuncSetCacheConfig` (C++ API)

## cudaError\_t cudaDeviceSetLimit (cudaLimit limit, size\_t value)

Set resource limits.

### Parameters

#### limit

- Limit to set

#### value

- Size of limit

### Returns

cudaSuccess, cudaErrorUnsupportedLimit, cudaErrorInvalidValue, cudaErrorMemoryAllocation

### Description

Setting `limit` to `value` is a request by the application to update the current limit maintained by the device. The driver is free to modify the requested value to meet h/w requirements (this could be clamping to minimum or maximum values, rounding up to nearest element size, etc). The application can use `cudaDeviceGetLimit()` to find out exactly what the limit has been set to.

Setting each `cudaLimit` has its own specific restrictions, so each is discussed here.

- ▶ `cudaLimitStackSize` controls the stack size in bytes of each GPU thread. This limit is only applicable to devices of compute capability 2.0 and higher. Attempting to set this limit on devices of compute capability less than 2.0 will result in the error `cudaErrorUnsupportedLimit` being returned.
- ▶ `cudaLimitPrintfFifoSize` controls the size in bytes of the shared FIFO used by the `printf()` and `fprintf()` device system calls. Setting `cudaLimitPrintfFifoSize` must be performed before launching any kernel that uses the `printf()` or `fprintf()` device system calls, otherwise `cudaErrorInvalidValue` will be returned. This limit is only applicable to devices of compute capability 2.0 and higher. Attempting to set this limit on devices of compute capability less than 2.0 will result in the error `cudaErrorUnsupportedLimit` being returned.
- ▶ `cudaLimitMallocHeapSize` controls the size in bytes of the heap used by the `malloc()` and `free()` device system calls. Setting `cudaLimitMallocHeapSize` must be performed before launching any kernel that uses the `malloc()` or `free()` device system calls, otherwise `cudaErrorInvalidValue` will be returned. This limit is only applicable to devices of compute capability 2.0 and higher. Attempting to set this limit on devices of compute capability less than 2.0 will result in the error `cudaErrorUnsupportedLimit` being returned.

- ▶ `cudaLimitDevRuntimeSyncDepth` controls the maximum nesting depth of a grid at which a thread can safely call `cudaDeviceSynchronize()`. Setting this limit must be performed before any launch of a kernel that uses the device runtime and calls `cudaDeviceSynchronize()` above the default sync depth, two levels of grids. Calls to `cudaDeviceSynchronize()` will fail with error code `cudaErrorSyncDepthExceeded` if the limitation is violated. This limit can be set smaller than the default or up the maximum launch depth of 24. When setting this limit, keep in mind that additional levels of sync depth require the runtime to reserve large amounts of device memory which can no longer be used for user allocations. If these reservations of device memory fail, `cudaDeviceSetLimit` will return `cudaErrorMemoryAllocation`, and the limit can be reset to a lower value. This limit is only applicable to devices of compute capability 3.5 and higher. Attempting to set this limit on devices of compute capability less than 3.5 will result in the error `cudaErrorUnsupportedLimit` being returned.
- ▶ `cudaLimitDevRuntimePendingLaunchCount` controls the maximum number of outstanding device runtime launches that can be made from the current device. A grid is outstanding from the point of launch up until the grid is known to have been completed. Device runtime launches which violate this limitation fail and return `cudaErrorLaunchPendingCountExceeded` when `cudaGetLastError()` is called after launch. If more pending launches than the default (2048 launches) are needed for a module using the device runtime, this limit can be increased. Keep in mind that being able to sustain additional pending launches will require the runtime to reserve larger amounts of device memory upfront which can no longer be used for allocations. If these reservations fail, `cudaDeviceSetLimit` will return `cudaErrorMemoryAllocation`, and the limit can be reset to a lower value. This limit is only applicable to devices of compute capability 3.5 and higher. Attempting to set this limit on devices of compute capability less than 3.5 will result in the error `cudaErrorUnsupportedLimit` being returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaDeviceGetLimit`

## `cudaError_t cudaDeviceSetSharedMemConfig(cudaSharedMemConfig config)`

Sets the shared memory configuration for the current device.

### Parameters

#### `config`

- Requested cache configuration

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInitializationError`

### Description

On devices with configurable shared memory banks, this function will set the shared memory bank size which is used for all subsequent kernel launches. Any per-function setting of shared memory set via `cudaFuncSetSharedMemConfig` will override the device wide setting.

Changing the shared memory configuration between launches may introduce a device side synchronization point.

Changing the shared memory bank size will not increase shared memory usage or affect occupancy of kernels, but may have major effects on performance. Larger bank sizes will allow for greater potential bandwidth to shared memory, but will change what kinds of accesses to shared memory will result in bank conflicts.

This function will do nothing on devices with fixed shared memory bank size.

The supported bank configurations are:

- ▶ `cudaSharedMemBankSizeDefault`: set bank width the device default (currently, four bytes)
- ▶ `cudaSharedMemBankSizeFourByte`: set shared memory bank width to be four bytes natively.
- ▶ `cudaSharedMemBankSizeEightByte`: set shared memory bank width to be eight bytes natively.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceSetCacheConfig](#), [cudaDeviceGetCacheConfig](#),  
[cudaDeviceGetSharedMemConfig](#), [cudaFuncSetCacheConfig](#)

## `cudaError_t cudaDeviceSynchronize (void)`

Wait for compute device to finish.

### Returns

[cudaSuccess](#)

### Description

Blocks until the device has completed all preceding requested tasks.

[cudaDeviceSynchronize\(\)](#) returns an error if one of the preceding tasks has failed. If the [cudaDeviceScheduleBlockingSync](#) flag was set for this device, the host thread will block until the device has finished its work.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaDeviceReset](#)

## `cudaError_t cudaGetDevice (int *device)`

Returns which device is currently being used.

### Parameters

#### **device**

- Returns the device on which the active host thread executes the device code.

### Returns

[cudaSuccess](#)

### Description

Returns in `*device` the current device for the calling host thread.



Note that this function may also return error codes from previous, asynchronous launches.



**See also:**

[cudaGetDeviceCount](#), [cudaSetDevice](#), [cudaGetDeviceProperties](#), [cudaChooseDevice](#)

## **cudaError\_t cudaGetDeviceCount (int \*count)**

Returns the number of compute-capable devices.

**Parameters****count**

- Returns the number of devices with compute capability greater or equal to 1.0

**Returns**

[cudaSuccess](#), [cudaErrorNoDevice](#), [cudaErrorInsufficientDriver](#)

**Description**

Returns in `*count` the number of devices with compute capability greater or equal to 1.0 that are available for execution. If there is no such device then `cudaGetDeviceCount()` will return [cudaErrorNoDevice](#). If no driver can be loaded to determine if any such devices exist then `cudaGetDeviceCount()` will return [cudaErrorInsufficientDriver](#).



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cudaGetDevice](#), [cudaSetDevice](#), [cudaGetDeviceProperties](#), [cudaChooseDevice](#)

## **cudaError\_t cudaGetDeviceProperties (cudaDeviceProp \*prop, int device)**

Returns information about the compute-device.

**Parameters****prop**

- Properties for the specified device

**device**

- Device number to get properties for

**Returns**

[cudaSuccess](#), [cudaErrorInvalidDevice](#)

## Description

Returns in \*prop the properties of device dev. The `cudaDeviceProp` structure is defined as:

```

struct cudaDeviceProp {
    char name[256];
    size_t totalGlobalMem;
    size_t sharedMemPerBlock;
    int regsPerBlock;
    int warpSize;
    size_t memPitch;
    int maxThreadsPerBlock;
    int maxThreadsDim[3];
    int maxGridSize[3];
    int clockRate;
    size_t totalConstMem;
    int major;
    int minor;
    size_t textureAlignment;
    size_t texturePitchAlignment;
    int deviceOverlap;
    int multiProcessorCount;
    int kernelExecTimeoutEnabled;
    int integrated;
    int canMapHostMemory;
    int computeMode;
    int maxTexture1D;
    int maxTexture1DMipmap;
    int maxTexture1DLinear;
    int maxTexture2D[2];
    int maxTexture2DMipmap[2];
    int maxTexture2DLinear[3];
    int maxTexture2DGather[2];
    int maxTexture3D[3];
    int maxTexture3DAlt[3];
    int maxTextureCubemap;
    int maxTexture1DLayered[2];
    int maxTexture2DLayered[3];
    int maxTextureCubemapLayered[2];
    int maxSurface1D;
    int maxSurface2D[2];
    int maxSurface3D[3];
    int maxSurface1DLayered[2];
    int maxSurface2DLayered[3];
    int maxSurfaceCubemap;
    int maxSurfaceCubemapLayered[2];
    size_t surfaceAlignment;
    int concurrentKernels;
    int ECCEnabled;
    int pciBusID;
    int pciDeviceID;
    int pciDomainID;
    int tccDriver;
    int asyncEngineCount;
    int unifiedAddressing;
    int memoryClockRate;
    int memoryBusWidth;
    int l2CacheSize;
    int maxThreadsPerMultiProcessor;
    int streamPrioritiesSupported;
}

```

where:

- ▶ `name[256]` is an ASCII string identifying the device;

- ▶ `totalGlobalMem` is the total amount of global memory available on the device in bytes;
- ▶ `sharedMemPerBlock` is the maximum amount of shared memory available to a thread block in bytes; this amount is shared by all thread blocks simultaneously resident on a multiprocessor;
- ▶ `regsPerBlock` is the maximum number of 32-bit registers available to a thread block; this number is shared by all thread blocks simultaneously resident on a multiprocessor;
- ▶ `warpSize` is the warp size in threads;
- ▶ `memPitch` is the maximum pitch in bytes allowed by the memory copy functions that involve memory regions allocated through `cudaMallocPitch()`;
- ▶ `maxThreadsPerBlock` is the maximum number of threads per block;
- ▶ `maxThreadsDim[3]` contains the maximum size of each dimension of a block;
- ▶ `maxGridSize[3]` contains the maximum size of each dimension of a grid;
- ▶ `clockRate` is the clock frequency in kilohertz;
- ▶ `totalConstMem` is the total amount of constant memory available on the device in bytes;
- ▶ `major`, `minor` are the major and minor revision numbers defining the device's compute capability;
- ▶ `textureAlignment` is the alignment requirement; texture base addresses that are aligned to `textureAlignment` bytes do not need an offset applied to texture fetches;
- ▶ `texturePitchAlignment` is the pitch alignment requirement for 2D texture references that are bound to pitched memory;
- ▶ `deviceOverlap` is 1 if the device can concurrently copy memory between host and device while executing a kernel, or 0 if not. Deprecated, use instead `asyncEngineCount`.
- ▶ `multiProcessorCount` is the number of multiprocessors on the device;
- ▶ `kernelExecTimeoutEnabled` is 1 if there is a run time limit for kernels executed on the device, or 0 if not.
- ▶ `integrated` is 1 if the device is an integrated (motherboard) GPU and 0 if it is a discrete (card) component.
- ▶ `canMapHostMemory` is 1 if the device can map host memory into the CUDA address space for use with `cudaHostAlloc()/cudaHostGetDevicePointer()`, or 0 if not;
- ▶ `computeMode` is the compute mode that the device is currently in. Available modes are as follows:
  - ▶ `cudaComputeModeDefault`: Default mode - Device is not restricted and multiple threads can use `cudaSetDevice()` with this device.
  - ▶ `cudaComputeModeExclusive`: Compute-exclusive mode - Only one thread will be able to use `cudaSetDevice()` with this device.
  - ▶ `cudaComputeModeProhibited`: Compute-prohibited mode - No threads can use `cudaSetDevice()` with this device.

- ▶ `cudaComputeModeExclusiveProcess`: Compute-exclusive-process mode - Many threads in one process will be able to use `cudaSetDevice()` with this device.

If `cudaSetDevice()` is called on an already occupied device with computeMode `cudaComputeModeExclusive`, `cudaErrorDeviceAlreadyInUse` will be immediately returned indicating the device cannot be used. When an occupied exclusive mode device is chosen with `cudaSetDevice`, all subsequent non-device management runtime functions will return `cudaErrorDevicesUnavailable`.

- ▶ `maxTexture1D` is the maximum 1D texture size.
- ▶ `maxTexture1DMipmap` is the maximum 1D mipmapped texture texture size.
- ▶ `maxTexture1DLinear` is the maximum 1D texture size for textures bound to linear memory.
- ▶ `maxTexture2D[2]` contains the maximum 2D texture dimensions.
- ▶ `maxTexture2DMipmap[2]` contains the maximum 2D mipmapped texture dimensions.
- ▶ `maxTexture2DLinear[3]` contains the maximum 2D texture dimensions for 2D textures bound to pitch linear memory.
- ▶ `maxTexture2DGather[2]` contains the maximum 2D texture dimensions if texture gather operations have to be performed.
- ▶ `maxTexture3D[3]` contains the maximum 3D texture dimensions.
- ▶ `maxTexture3DAlt[3]` contains the maximum alternate 3D texture dimensions.
- ▶ `maxTextureCubemap` is the maximum cubemap texture width or height.
- ▶ `maxTexture1DLayered[2]` contains the maximum 1D layered texture dimensions.
- ▶ `maxTexture2DLayered[3]` contains the maximum 2D layered texture dimensions.
- ▶ `maxTextureCubemapLayered[2]` contains the maximum cubemap layered texture dimensions.
- ▶ `maxSurface1D` is the maximum 1D surface size.
- ▶ `maxSurface2D[2]` contains the maximum 2D surface dimensions.
- ▶ `maxSurface3D[3]` contains the maximum 3D surface dimensions.
- ▶ `maxSurface1DLayered[2]` contains the maximum 1D layered surface dimensions.
- ▶ `maxSurface2DLayered[3]` contains the maximum 2D layered surface dimensions.
- ▶ `maxSurfaceCubemap` is the maximum cubemap surface width or height.
- ▶ `maxSurfaceCubemapLayered[2]` contains the maximum cubemap layered surface dimensions.
- ▶ `surfaceAlignment` specifies the alignment requirements for surfaces.
- ▶ `concurrentKernels` is 1 if the device supports executing multiple kernels within the same context simultaneously, or 0 if not. It is not guaranteed that multiple kernels will be resident on the device concurrently so this feature should not be relied upon for correctness;
- ▶ `ECCEnabled` is 1 if the device has ECC support turned on, or 0 if not.
- ▶ `pciBusID` is the PCI bus identifier of the device.

- ▶ `pciDeviceID` is the PCI device (sometimes called slot) identifier of the device.
- ▶ `pciDomainID` is the PCI domain identifier of the device.
- ▶ `tccDriver` is 1 if the device is using a TCC driver or 0 if not.
- ▶ `asyncEngineCount` is 1 when the device can concurrently copy memory between host and device while executing a kernel. It is 2 when the device can concurrently copy memory between host and device in both directions and execute a kernel at the same time. It is 0 if neither of these is supported.
- ▶ `unifiedAddressing` is 1 if the device shares a unified address space with the host and 0 otherwise.
- ▶ `memoryClockRate` is the peak memory clock frequency in kilohertz.
- ▶ `memoryBusWidth` is the memory bus width in bits.
- ▶ `l2CacheSize` is L2 cache size in bytes.
- ▶ `maxThreadsPerMultiProcessor` is the number of maximum resident threads per multiprocessor.
- ▶ `streamPrioritiesSupported` is 1 if the device supports stream priorities, or 0 if it is not supported.

See also:

`cudaGetDeviceCount`, `cudaGetDevice`, `cudaSetDevice`, `cudaChooseDevice`,  
`cudaDeviceGetAttribute`

## `cudaError_t cudaIpcCloseMemHandle (void *devPtr)`

Close memory mapped with `cudaIpcOpenMemHandle`.

### Parameters

#### `devPtr`

- Device pointer returned by `cudaIpcOpenMemHandle`

### Returns

`cudaSuccess`, `cudaErrorMapBufferObjectFailed`, `cudaErrorInvalidResourceHandle`,

### Description

Unmaps memory returned by `cudaIpcOpenMemHandle`. The original allocation in the exporting process as well as imported mappings in other processes will be unaffected.

Any resources used to enable peer access will be freed if this is the last mapping using them.

IPC functionality is restricted to devices with support for unified addressing on Linux operating systems.

**See also:**

[cudaMalloc](#), [cudaFree](#), [cudaIpcGetEventHandle](#), [cudaIpcOpenEventHandle](#),  
[cudaIpcGetMemHandle](#), [cudaIpcOpenMemHandle](#),

## **cudaError\_t cudaIpcGetEventHandle (cudaIpcEventHandle\_t \*handle, cudaEvent\_t event)**

Gets an interprocess handle for a previously allocated event.

**Parameters****handle**

- Pointer to a user allocated [cudaIpcEventHandle](#) in which to return the opaque event handle

**event**

- Event allocated with [cudaEventInterprocess](#) and [cudaEventDisableTiming](#) flags.

**Returns**

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorMemoryAllocation](#),  
[cudaErrorMapBufferObjectFailed](#)

**Description**

Takes as input a previously allocated event. This event must have been created with the [cudaEventInterprocess](#) and [cudaEventDisableTiming](#) flags set. This opaque handle may be copied into other processes and opened with [cudaIpcOpenEventHandle](#) to allow efficient hardware synchronization between GPU work in different processes.

After the event has been opened in the importing process, [cudaEventRecord](#), [cudaEventSynchronize](#), [cudaStreamWaitEvent](#) and [cudaEventQuery](#) may be used in either process. Performing operations on the imported event after the exported event has been freed with [cudaEventDestroy](#) will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux operating systems.

**See also:**

[cudaEventCreate](#), [cudaEventDestroy](#), [cudaEventSynchronize](#), [cudaEventQuery](#),  
[cudaStreamWaitEvent](#), [cudaIpcOpenEventHandle](#), [cudaIpcGetMemHandle](#),  
[cudaIpcOpenMemHandle](#), [cudaIpcCloseMemHandle](#)

## `cudaError_t cudaIpcGetMemHandle` (`cudaIpcMemHandle_t *handle, void *devPtr`)

Gets an interprocess memory handle for an existing device memory allocation.

### Parameters

#### **handle**

- Pointer to user allocated `cudaIpcMemHandle` to return the handle in.

#### **devPtr**

- Base pointer to previously allocated device memory

### Returns

`cudaSuccess`, `cudaErrorInvalidResourceHandle`, `cudaErrorMemoryAllocation`,  
`cudaErrorMapBufferObjectFailed`,

### Description

Takes a pointer to the base of an existing device memory allocation created with `cudaMalloc` and exports it for use in another process. This is a lightweight operation and may be called multiple times on an allocation without adverse effects.

If a region of memory is freed with `cudaFree` and a subsequent call to `cudaMalloc` returns memory with the same device address, `cudaIpcGetMemHandle` will return a unique handle for the new memory.

IPC functionality is restricted to devices with support for unified addressing on Linux operating systems.

### See also:

`cudaMalloc`, `cudaFree`, `cudaIpcGetEventHandle`, `cudaIpcOpenEventHandle`,  
`cudaIpcOpenMemHandle`, `cudaIpcCloseMemHandle`

## `cudaError_t cudaIpcOpenEventHandle` (`cudaEvent_t *event, cudaIpcEventHandle_t handle`)

Opens an interprocess event handle for use in the current process.

### Parameters

#### **event**

- Returns the imported event

#### **handle**

- Interprocess handle to open

**Returns**

[cudaSuccess](#), [cudaErrorMapBufferObjectFailed](#), [cudaErrorInvalidResourceHandle](#)

**Description**

Opens an interprocess event handle exported from another process with [cudaIpcGetEventHandle](#). This function returns a [cudaEvent\\_t](#) that behaves like a locally created event with the [cudaEventDisableTiming](#) flag specified. This event must be freed with [cudaEventDestroy](#).

Performing operations on the imported event after the exported event has been freed with [cudaEventDestroy](#) will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux operating systems.

**See also:**

[cudaEventCreate](#), [cudaEventDestroy](#), [cudaEventSynchronize](#), [cudaEventQuery](#), [cudaStreamWaitEvent](#), [cudaIpcGetEventHandle](#), [cudaIpcGetMemHandle](#), [cudaIpcOpenMemHandle](#), [cudaIpcCloseMemHandle](#)

## **`cudaError_t cudaIpcOpenMemHandle (void **devPtr, cudaIpcMemHandle_t handle, unsigned int flags)`**

Opens an interprocess memory handle exported from another process and returns a device pointer usable in the local process.

**Parameters****devPtr**

- Returned device pointer

**handle**

- [cudaIpcMemHandle](#) to open

**flags**

- Flags for this operation. Must be specified as [cudaIpcMemLazyEnablePeerAccess](#)

**Returns**

[cudaSuccess](#), [cudaErrorMapBufferObjectFailed](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorTooManyPeers](#)

**Description**

Maps memory exported from another process with [cudaIpcGetMemHandle](#) into the current device address space. For contexts on different devices [cudaIpcOpenMemHandle](#) can attempt to enable peer access between the devices as



if the user called `cudaDeviceEnablePeerAccess`. This behavior is controlled by the `cudaIpcMemLazyEnablePeerAccess` flag. `cudaDeviceCanAccessPeer` can determine if a mapping is possible.

Contexts that may open `cudaIpcMemHandles` are restricted in the following way. `cudaIpcMemHandles` from each device in a given process may only be opened by one context per device per other process.

Memory returned from `cudaIpcOpenMemHandle` must be freed with `cudaIpcCloseMemHandle`.

Calling `cudaFree` on an exported memory region before calling `cudaIpcCloseMemHandle` in the importing context will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux operating systems.



No guarantees are made about the address returned in `*devPtr`. In particular, multiple processes may not receive the same address for the same handle.

#### See also:

`cudaMalloc`, `cudaFree`, `cudaIpcGetEventHandle`, `cudaIpcOpenEventHandle`, `cudaIpcGetMemHandle`, `cudaIpcCloseMemHandle`, `cudaDeviceEnablePeerAccess`, `cudaDeviceCanAccessPeer`,

## `cudaError_t cudaSetDevice (int device)`

Set device to be used for GPU executions.

### Parameters

#### **device**

- Device on which the active host thread should execute the device code.

### Returns

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorDeviceAlreadyInUse`

### Description

Sets `device` as the current device for the calling host thread. Valid device id's are 0 to (`cudaGetDeviceCount()` - 1).

Any device memory subsequently allocated from this host thread using `cudaMalloc()`, `cudaMallocPitch()` or `cudaMallocArray()` will be physically resident on `device`.

Any host memory allocated from this host thread using `cudaMallocHost()` or `cudaHostAlloc()` or `cudaHostRegister()` will have its lifetime associated with `device`.

Any streams or events created from this host thread will be associated with `device`. Any kernels launched from this host thread using the `<<<>>>` operator or `cudaLaunch()` will be executed on `device`.

This call may be made from any host thread, to any device, and at any time. This function will do no synchronization with the previous or new device, and should be considered a very low overhead call.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGetDeviceCount`, `cudaGetDevice`, `cudaGetDeviceProperties`, `cudaChooseDevice`

## `cudaError_t cudaSetDeviceFlags (unsigned int flags)`

Sets flags to be used for device executions.

### Parameters

#### `flags`

- Parameters for device operation

### Returns

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorSetOnActiveProcess`

### Description

Records `flags` as the flags to use when initializing the current device. If no device has been made current to the calling thread then `flags` will be applied to the initialization of any device initialized by the calling host thread, unless that device has had its initialization flags set explicitly by this or any host thread.

If the current device has been set and that device has already been initialized then this call will fail with the error `cudaErrorSetOnActiveProcess`. In this case it is necessary to reset device using `cudaDeviceReset()` before the device's initialization flags may be set.

The two LSBs of the `flags` parameter can be used to control how the CPU thread interacts with the OS scheduler when waiting for results from the device.

- `cudaDeviceScheduleAuto`: The default value if the `flags` parameter is zero, uses a heuristic based on the number of active CUDA contexts in the process `C` and the number of logical processors in the system `P`. If  $C > P$ , then CUDA will yield to other OS threads when waiting for the device, otherwise CUDA will not yield while waiting for results and actively spin on the processor.

- ▶ `cudaDeviceScheduleSpin`: Instruct CUDA to actively spin when waiting for results from the device. This can decrease latency when waiting for the device, but may lower the performance of CPU threads if they are performing work in parallel with the CUDA thread.
- ▶ `cudaDeviceScheduleYield`: Instruct CUDA to yield its thread when waiting for results from the device. This can increase latency when waiting for the device, but can increase the performance of CPU threads performing work in parallel with the device.
- ▶ `cudaDeviceScheduleBlockingSync`: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the device to finish work.
- ▶ `cudaDeviceBlockingSync`: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the device to finish work.

**Deprecated:** This flag was deprecated as of CUDA 4.0 and replaced with `cudaDeviceScheduleBlockingSync`.

- ▶ `cudaDeviceMapHost`: This flag must be set in order to allocate pinned host memory that is accessible to the device. If this flag is not set, `cudaHostGetDevicePointer()` will always return a failure code.
- ▶ `cudaDeviceLmemResizeToMax`: Instruct CUDA to not reduce local memory after resizing local memory for a kernel. This can prevent thrashing by local memory allocations when launching many kernels with high local memory usage at the cost of potentially increased memory usage.

**See also:**

`cudaGetDeviceCount`, `cudaGetDevice`, `cudaGetDeviceProperties`, `cudaSetDevice`, `cudaSetValidDevices`, `cudaChooseDevice`

## `cudaError_t cudaSetValidDevices (int *device_arr, int len)`

Set a list of devices that can be used for CUDA.

### Parameters

#### `device_arr`

- List of devices to try

#### `len`

- Number of devices in specified list

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevice`

## Description

Sets a list of devices for CUDA execution in priority order using `device_arr`. The parameter `len` specifies the number of elements in the list. CUDA will try devices from the list sequentially until it finds one that works. If this function is not called, or if it is called with a `len` of 0, then CUDA will go back to its default behavior of trying devices sequentially from a default list containing all of the available CUDA devices in the system. If a specified device ID in the list does not exist, this function will return `cudaErrorInvalidDevice`. If `len` is not 0 and `device_arr` is NULL or if `len` exceeds the number of devices in the system, then `cudaErrorInvalidValue` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaGetDeviceCount`, `cudaSetDevice`, `cudaGetDeviceProperties`, `cudaSetDeviceFlags`, `cudaChooseDevice`

## 2.2. Thread Management [DEPRECATED]

This section describes deprecated thread management functions of the CUDA runtime application programming interface.

### `cudaError_t cudaThreadExit (void)`

Exit and clean up from CUDA launches.

## Returns

`cudaSuccess`

## Description

### Deprecated

Note that this function is deprecated because its name does not reflect its behavior. Its functionality is identical to the non-deprecated function `cudaDeviceReset()`, which should be used instead.

Explicitly destroys all cleans up all resources associated with the current device in the current process. Any subsequent API call to this device will reinitialize the device.

Note that this function will reset the device immediately. It is the caller's responsibility to ensure that the device is not being accessed by any other host threads from the process when this function is called.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceReset](#)

## `cudaError_t cudaThreadGetCacheConfig` (`cudaFuncCache *pCacheConfig`)

Returns the preferred cache configuration for the current device.

### Parameters

#### `pCacheConfig`

- Returned cache configuration

### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#)

### Description

#### Deprecated

Note that this function is deprecated because its name does not reflect its behavior. Its functionality is identical to the non-deprecated function [cudaDeviceGetCacheConfig\(\)](#), which should be used instead.

On devices where the L1 cache and shared memory use the same hardware resources, this returns through `pCacheConfig` the preferred cache configuration for the current device. This is only a preference. The runtime will use the requested configuration if possible, but it is free to choose a different configuration if required to execute functions.

This will return a `pCacheConfig` of [cudaFuncCachePreferNone](#) on devices where the size of the L1 cache and shared memory are fixed.

The supported cache configurations are:

- ▶ [cudaFuncCachePreferNone](#): no preference for shared memory or L1 (default)
- ▶ [cudaFuncCachePreferShared](#): prefer larger shared memory and smaller L1 cache
- ▶ [cudaFuncCachePreferL1](#): prefer larger L1 cache and smaller shared memory



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceGetCacheConfig](#)

## `cudaError_t cudaThreadGetLimit (size_t *pValue, cudaLimit limit)`

Returns resource limits.

### Parameters

#### **pValue**

- Returned size in bytes of limit

#### **limit**

- Limit to query

### Returns

[cudaSuccess](#), [cudaErrorUnsupportedLimit](#), [cudaErrorInvalidValue](#)

### Description

#### Deprecated

Note that this function is deprecated because its name does not reflect its behavior. Its functionality is identical to the non-deprecated function [cudaDeviceGetLimit\(\)](#), which should be used instead.

Returns in \*pValue the current size of limit. The supported [cudaLimit](#) values are:

- ▶ [cudaLimitStackSize](#): stack size of each GPU thread;
- ▶ [cudaLimitPrintfFifoSize](#): size of the shared FIFO used by the printf() and fprintf() device system calls.
- ▶ [cudaLimitMallocHeapSize](#): size of the heap used by the malloc() and free() device system calls;



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceGetLimit](#)

## cudaError\_t cudaThreadSetCacheConfig (cudaFuncCache cacheConfig)

Sets the preferred cache configuration for the current device.

### Parameters

#### cacheConfig

- Requested cache configuration

### Returns

cudaSuccess, cudaErrorInitializationError

### Description

#### Deprecated

Note that this function is deprecated because its name does not reflect its behavior. Its functionality is identical to the non-deprecated function `cudaDeviceSetCacheConfig()`, which should be used instead.

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `cacheConfig` the preferred cache configuration for the current device. This is only a preference. The runtime will use the requested configuration if possible, but it is free to choose a different configuration if required to execute the function. Any function preference set via `cudaFuncSetCacheConfig` (C API) or `cudaFuncSetCacheConfig` (C++ API) will be preferred over this device-wide setting. Setting the device-wide cache configuration to `cudaFuncCachePreferNone` will cause subsequent kernel launches to prefer to not change the cache configuration unless required to launch the kernel.

This setting does nothing on devices where the size of the L1 cache and shared memory are fixed.

Launching a kernel with a different preference than the most recent preference setting may insert a device-side synchronization point.

The supported cache configurations are:

- ▶ `cudaFuncCachePreferNone`: no preference for shared memory or L1 (default)
- ▶ `cudaFuncCachePreferShared`: prefer larger shared memory and smaller L1 cache
- ▶ `cudaFuncCachePreferL1`: prefer larger L1 cache and smaller shared memory



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaDeviceSetCacheConfig](#)

## `cudaError_t cudaThreadSetLimit (cudaLimit limit, size_t value)`

Set resource limits.

### Parameters

#### **limit**

- Limit to set

#### **value**

- Size in bytes of limit

### Returns

[cudaSuccess](#), [cudaErrorUnsupportedLimit](#), [cudaErrorInvalidValue](#)

### Description

#### Deprecated

Note that this function is deprecated because its name does not reflect its behavior. Its functionality is identical to the non-deprecated function [cudaDeviceSetLimit\(\)](#), which should be used instead.

Setting `limit` to `value` is a request by the application to update the current limit maintained by the device. The driver is free to modify the requested value to meet h/w requirements (this could be clamping to minimum or maximum values, rounding up to nearest element size, etc). The application can use [cudaThreadGetLimit\(\)](#) to find out exactly what the limit has been set to.

Setting each [cudaLimit](#) has its own specific restrictions, so each is discussed here.

- ▶ [cudaLimitStackSize](#) controls the stack size of each GPU thread. This limit is only applicable to devices of compute capability 2.0 and higher. Attempting to set this limit on devices of compute capability less than 2.0 will result in the error [cudaErrorUnsupportedLimit](#) being returned.
- ▶ [cudaLimitPrintfFifoSize](#) controls the size of the shared FIFO used by the `printf()` and `fprintf()` device system calls. Setting [cudaLimitPrintfFifoSize](#) must be performed before launching any kernel that uses the `printf()` or `fprintf()` device system calls, otherwise [cudaErrorInvalidValue](#) will be returned. This limit is only applicable to devices of compute capability 2.0 and higher. Attempting to set this limit on devices of compute capability less than 2.0 will result in the error [cudaErrorUnsupportedLimit](#) being returned.



- ▶ `cudaLimitMallocHeapSize` controls the size of the heap used by the `malloc()` and `free()` device system calls. Setting `cudaLimitMallocHeapSize` must be performed before launching any kernel that uses the `malloc()` or `free()` device system calls, otherwise `cudaErrorInvalidValue` will be returned. This limit is only applicable to devices of compute capability 2.0 and higher. Attempting to set this limit on devices of compute capability less than 2.0 will result in the error `cudaErrorUnsupportedLimit` being returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaDeviceSetLimit`

## `cudaError_t cudaThreadSynchronize (void)`

Wait for compute device to finish.

### Returns

`cudaSuccess`

### Description

#### Deprecated

Note that this function is deprecated because its name does not reflect its behavior. Its functionality is similar to the non-deprecated function `cudaDeviceSynchronize()`, which should be used instead.

Blocks until the device has completed all preceding requested tasks.

`cudaThreadSynchronize()` returns an error if one of the preceding tasks has failed. If the `cudaDeviceScheduleBlockingSync` flag was set for this device, the host thread will block until the device has finished its work.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaDeviceSynchronize`

## 2.3. Error Handling

This section describes the error handling functions of the CUDA runtime application programming interface.

### `const __cuda_builtin__ char *cudaGetErrorString(cudaError_t error)`

Returns the message string from an error code.

#### Parameters

##### **error**

- Error code to convert to string

#### Returns

`char*` pointer to a NULL-terminated string

#### Description

Returns the message string from an error code.

#### See also:

`cudaGetLastError`, `cudaPeekAtLastError`, `cudaError`

### `cudaError_t cudaGetLastError (void)`

Returns the last error from a runtime call.

#### Returns

`cudaSuccess`, `cudaErrorMissingConfiguration`, `cudaErrorMemoryAllocation`, `cudaErrorInitializationError`, `cudaErrorLaunchFailure`, `cudaErrorLaunchTimeout`, `cudaErrorLaunchOutOfResources`, `cudaErrorInvalidDeviceFunction`, `cudaErrorInvalidConfiguration`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`, `cudaErrorInvalidPitchValue`, `cudaErrorInvalidSymbol`, `cudaErrorUnmapBufferObjectFailed`, `cudaErrorInvalidHostPointer`, `cudaErrorInvalidDevicePointer`, `cudaErrorInvalidTexture`, `cudaErrorInvalidTextureBinding`, `cudaErrorInvalidChannelDescriptor`, `cudaErrorInvalidMemcpyDirection`, `cudaErrorInvalidFilterSetting`, `cudaErrorInvalidNormSetting`, `cudaErrorUnknown`, `cudaErrorInvalidResourceHandle`, `cudaErrorInsufficientDriver`, `cudaErrorSetOnActiveProcess`, `cudaErrorStartupFailure`,

## Description

Returns the last error that has been produced by any of the runtime calls in the same host thread and resets it to `cudaSuccess`.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaPeekAtLastError`, `cudaGetErrorString`, `cudaError`

## `cudaError_t cudaPeekAtLastError (void)`

Returns the last error from a runtime call.

## Returns

`cudaSuccess`, `cudaErrorMissingConfiguration`, `cudaErrorMemoryAllocation`, `cudaErrorInitializationError`, `cudaErrorLaunchFailure`, `cudaErrorLaunchTimeout`, `cudaErrorLaunchOutOfResources`, `cudaErrorInvalidDeviceFunction`, `cudaErrorInvalidConfiguration`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`, `cudaErrorInvalidPitchValue`, `cudaErrorInvalidSymbol`, `cudaErrorUnmapBufferObjectFailed`, `cudaErrorInvalidHostPointer`, `cudaErrorInvalidDevicePointer`, `cudaErrorInvalidTexture`, `cudaErrorInvalidTextureBinding`, `cudaErrorInvalidChannelDescriptor`, `cudaErrorInvalidMemcpyDirection`, `cudaErrorInvalidFilterSetting`, `cudaErrorInvalidNormSetting`, `cudaErrorUnknown`, `cudaErrorInvalidResourceHandle`, `cudaErrorInsufficientDriver`, `cudaErrorSetOnActiveProcess`, `cudaErrorStartupFailure`,

## Description

Returns the last error that has been produced by any of the runtime calls in the same host thread. Note that this call does not reset the error to `cudaSuccess` like `cudaGetLastError()`.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaGetLastError`, `cudaGetErrorString`, `cudaError`

## 2.4. Stream Management

This section describes the stream management functions of the CUDA runtime application programming interface.

```
typedef void (CUDART_CB *cudaStreamCallback_t)
(cudaStream_t stream, cudaError_t status, void*
userData)
```

Type of stream callback functions.

```
cudaError_t cudaStreamAddCallback (cudaStream_t
stream, cudaStreamCallback_t callback, void *userData,
unsigned int flags)
```

Add a callback to a compute stream.

### Parameters

#### **stream**

- Stream to add callback to

#### **callback**

- The function to call once preceding stream operations are complete

#### **userData**

- User specified data to be passed to the callback function

#### **flags**

- Reserved for future use, must be 0

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorNotSupported](#)

### Description

Adds a callback to be called on the host after all currently enqueued items in the stream have completed. For each `cudaStreamAddCallback` call, a callback will be executed exactly once. The callback will block later work in the stream until it is finished.

The callback may be passed [cudaSuccess](#) or an error code. In the event of a device error, all subsequently executed callbacks will receive an appropriate [cudaError\\_t](#).

Callbacks must not make any CUDA API calls. Attempting to use CUDA APIs will result in [cudaErrorNotPermitted](#). Callbacks must not perform any synchronization that may depend on outstanding device work or other callbacks that are not mandated to

run earlier. Callbacks without a mandated order (in independent streams) execute in undefined order and may be serialized.

This API requires compute capability 1.1 or greater. See [cudaDeviceGetAttribute](#) or [cudaGetDeviceProperties](#) to query compute capability. Calling this API with an earlier compute version will return [cudaErrorNotSupported](#).



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaStreamCreate](#), [cudaStreamCreateWithFlags](#), [cudaStreamQuery](#), [cudaStreamSynchronize](#), [cudaStreamWaitEvent](#), [cudaStreamDestroy](#)

## cudaError\_t cudaStreamCreate (cudaStream\_t \*pStream)

Create an asynchronous stream.

#### Parameters

##### pStream

- Pointer to new stream identifier

#### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#)

#### Description

Creates a new asynchronous stream.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaStreamCreateWithPriority](#), [cudaStreamCreateWithFlags](#), [cudaStreamGetPriority](#), [cudaStreamGetFlags](#), [cudaStreamQuery](#), [cudaStreamSynchronize](#), [cudaStreamWaitEvent](#), [cudaStreamAddCallback](#), [cudaStreamDestroy](#)

## `cudaError_t cudaStreamCreateWithFlags (cudaStream_t *pStream, unsigned int flags)`

Create an asynchronous stream.

### Parameters

#### `pStream`

- Pointer to new stream identifier

#### `flags`

- Parameters for stream creation

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Creates a new asynchronous stream. The `flags` argument determines the behaviors of the stream. Valid values for `flags` are

- ▶ `cudaStreamDefault`: Default stream creation flag.
- ▶ `cudaStreamNonBlocking`: Specifies that work running in the created stream may run concurrently with work in stream 0 (the NULL stream), and that the created stream should perform no implicit synchronization with stream 0.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaStreamCreate`, `cudaStreamCreateWithPriority`, `cudaStreamGetFlags`,  
`cudaStreamQuery`, `cudaStreamSynchronize`, `cudaStreamWaitEvent`,  
`cudaStreamAddCallback`, `cudaStreamDestroy`

## `cudaError_t cudaStreamCreateWithPriority (cudaStream_t *pStream, unsigned int flags, int priority)`

Create an asynchronous stream with the specified priority.

### Parameters

#### `pStream`

- Pointer to new stream identifier

**flags**

- Flags for stream creation. See [cudaStreamCreateWithFlags](#) for a list of valid flags that can be passed

**priority**

- Priority of the stream. Lower numbers represent higher priorities. See [cudaDeviceGetStreamPriorityRange](#) for more information about the meaningful stream priorities that can be passed.

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#)

**Description**

Creates a stream with the specified priority and returns a handle in `pStream`. This API alters the scheduler priority of work in the stream. Work in a higher priority stream may preempt work already executing in a low priority stream.

`priority` follows a convention where lower numbers represent higher priorities. '0' represents default priority. The range of meaningful numerical priorities can be queried using [cudaDeviceGetStreamPriorityRange](#). If the specified priority is outside the numerical range returned by [cudaDeviceGetStreamPriorityRange](#), it will automatically be clamped to the lowest or the highest number in the range.



- Note that this function may also return error codes from previous, asynchronous launches.
- Stream priorities are supported only on Quadro and Tesla GPUs with compute capability 3.5 or higher.
- In the current implementation, only compute kernels launched in priority streams are affected by the stream's priority. Stream priorities have no effect on host-to-device and device-to-host memory operations.

**See also:**

[cudaStreamCreate](#), [cudaStreamCreateWithFlags](#), [cudaDeviceGetStreamPriorityRange](#), [cudaStreamGetPriority](#), [cudaStreamQuery](#), [cudaStreamWaitEvent](#), [cudaStreamAddCallback](#), [cudaStreamSynchronize](#), [cudaStreamDestroy](#)

## cudaError\_t cudaStreamDestroy (cudaStream\_t stream)

Destroys and cleans up an asynchronous stream.

### Parameters

#### **stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#)

### Description

Destroys and cleans up the asynchronous stream specified by `stream`.

In case the device is still doing work in the stream `stream` when `cudaStreamDestroy()` is called, the function will return immediately and the resources associated with `stream` will be released automatically once the device has completed all work in `stream`.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaStreamCreate](#), [cudaStreamCreateWithFlags](#), [cudaStreamQuery](#),  
[cudaStreamWaitEvent](#), [cudaStreamSynchronize](#), [cudaStreamAddCallback](#)

## cudaError\_t cudaStreamGetFlags (cudaStream\_t hStream, unsigned int \*flags)

Query the flags of a stream.

### Parameters

#### **hStream**

- Handle to the stream to be queried

#### **flags**

- Pointer to an unsigned integer in which the stream's flags are returned

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#)



## Description

Query the flags of a stream. The flags are returned in `flags`. See [cudaStreamCreateWithFlags](#) for a list of valid flags.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cudaStreamCreateWithPriority](#), [cudaStreamCreateWithFlags](#), [cudaStreamGetPriority](#)

## `cudaError_t cudaStreamGetPriority (cudaStream_t hStream, int *priority)`

Query the priority of a stream.

## Parameters

### `hStream`

- Handle to the stream to be queried

### `priority`

- Pointer to a signed integer in which the stream's priority is returned

## Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#)

## Description

Query the priority of a stream. The priority is returned in `priority`. Note that if the stream was created with a priority outside the meaningful numerical range returned by [cudaDeviceGetStreamPriorityRange](#), this function returns the clamped priority. See [cudaStreamCreateWithPriority](#) for details about priority clamping.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cudaStreamCreateWithPriority](#), [cudaDeviceGetStreamPriorityRange](#), [cudaStreamGetFlags](#)

## cudaError\_t cudaStreamQuery (cudaStream\_t stream)

Queries an asynchronous stream for completion status.

### Parameters

#### **stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorNotReady](#), [cudaErrorInvalidResourceHandle](#)

### Description

Returns [cudaSuccess](#) if all operations in `stream` have completed, or [cudaErrorNotReady](#) if not.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaStreamCreate](#), [cudaStreamCreateWithFlags](#), [cudaStreamWaitEvent](#), [cudaStreamSynchronize](#), [cudaStreamAddCallback](#), [cudaStreamDestroy](#)

## cudaError\_t cudaStreamSynchronize (cudaStream\_t stream)

Waits for stream tasks to complete.

### Parameters

#### **stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#)

### Description

Blocks until `stream` has completed all operations. If the [cudaDeviceScheduleBlockingSync](#) flag was set for this device, the host thread will block until the stream is finished with all of its tasks.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaStreamCreate](#), [cudaStreamCreateWithFlags](#), [cudaStreamQuery](#),  
[cudaStreamWaitEvent](#), [cudaStreamAddCallback](#), [cudaStreamDestroy](#)

## `cudaError_t cudaStreamWaitEvent (cudaStream_t stream, cudaEvent_t event, unsigned int flags)`

Make a compute stream wait on an event.

### Parameters

#### **stream**

- Stream to wait

#### **event**

- Event to wait on

#### **flags**

- Parameters for the operation (must be 0)

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#)

### Description

Makes all future work submitted to `stream` wait until `event` reports completion before beginning execution. This synchronization will be performed efficiently on the device. The event `event` may be from a different context than `stream`, in which case this function will perform cross-device synchronization.

The stream `stream` will wait only for the completion of the most recent host call to [cudaEventRecord\(\)](#) on `event`. Once this call has returned, any functions (including [cudaEventRecord\(\)](#) and [cudaEventDestroy\(\)](#)) may be called on `event` again, and the subsequent calls will not have any effect on `stream`.

If `stream` is `NULL`, any future work submitted in any stream will wait for `event` to complete before beginning execution. This effectively creates a barrier for all future work submitted to the device on this thread.

If [cudaEventRecord\(\)](#) has not been called on `event`, this call acts as if the record has already completed, and so is a functional no-op.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaStreamCreate](#), [cudaStreamCreateWithFlags](#), [cudaStreamQuery](#),  
[cudaStreamSynchronize](#), [cudaStreamAddCallback](#), [cudaStreamDestroy](#)

## 2.5. Event Management

This section describes the event management functions of the CUDA runtime application programming interface.

### `cudaError_t cudaEventCreate (cudaEvent_t *event)`

Creates an event object.

#### Parameters

##### **event**

- Newly created event

#### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#), [cudaErrorInvalidValue](#),  
[cudaErrorLaunchFailure](#), [cudaErrorMemoryAllocation](#)

#### Description

Creates an event object using [cudaEventDefault](#).



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaEventCreate](#) (C++ API), [cudaEventCreateWithFlags](#), [cudaEventRecord](#),  
[cudaEventQuery](#), [cudaEventSynchronize](#), [cudaEventDestroy](#), [cudaEventElapsedTime](#),  
[cudaStreamWaitEvent](#)

## cudaError\_t cudaEventCreateWithFlags (cudaEvent\_t \*event, unsigned int flags)

Creates an event object with the specified flags.

### Parameters

#### event

- Newly created event

#### flags

- Flags for new event

### Returns

cudaSuccess, cudaErrorInitializationError, cudaErrorInvalidValue, cudaErrorLaunchFailure, cudaErrorMemoryAllocation

### Description

Creates an event object with the specified flags. Valid flags include:

- ▶ **cudaEventDefault**: Default event creation flag.
- ▶ **cudaEventBlockingSync**: Specifies that event should use blocking synchronization. A host thread that uses **cudaEventSynchronize()** to wait on an event created with this flag will block until the event actually completes.
- ▶ **cudaEventDisableTiming**: Specifies that the created event does not need to record timing data. Events created with this flag specified and the **cudaEventBlockingSync** flag not specified will provide the best performance when used with **cudaStreamWaitEvent()** and **cudaEventQuery()**.
- ▶ **cudaEventInterprocess**: Specifies that the created event may be used as an interprocess event by **cudaIpcGetEventHandle()**. **cudaEventInterprocess** must be specified along with **cudaEventDisableTiming**.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

**cudaEventCreate** ( C API), **cudaEventSynchronize**, **cudaEventDestroy**, **cudaEventElapsedTime**, **cudaStreamWaitEvent**

## cudaError\_t cudaEventDestroy (cudaEvent\_t event)

Destroys an event object.

### Parameters

#### event

- Event to destroy

### Returns

cudaSuccess, cudaErrorInitializationError, cudaErrorInvalidValue, cudaErrorLaunchFailure

### Description

Destroys the event specified by event.

In case event has been recorded but has not yet been completed when `cudaEventDestroy()` is called, the function will return immediately and the resources associated with event will be released automatically once the device has completed event.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

cudaEventCreate ( C API), cudaEventCreateWithFlags, cudaEventQuery, cudaEventSynchronize, cudaEventRecord, cudaEventElapsedTime

## cudaError\_t cudaEventElapsedTime (float \*ms, cudaEvent\_t start, cudaEvent\_t end)

Computes the elapsed time between events.

### Parameters

#### ms

- Time between start and end in ms

#### start

- Starting event

#### end

- Ending event

## Returns

`cudaSuccess`, `cudaErrorNotReady`, `cudaErrorInvalidValue`, `cudaErrorInitializationError`, `cudaErrorInvalidResourceHandle`, `cudaErrorLaunchFailure`

## Description

Computes the elapsed time between two events (in milliseconds with a resolution of around 0.5 microseconds).

If either event was last recorded in a non-NULL stream, the resulting time may be greater than expected (even if both used the same stream handle). This happens because the `cudaEventRecord()` operation takes place asynchronously and there is no guarantee that the measured latency is actually just between the two events. Any number of other different stream operations could execute in between the two measured events, thus altering the timing in a significant way.

If `cudaEventRecord()` has not been called on either event, then `cudaErrorInvalidResourceHandle` is returned. If `cudaEventRecord()` has been called on both events but one or both of them has not yet been completed (that is, `cudaEventQuery()` would return `cudaErrorNotReady` on at least one of the events), `cudaErrorNotReady` is returned. If either event was created with the `cudaEventDisableTiming` flag, then this function will return `cudaErrorInvalidResourceHandle`.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaEventCreate` ( C API), `cudaEventCreateWithFlags`, `cudaEventQuery`, `cudaEventSynchronize`, `cudaEventDestroy`, `cudaEventRecord`

## `cudaError_t cudaEventQuery (cudaEvent_t event)`

Queries an event's status.

## Parameters

### **event**

- Event to query

## Returns

`cudaSuccess`, `cudaErrorNotReady`, `cudaErrorInitializationError`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorLaunchFailure`

## Description

Query the status of all device work preceding the most recent call to `cudaEventRecord()` (in the appropriate compute streams, as specified by the arguments to `cudaEventRecord()`).

If this work has successfully been completed by the device, or if `cudaEventRecord()` has not been called on `event`, then `cudaSuccess` is returned. If this work has not yet been completed by the device then `cudaErrorNotReady` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaEventCreate` ( C API), `cudaEventCreateWithFlags`, `cudaEventRecord`, `cudaEventSynchronize`, `cudaEventDestroy`, `cudaEventElapsedTime`

## `cudaError_t cudaEventRecord (cudaEvent_t event, cudaStream_t stream)`

Records an event.

## Parameters

### **event**

- Event to record

### **stream**

- Stream in which to record event

## Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInitializationError`, `cudaErrorInvalidResourceHandle`, `cudaErrorLaunchFailure`

## Description

Records an event. If `stream` is non-zero, the event is recorded after all preceding operations in `stream` have been completed; otherwise, it is recorded after all preceding operations in the CUDA context have been completed. Since operation is asynchronous, `cudaEventQuery()` and/or `cudaEventSynchronize()` must be used to determine when the event has actually been recorded.

If `cudaEventRecord()` has previously been called on `event`, then this call will overwrite any existing state in `event`. Any subsequent calls which examine the status of `event` will only examine the completion of this most recent call to `cudaEventRecord()`.





Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaEventCreate](#) ( C API), [cudaEventCreateWithFlags](#), [cudaEventQuery](#), [cudaEventSynchronize](#), [cudaEventDestroy](#), [cudaEventElapsedTime](#), [cudaStreamWaitEvent](#)

## `cudaError_t cudaEventSynchronize (cudaEvent_t event)`

Waits for an event to complete.

#### Parameters

##### **event**

- Event to wait for

#### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorLaunchFailure](#)

#### Description

Wait until the completion of all device work preceding the most recent call to [cudaEventRecord\(\)](#) (in the appropriate compute streams, as specified by the arguments to [cudaEventRecord\(\)](#)).

If [cudaEventRecord\(\)](#) has not been called on `event`, [cudaSuccess](#) is returned immediately.

Waiting for an event that was created with the [cudaEventBlockingSync](#) flag will cause the calling CPU thread to block until the event has been completed by the device. If the [cudaEventBlockingSync](#) flag has not been set, then the CPU thread will busy-wait until the event has been completed by the device.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaEventCreate](#) ( C API), [cudaEventCreateWithFlags](#), [cudaEventRecord](#), [cudaEventQuery](#), [cudaEventDestroy](#), [cudaEventElapsedTime](#)

## 2.6. Execution Control

This section describes the execution control functions of the CUDA runtime application programming interface.

Some functions have overloaded C++ API template versions documented separately in the [C++ API Routines](#) module.

### **cudaError\_t cudaConfigureCall (dim3 gridDim, dim3 blockDim, size\_t sharedMem, cudaStream\_t stream)**

Configure a device-launch.

#### **Parameters**

##### **gridDim**

- Grid dimensions

##### **blockDim**

- Block dimensions

##### **sharedMem**

- Shared memory

##### **stream**

- Stream identifier

#### **Returns**

[cudaSuccess](#), [cudaErrorInvalidConfiguration](#)

#### **Description**

Specifies the grid and block dimensions for the device call to be executed similar to the execution configuration syntax. [cudaConfigureCall\(\)](#) is stack based. Each call pushes data on top of an execution stack. This data contains the dimension for the grid and thread blocks, together with any arguments for the call.



Note that this function may also return error codes from previous, asynchronous launches.

#### **See also:**

[cudaFuncSetCacheConfig](#) ( C API), [cudaFuncGetAttributes](#) ( C API), [cudaLaunch](#) ( C API), [cudaSetDoubleForDevice](#), [cudaSetDoubleForHost](#), [cudaSetupArgument](#) ( C API),

## cudaError\_t cudaFuncGetAttributes (cudaFuncAttributes \*attr, const void \*func)

Find out attributes for a given function.

### Parameters

**attr**

- Return pointer to function's attributes

**func**

- Device function symbol

### Returns

cudaSuccess, cudaErrorInitializationError, cudaErrorInvalidDeviceFunction

### Description

This function obtains the attributes of a function specified via `func`. `func` is a device function symbol and must be declared as a `__global__` function. The fetched attributes are placed in `attr`. If the specified function does not exist, then `cudaErrorInvalidDeviceFunction` is returned.

Note that some function attributes such as `maxThreadsPerBlock` may vary based on the device that is currently being used.



- Note that this function may also return error codes from previous, asynchronous launches.
- Use of a string naming a function as the `func` paramater was deprecated in CUDA 4.1 and removed in CUDA 5.0.

### See also:

cudaConfigureCall, cudaFuncSetCacheConfig ( C API), cudaFuncGetAttributes (C ++ API), cudaLaunch ( C API), cudaSetDoubleForDevice, cudaSetDoubleForHost, cudaSetupArgument ( C API)

## cudaError\_t cudaFuncSetCacheConfig (const void \*func, cudaFuncCache cacheConfig)

Sets the preferred cache configuration for a device function.

### Parameters

#### func

- Device function symbol

#### cacheConfig

- Requested cache configuration

### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#), [cudaErrorInvalidDeviceFunction](#)

### Description

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `cacheConfig` the preferred cache configuration for the function specified via `func`. This is only a preference. The runtime will use the requested configuration if possible, but it is free to choose a different configuration if required to execute `func`.

`func` is a device function symbol and must be declared as a `__global__` function. If the specified function does not exist, then [cudaErrorInvalidDeviceFunction](#) is returned.

This setting does nothing on devices where the size of the L1 cache and shared memory are fixed.

Launching a kernel with a different preference than the most recent preference setting may insert a device-side synchronization point.

The supported cache configurations are:

- ▶ [cudaFuncCachePreferNone](#): no preference for shared memory or L1 (default)
- ▶ [cudaFuncCachePreferShared](#): prefer larger shared memory and smaller L1 cache
- ▶ [cudaFuncCachePreferL1](#): prefer larger L1 cache and smaller shared memory



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ Use of a string naming a function as the `func` parameter was deprecated in CUDA 4.1 and removed in CUDA 5.0.

See also:

[cudaConfigureCall](#), [cudaFuncSetCacheConfig](#) (C++ API), [cudaFuncGetAttributes](#) ( C API), [cudaLaunch](#) ( C API), [cudaSetDoubleForDevice](#), [cudaSetDoubleForHost](#), [cudaSetupArgument](#) ( C API), [cudaThreadGetCacheConfig](#), [cudaThreadSetCacheConfig](#)

## **cudaError\_t cudaFuncSetSharedMemConfig (const void \*func, cudaSharedMemConfig config)**

Sets the shared memory configuration for a device function.

### **Parameters**

#### **func**

- Device function symbol

#### **config**

- Requested shared memory configuration

### **Returns**

[cudaSuccess](#), [cudaErrorInitializationError](#), [cudaErrorInvalidDeviceFunction](#), [cudaErrorInvalidValue](#),

### **Description**

On devices with configurable shared memory banks, this function will force all subsequent launches of the specified device function to have the given shared memory bank size configuration. On any given launch of the function, the shared memory configuration of the device will be temporarily changed if needed to suit the function's preferred configuration. Changes in shared memory configuration between subsequent launches of functions, may introduce a device side synchronization point.

Any per-function setting of shared memory bank size set via [cudaFuncSetSharedMemConfig](#) will override the device wide setting set by [cudaDeviceSetSharedMemConfig](#).

Changing the shared memory bank size will not increase shared memory usage or affect occupancy of kernels, but may have major effects on performance. Larger bank sizes will allow for greater potential bandwidth to shared memory, but will change what kinds of accesses to shared memory will result in bank conflicts.

This function will do nothing on devices with fixed shared memory bank size.

The supported bank configurations are:

- ▶ [cudaSharedMemBankSizeDefault](#): use the device's shared memory configuration when launching this function.
- ▶ [cudaSharedMemBankSizeFourByte](#): set shared memory bank width to be four bytes natively when launching this function.

- ▶ `cudaSharedMemBankSizeEightByte`: set shared memory bank width to be eight bytes natively when launching this function.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ Use of a string naming a function as the `func` paramater was deprecated in CUDA 4.1 and removed in CUDA 5.0.

#### See also:

`cudaConfigureCall`, `cudaDeviceSetSharedMemConfig`,  
`cudaDeviceGetSharedMemConfig`, `cudaDeviceSetCacheConfig`,  
`cudaDeviceGetCacheConfig`, `cudaFuncSetCacheConfig`

## `cudaError_t cudaLaunch (const void *func)`

Launches a device function.

### Parameters

#### `func`

- Device function symbol

### Returns

`cudaSuccess`, `cudaErrorInvalidDeviceFunction`, `cudaErrorInvalidConfiguration`,  
`cudaErrorLaunchFailure`, `cudaErrorLaunchTimeout`, `cudaErrorLaunchOutOfResources`,  
`cudaErrorSharedObjectInitFailed`

### Description

Launches the function `func` on the device. The parameter `func` must be a device function symbol. The parameter specified by `func` must be declared as a `__global__` function. `cudaLaunch()` must be preceded by a call to `cudaConfigureCall()` since it pops the data that was pushed by `cudaConfigureCall()` from the execution stack.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ Use of a string naming a variable as the `symbol` paramater was removed in CUDA 5.0.

#### See also:

[cudaConfigureCall](#), [cudaFuncSetCacheConfig](#) ( C API), [cudaFuncGetAttributes](#) ( C API), [cudaLaunch](#) (C++ API), [cudaSetDoubleForDevice](#), [cudaSetDoubleForHost](#), [cudaSetupArgument](#) ( C API), [cudaThreadGetCacheConfig](#), [cudaThreadSetCacheConfig](#)

## `cudaError_t cudaSetDoubleForDevice (double *d)`

Converts a double argument to be executed on a device.

### Parameters

**d**

- Double to convert

### Returns

[cudaSuccess](#)

### Description

Converts the double value of `d` to an internal float representation if the device does not support double arithmetic. If the device does natively support doubles, then this function does nothing.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaConfigureCall](#), [cudaFuncSetCacheConfig](#) ( C API), [cudaFuncGetAttributes](#) ( C API), [cudaLaunch](#) ( C API), [cudaSetDoubleForHost](#), [cudaSetupArgument](#) ( C API)

## `cudaError_t cudaSetDoubleForHost (double *d)`

Converts a double argument after execution on a device.

### Parameters

**d**

- Double to convert

### Returns

[cudaSuccess](#)

## Description

Converts the double value of `d` from a potentially internal float representation if the device does not support double arithmetic. If the device does natively support doubles, then this function does nothing.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

[cudaConfigureCall](#), [cudaFuncSetCacheConfig \( C API\)](#), [cudaFuncGetAttributes \( C API\)](#), [cudaLaunch \( C API\)](#), [cudaSetDoubleForDevice](#), [cudaSetupArgument \( C API\)](#)

## `cudaError_t cudaSetupArgument (const void *arg, size_t size, size_t offset)`

Configure a device launch.

## Parameters

### `arg`

- Argument to push for a kernel launch

### `size`

- Size of argument

### `offset`

- Offset in argument stack to push new arg

## Returns

[cudaSuccess](#)

## Description

Pushes `size` bytes of the argument pointed to by `arg` at `offset` bytes from the start of the parameter passing area, which starts at offset 0. The arguments are stored in the top of the execution stack. [cudaSetupArgument\(\)](#) must be preceded by a call to [cudaConfigureCall\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

## See also:



`cudaConfigureCall`, `cudaFuncSetCacheConfig` ( C API), `cudaFuncGetAttributes` ( C API), `cudaLaunch` ( C API), `cudaSetDoubleForDevice`, `cudaSetDoubleForHost`, `cudaSetupArgument` (C++ API),

## 2.7. Memory Management

This section describes the memory management functions of the CUDA runtime application programming interface.

Some functions have overloaded C++ API template versions documented separately in the [C++ API Routines](#) module.

**`cudaError_t cudaArrayGetInfo (cudaChannelFormatDesc *desc, cudaExtent *extent, unsigned int *flags, cudaArray_t array)`**

Gets info about the specified `cudaArray`.

### Parameters

#### **desc**

- Returned array type

#### **extent**

- Returned array shape. 2D arrays will have depth of zero

#### **flags**

- Returned array flags

#### **array**

- The `cudaArray` to get info for

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Returns in `*desc`, `*extent` and `*flags` respectively, the type, shape and flags of `array`.

Any of `*desc`, `*extent` and `*flags` may be specified as `NULL`.



Note that this function may also return error codes from previous, asynchronous launches.

## cudaError\_t cudaFree (void \*devPtr)

Frees memory on the device.

### Parameters

#### devPtr

- Device pointer to memory to free

### Returns

cudaSuccess, cudaErrorInvalidDevicePointer, cudaErrorInitializationError

### Description

Frees the memory space pointed to by `devPtr`, which must have been returned by a previous call to `cudaMalloc()` or `cudaMallocPitch()`. Otherwise, or if `cudaFree(devPtr)` has already been called before, an error is returned. If `devPtr` is 0, no operation is performed. `cudaFree()` returns `cudaErrorInvalidDevicePointer` in case of failure.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaMalloc`, `cudaMallocPitch`, `cudaMallocArray`, `cudaFreeArray`, `cudaMallocHost` ( C API), `cudaFreeHost`, `cudaMalloc3D`, `cudaMalloc3DArray`, `cudaHostAlloc`

## cudaError\_t cudaFreeArray (cudaArray\_t array)

Frees an array on the device.

### Parameters

#### array

- Pointer to array to free

### Returns

cudaSuccess, cudaErrorInvalidValue, cudaErrorInitializationError

### Description

Frees the CUDA array `array`, which must have been \* returned by a previous call to `cudaMallocArray()`. If `cudaFreeArray(array)` has already been called before, `cudaErrorInvalidValue` is returned. If `devPtr` is 0, no operation is performed.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaMalloc](#), [cudaMallocPitch](#), [cudaFree](#), [cudaMallocArray](#), [cudaMallocHost](#) ( C API), [cudaFreeHost](#), [cudaHostAlloc](#)

## cudaError\_t cudaFreeHost (void \*ptr)

Frees page-locked memory.

#### Parameters

##### ptr

- Pointer to memory to free

#### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#)

#### Description

Frees the memory space pointed to by `hostPtr`, which must have been returned by a previous call to [cudaMallocHost\(\)](#) or [cudaHostAlloc\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaMalloc](#), [cudaMallocPitch](#), [cudaFree](#), [cudaMallocArray](#), [cudaFreeArray](#), [cudaMallocHost](#) ( C API), [cudaMalloc3D](#), [cudaMalloc3DArray](#), [cudaHostAlloc](#)

## cudaError\_t cudaFreeMipmappedArray (cudaMipmappedArray\_t mipmappedArray)

Frees a mipmapped array on the device.

#### Parameters

##### mipmappedArray

- Pointer to mipmapped array to free

**Returns**

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInitializationError`

**Description**

Frees the CUDA mipmapped array `mipmappedArray`, which must have been returned by a previous call to `cudaMallocMipmappedArray()`. If `cudaFreeMipmappedArray(mipmappedArray)` has already been called before, `cudaErrorInvalidValue` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaMalloc`, `cudaMallocPitch`, `cudaFree`, `cudaMallocArray`, `cudaMallocHost` ( C API), `cudaFreeHost`, `cudaHostAlloc`

## `cudaError_t cudaGetMipmappedArrayLevel` (`cudaArray_t *levelArray`, `cudaMipmappedArray_const_t mipmappedArray`, `unsigned int level`)

Gets a mipmap level of a CUDA mipmapped array.

**Parameters****levelArray**

- Returned mipmap level CUDA array

**mipmappedArray**

- CUDA mipmapped array

**level**

- Mipmap level

**Returns**

`cudaSuccess`, `cudaErrorInvalidValue`

**Description**

Returns in `*levelArray` a CUDA array that represents a single mipmap level of the CUDA mipmapped array `mipmappedArray`.

If `level` is greater than the maximum number of levels in this mipmapped array, `cudaErrorInvalidValue` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaMalloc3D](#), [cudaMalloc](#), [cudaMallocPitch](#), [cudaFree](#), [cudaFreeArray](#),  
[cudaMallocHost \( C API\)](#), [cudaFreeHost](#), [cudaHostAlloc](#), [make\\_cudaExtent](#)

## cudaError\_t cudaGetSymbolAddress (void \*\*devPtr, const void \*symbol)

Finds the address associated with a CUDA symbol.

#### Parameters

##### devPtr

- Return device pointer associated with symbol

##### symbol

- Device symbol address

#### Returns

[cudaSuccess](#), [cudaErrorInvalidSymbol](#)

#### Description

Returns in \*devPtr the address of symbol `symbol` on the device. `symbol` is a variable that resides in global or constant memory space. If `symbol` cannot be found, or if `symbol` is not declared in the global or constant memory space, \*devPtr is unchanged and the error [cudaErrorInvalidSymbol](#) is returned.



- Note that this function may also return error codes from previous, asynchronous launches.
- Use of a string naming a variable as the `symbol` parameter was deprecated in CUDA 4.1 and removed in CUDA 5.0.

#### See also:

[cudaGetSymbolAddress \(C++ API\)](#), [cudaGetSymbolSize \( C API\)](#)

## cudaError\_t cudaGetSymbolSize (size\_t \*size, const void \*symbol)

Finds the size of the object associated with a CUDA symbol.

### Parameters

#### size

- Size of object associated with symbol

#### symbol

- Device symbol address

### Returns

[cudaSuccess](#), [cudaErrorInvalidSymbol](#)

### Description

Returns in \*size the size of symbol symbol. symbol is a variable that resides in global or constant memory space. If symbol cannot be found, or if symbol is not declared in global or constant memory space, \*size is unchanged and the error [cudaErrorInvalidSymbol](#) is returned.



- Note that this function may also return error codes from previous, asynchronous launches.
- Use of a string naming a variable as the symbol paramater was deprecated in CUDA 4.1 and removed in CUDA 5.0.

### See also:

[cudaGetSymbolAddress](#) ( C API), [cudaGetSymbolSize](#) (C++ API)

## cudaError\_t cudaHostAlloc (void \*\*pHost, size\_t size, unsigned int flags)

Allocates page-locked memory on the host.

### Parameters

#### pHost

- Device pointer to allocated memory

#### size

- Requested allocation size in bytes

**flags**

- Requested properties of allocated memory

**Returns**

[cudaSuccess](#), [cudaErrorMemoryAllocation](#)

**Description**

Allocates `size` bytes of host memory that is page-locked and accessible to the device. The driver tracks the virtual memory ranges allocated with this function and automatically accelerates calls to functions such as [cudaMemcpy\(\)](#). Since the memory can be accessed directly by the device, it can be read or written with much higher bandwidth than pageable memory obtained with functions such as `malloc()`. Allocating excessive amounts of pinned memory may degrade system performance, since it reduces the amount of memory available to the system for paging. As a result, this function is best used sparingly to allocate staging areas for data exchange between host and device.

The `flags` parameter enables different options to be specified that affect the allocation, as follows.

- ▶ [cudaHostAllocDefault](#): This flag's value is defined to be 0 and causes [cudaHostAlloc\(\)](#) to emulate [cudaMallocHost\(\)](#).
- ▶ [cudaHostAllocPortable](#): The memory returned by this call will be considered as pinned memory by all CUDA contexts, not just the one that performed the allocation.
- ▶ [cudaHostAllocMapped](#): Maps the allocation into the CUDA address space. The device pointer to the memory may be obtained by calling [cudaHostGetDevicePointer\(\)](#).
- ▶ [cudaHostAllocWriteCombined](#): Allocates the memory as write-combined (WC). WC memory can be transferred across the PCI Express bus more quickly on some system configurations, but cannot be read efficiently by most CPUs. WC memory is a good option for buffers that will be written by the CPU and read by the device via mapped pinned memory or host->device transfers.

All of these flags are orthogonal to one another: a developer may allocate memory that is portable, mapped and/or write-combined with no restrictions.

[cudaSetDeviceFlags\(\)](#) must have been called with the [cudaDeviceMapHost](#) flag in order for the [cudaHostAllocMapped](#) flag to have any effect.

The [cudaHostAllocMapped](#) flag may be specified on CUDA contexts for devices that do not support mapped pinned memory. The failure is deferred to [cudaHostGetDevicePointer\(\)](#) because the memory may be mapped into other CUDA contexts via the [cudaHostAllocPortable](#) flag.

Memory allocated by this function must be freed with [cudaFreeHost\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaSetDeviceFlags](#), [cudaMallocHost](#) ( C API), [cudaFreeHost](#)

## **cudaError\_t cudaHostGetDevicePointer (void \*\*pDevice, void \*pHost, unsigned int flags)**

Passes back device pointer of mapped host memory allocated by [cudaHostAlloc](#) or registered by [cudaHostRegister](#).

### **Parameters**

#### **pDevice**

- Returned device pointer for mapped memory

#### **pHost**

- Requested host pointer mapping

#### **flags**

- Flags for extensions (must be 0 for now)

### **Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorMemoryAllocation](#)

### **Description**

Passes back the device pointer corresponding to the mapped, pinned host buffer allocated by [cudaHostAlloc\(\)](#) or registered by [cudaHostRegister\(\)](#).

[cudaHostGetDevicePointer\(\)](#) will fail if the [cudaDeviceMapHost](#) flag was not specified before deferred context creation occurred, or if called on a device that does not support mapped, pinned memory.

`flags` provides for future releases. For now, it must be set to 0.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaSetDeviceFlags](#), [cudaHostAlloc](#)



## `cudaError_t cudaHostGetFlags (unsigned int *pFlags, void *pHost)`

Passes back flags used to allocate pinned host memory allocated by `cudaHostAlloc`.

### Parameters

#### **pFlags**

- Returned flags word

#### **pHost**

- Host pointer

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

`cudaHostGetFlags()` will fail if the input pointer does not reside in an address range allocated by `cudaHostAlloc()`.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaHostAlloc`

## `cudaError_t cudaHostRegister (void *ptr, size_t size, unsigned int flags)`

Registers an existing host memory range for use by CUDA.

### Parameters

#### **ptr**

- Host pointer to memory to page-lock

#### **size**

- Size in bytes of the address range to page-lock in bytes

#### **flags**

- Flags for allocation request

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorMemoryAllocation`

## Description

Page-locks the memory range specified by `ptr` and `size` and maps it for the device(s) as specified by `flags`. This memory range also is added to the same tracking mechanism as `cudaHostAlloc()` to automatically accelerate calls to functions such as `cudaMemcpy()`. Since the memory can be accessed directly by the device, it can be read or written with much higher bandwidth than pageable memory that has not been registered. Page-locking excessive amounts of memory may degrade system performance, since it reduces the amount of memory available to the system for paging. As a result, this function is best used sparingly to register staging areas for data exchange between host and device.

The `flags` parameter enables different options to be specified that affect the allocation, as follows.

- ▶ `cudaHostRegisterPortable`: The memory returned by this call will be considered as pinned memory by all CUDA contexts, not just the one that performed the allocation.
- ▶ `cudaHostRegisterMapped`: Maps the allocation into the CUDA address space. The device pointer to the memory may be obtained by calling `cudaHostGetDevicePointer()`. This feature is available only on GPUs with compute capability greater than or equal to 1.1.

All of these flags are orthogonal to one another: a developer may page-lock memory that is portable or mapped with no restrictions.

The CUDA context must have been created with the `cudaMapHost` flag in order for the `cudaHostRegisterMapped` flag to have any effect.

The `cudaHostRegisterMapped` flag may be specified on CUDA contexts for devices that do not support mapped pinned memory. The failure is deferred to `cudaHostGetDevicePointer()` because the memory may be mapped into other CUDA contexts via the `cudaHostRegisterPortable` flag.

The memory page-locked by this function must be unregistered with `cudaHostUnregister()`.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaHostUnregister`, `cudaHostGetFlags`, `cudaHostGetDevicePointer`

## cudaError\_t cudaHostUnregister (void \*ptr)

Unregisters a memory range that was registered with `cudaHostRegister`.

### Parameters

#### **ptr**

- Host pointer to memory to unregister

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Unmaps the memory range whose base address is specified by `ptr`, and makes it pageable again.

The base address must be the same one specified to `cudaHostRegister()`.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaHostUnregister`

## cudaError\_t cudaMalloc (void \*\*devPtr, size\_t size)

Allocate memory on the device.

### Parameters

#### **devPtr**

- Pointer to allocated device memory

#### **size**

- Requested allocation size in bytes

### Returns

`cudaSuccess`, `cudaErrorMemoryAllocation`

### Description

Allocates `size` bytes of linear memory on the device and returns in `*devPtr` a pointer to the allocated memory. The allocated memory is suitably aligned for any kind of

variable. The memory is not cleared. `cudaMalloc()` returns `cudaErrorMemoryAllocation` in case of failure.

#### See also:

`cudaMallocPitch`, `cudaFree`, `cudaMallocArray`, `cudaFreeArray`, `cudaMalloc3D`, `cudaMalloc3DArray`, `cudaMallocHost` ( C API), `cudaFreeHost`, `cudaHostAlloc`

## `cudaError_t cudaMalloc3D (cudaPitchedPtr *pitchedDevPtr, cudaExtent extent)`

Allocates logical 1D, 2D, or 3D memory objects on the device.

### Parameters

#### `pitchedDevPtr`

- Pointer to allocated pitched device memory

#### `extent`

- Requested allocation size (`width` field in bytes)

### Returns

`cudaSuccess`, `cudaErrorMemoryAllocation`

### Description

Allocates at least `width * height * depth` bytes of linear memory on the device and returns a `cudaPitchedPtr` in which `ptr` is a pointer to the allocated memory. The function may pad the allocation to ensure hardware alignment requirements are met. The pitch returned in the `pitch` field of `pitchedDevPtr` is the width in bytes of the allocation.

The returned `cudaPitchedPtr` contains additional fields `xsize` and `ysize`, the logical width and height of the allocation, which are equivalent to the `width` and `height` `extent` parameters provided by the programmer during allocation.

For allocations of 2D and 3D objects, it is highly recommended that programmers perform allocations using `cudaMalloc3D()` or `cudaMallocPitch()`. Due to alignment restrictions in the hardware, this is especially true if the application will be performing memory copies involving 2D or 3D objects (whether linear memory or CUDA arrays).



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaMallocPitch`, `cudaFree`, `cudaMemcpy3D`, `cudaMemset3D`, `cudaMalloc3DArray`, `cudaMallocArray`, `cudaFreeArray`, `cudaMallocHost` ( C API), `cudaFreeHost`, `cudaHostAlloc`, `make_cudaPitchedPtr`, `make_cudaExtent`

## `cudaError_t cudaMalloc3DArray (cudaArray_t *array, const cudaChannelFormatDesc *desc, cudaExtent extent, unsigned int flags)`

Allocate an array on the device.

### Parameters

#### **array**

- Pointer to allocated array in device memory

#### **desc**

- Requested channel format

#### **extent**

- Requested allocation size (width field in elements)

#### **flags**

- Flags for extensions

### Returns

`cudaSuccess`, `cudaErrorMemoryAllocation`

### Description

Allocates a CUDA array according to the `cudaChannelFormatDesc` structure `desc` and returns a handle to the new CUDA array in `*array`.

The `cudaChannelFormatDesc` is defined as:

```
↑ struct cudaChannelFormatDesc {
    int x, y, z, w;
    enum cudaChannelFormatKind
      f;
};
```

where `cudaChannelFormatKind` is one of `cudaChannelFormatKindSigned`, `cudaChannelFormatKindUnsigned`, or `cudaChannelFormatKindFloat`.

`cudaMalloc3DArray()` can allocate the following:

- ▶ A 1D array is allocated if the height and depth extents are both zero.
- ▶ A 2D array is allocated if only the depth extent is zero.
- ▶ A 3D array is allocated if all three extents are non-zero.
- ▶ A 1D layered CUDA array is allocated if only the height extent is zero and the `cudaArrayLayered` flag is set. Each layer is a 1D array. The number of layers is determined by the depth extent.

- ▶ A 2D layered CUDA array is allocated if all three extents are non-zero and the `cudaArrayLayered` flag is set. Each layer is a 2D array. The number of layers is determined by the depth extent.
- ▶ A cubemap CUDA array is allocated if all three extents are non-zero and the `cudaArrayCubemap` flag is set. Width must be equal to height, and depth must be six. A cubemap is a special type of 2D layered CUDA array, where the six layers represent the six faces of a cube. The order of the six layers in memory is the same as that listed in `cudaGraphicsCubeFace`.
- ▶ A cubemap layered CUDA array is allocated if all three extents are non-zero, and both, `cudaArrayCubemap` and `cudaArrayLayered` flags are set. Width must be equal to height, and depth must be a multiple of six. A cubemap layered CUDA array is a special type of 2D layered CUDA array that consists of a collection of cubemaps. The first six layers represent the first cubemap, the next six layers form the second cubemap, and so on.

The `flags` parameter enables different options to be specified that affect the allocation, as follows.

- ▶ `cudaArrayDefault`: This flag's value is defined to be 0 and provides default array allocation
- ▶ `cudaArrayLayered`: Allocates a layered CUDA array, with the depth extent indicating the number of layers
- ▶ `cudaArrayCubemap`: Allocates a cubemap CUDA array. Width must be equal to height, and depth must be six. If the `cudaArrayLayered` flag is also set, depth must be a multiple of six.
- ▶ `cudaArraySurfaceLoadStore`: Allocates a CUDA array that could be read from or written to using a surface reference.
- ▶ `cudaArrayTextureGather`: This flag indicates that texture gather operations will be performed on the CUDA array. Texture gather can only be performed on 2D CUDA arrays.

The width, height and depth extents must meet certain size requirements as listed in the following table. All values are specified in elements.

Note that 2D CUDA arrays have different size requirements if the `cudaArrayTextureGather` flag is set. In that case, the valid range for (width, height, depth) is ((1,maxTexture2DGather[0]), (1,maxTexture2DGather[1]), 0).

CUDA array type	Valid extents that must always be met {(width range in elements), (height range), (depth range)}	Valid extents with <code>cudaArraySurfaceLoadStore</code> set {(width range in elements), (height range), (depth range)}
1D	{ (1,maxTexture1D), 0, 0 }	{ (1,maxSurface1D), 0, 0 }

CUDA array type	Valid extents that must always be met {(width range in elements), (height range), (depth range)}	Valid extents with cudaArraySurfaceLoadStore set {(width range in elements), (height range), (depth range)}
2D	{ (1,maxTexture2D[0]), (1,maxTexture2D[1]), 0 }	{ (1,maxSurface2D[0]), (1,maxSurface2D[1]), 0 }
3D	{ (1,maxTexture3D[0]), (1,maxTexture3D[1]), (1,maxTexture3D[2]) } OR { (1,maxTexture3DAlt[0]), (1,maxTexture3DAlt[1]), (1,maxTexture3DAlt[2]) }	{ (1,maxSurface3D[0]), (1,maxSurface3D[1]), (1,maxSurface3D[2]) }
1D Layered	{ (1,maxTexture1DLayered[0]), 0, (1,maxTexture1DLayered[1]) }	{ (1,maxSurface1DLayered[0]), 0, (1,maxSurface1DLayered[1]) }
2D Layered	{ (1,maxTexture2DLayered[0]), (1,maxTexture2DLayered[1]), (1,maxTexture2DLayered[2]) }	{ (1,maxSurface2DLayered[0]), (1,maxSurface2DLayered[1]), (1,maxSurface2DLayered[2]) }
Cubemap	{ (1,maxTextureCubemap), (1,maxTextureCubemap), 6 }	{ (1,maxSurfaceCubemap), (1,maxSurfaceCubemap), 6 }
Cubemap Layered	{ (1,maxTextureCubemapLayered[0]), (1,maxTextureCubemapLayered[0]), (1,maxTextureCubemapLayered[1]) }	{ (1,maxSurfaceCubemapLayered[0]), (1,maxSurfaceCubemapLayered[0]), (1,maxSurfaceCubemapLayered[1]) }



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaMalloc3D](#), [cudaMalloc](#), [cudaMallocPitch](#), [cudaFree](#), [cudaFreeArray](#),  
[cudaMallocHost](#) ( C API), [cudaFreeHost](#), [cudaHostAlloc](#), [make\\_cudaExtent](#)

## `cudaError_t cudaMallocArray (cudaArray_t *array, const cudaChannelFormatDesc *desc, size_t width, size_t height, unsigned int flags)`

Allocate an array on the device.

### Parameters

#### **array**

- Pointer to allocated array in device memory

#### **desc**

- Requested channel format

#### **width**

- Requested array allocation width

#### **height**

- Requested array allocation height

#### **flags**

- Requested properties of allocated array

### Returns

`cudaSuccess`, `cudaErrorMemoryAllocation`

### Description

Allocates a CUDA array according to the `cudaChannelFormatDesc` structure `desc` and returns a handle to the new CUDA array in `*array`.

The `cudaChannelFormatDesc` is defined as:

```
struct cudaChannelFormatDesc {
    int x, y, z, w;
    enum cudaChannelFormatKind
        f;
};
```

where `cudaChannelFormatKind` is one of `cudaChannelFormatKindSigned`, `cudaChannelFormatKindUnsigned`, or `cudaChannelFormatKindFloat`.

The `flags` parameter enables different options to be specified that affect the allocation, as follows.

- ▶ `cudaArrayDefault`: This flag's value is defined to be 0 and provides default array allocation
- ▶ `cudaArraySurfaceLoadStore`: Allocates an array that can be read from or written to using a surface reference
- ▶ `cudaArrayTextureGather`: This flag indicates that texture gather operations will be performed on the array.



`width` and `height` must meet certain size requirements. See [cudaMalloc3DArray\(\)](#) for more details.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaMalloc](#), [cudaMallocPitch](#), [cudaFree](#), [cudaFreeArray](#), [cudaMallocHost](#) ( C API), [cudaFreeHost](#), [cudaMalloc3D](#), [cudaMalloc3DArray](#), [cudaHostAlloc](#)

## cudaError\_t cudaMallocHost (void \*\*ptr, size\_t size)

Allocates page-locked memory on the host.

### Parameters

#### **ptr**

- Pointer to allocated host memory

#### **size**

- Requested allocation size in bytes

### Returns

[cudaSuccess](#), [cudaErrorMemoryAllocation](#)

### Description

Allocates `size` bytes of host memory that is page-locked and accessible to the device. The driver tracks the virtual memory ranges allocated with this function and automatically accelerates calls to functions such as [cudaMemcpy\\*](#)(). Since the memory can be accessed directly by the device, it can be read or written with much higher bandwidth than pageable memory obtained with functions such as `malloc()`. Allocating excessive amounts of memory with [cudaMallocHost\(\)](#) may degrade system performance, since it reduces the amount of memory available to the system for paging. As a result, this function is best used sparingly to allocate staging areas for data exchange between host and device.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaMalloc`, `cudaMallocPitch`, `cudaMallocArray`, `cudaMalloc3D`, `cudaMalloc3DArray`, `cudaHostAlloc`, `cudaFree`, `cudaFreeArray`, `cudaMallocHost` (C++ API), `cudaFreeHost`, `cudaHostAlloc`

**`cudaError_t cudaMallocMipmappedArray`**  
**(`cudaMipmappedArray_t *mipmappedArray`, `const cudaChannelFormatDesc *desc`, `cudaExtent extent`, `unsigned int numLevels`, `unsigned int flags`)**

Allocate a mipmapped array on the device.

### Parameters

#### **`mipmappedArray`**

- Pointer to allocated mipmapped array in device memory

#### **`desc`**

- Requested channel format

#### **`extent`**

- Requested allocation size (`width` field in elements)

#### **`numLevels`**

- Number of mipmap levels to allocate

#### **`flags`**

- Flags for extensions

### Returns

`cudaSuccess`, `cudaErrorMemoryAllocation`

### Description

Allocates a CUDA mipmapped array according to the `cudaChannelFormatDesc` structure `desc` and returns a handle to the new CUDA mipmapped array in `*mipmappedArray`. `numLevels` specifies the number of mipmap levels to be allocated. This value is clamped to the range  $[1, 1 + \text{floor}(\log_2(\max(\text{width}, \text{height}, \text{depth})))]$ .

The `cudaChannelFormatDesc` is defined as:

```
↑ struct cudaChannelFormatDesc {
    int x, y, z, w;
    enum cudaChannelFormatKind
      f;
};
```

where `cudaChannelFormatKind` is one of `cudaChannelFormatKindSigned`, `cudaChannelFormatKindUnsigned`, or `cudaChannelFormatKindFloat`.

`cudaMallocMipmappedArray()` can allocate the following:

- ▶ A 1D mipmapped array is allocated if the height and depth extents are both zero.

- ▶ A 2D mipmapped array is allocated if only the depth extent is zero.
- ▶ A 3D mipmapped array is allocated if all three extents are non-zero.
- ▶ A 1D layered CUDA mipmapped array is allocated if only the height extent is zero and the `cudaArrayLayered` flag is set. Each layer is a 1D mipmapped array. The number of layers is determined by the depth extent.
- ▶ A 2D layered CUDA mipmapped array is allocated if all three extents are non-zero and the `cudaArrayLayered` flag is set. Each layer is a 2D mipmapped array. The number of layers is determined by the depth extent.
- ▶ A cubemap CUDA mipmapped array is allocated if all three extents are non-zero and the `cudaArrayCubemap` flag is set. Width must be equal to height, and depth must be six. The order of the six layers in memory is the same as that listed in `cudaGraphicsCubeFace`.
- ▶ A cubemap layered CUDA mipmapped array is allocated if all three extents are non-zero, and both, `cudaArrayCubemap` and `cudaArrayLayered` flags are set. Width must be equal to height, and depth must be a multiple of six. A cubemap layered CUDA mipmapped array is a special type of 2D layered CUDA mipmapped array that consists of a collection of cubemap mipmapped arrays. The first six layers represent the first cubemap mipmapped array, the next six layers form the second cubemap mipmapped array, and so on.

The `flags` parameter enables different options to be specified that affect the allocation, as follows.

- ▶ `cudaArrayDefault`: This flag's value is defined to be 0 and provides default mipmapped array allocation
- ▶ `cudaArrayLayered`: Allocates a layered CUDA mipmapped array, with the depth extent indicating the number of layers
- ▶ `cudaArrayCubemap`: Allocates a cubemap CUDA mipmapped array. Width must be equal to height, and depth must be six. If the `cudaArrayLayered` flag is also set, depth must be a multiple of six.
- ▶ `cudaArraySurfaceLoadStore`: This flag indicates that individual mipmap levels of the CUDA mipmapped array will be read from or written to using a surface reference.
- ▶ `cudaArrayTextureGather`: This flag indicates that texture gather operations will be performed on the CUDA array. Texture gather can only be performed on 2D CUDA mipmapped arrays, and the gather operations are performed only on the most detailed mipmap level.

The width, height and depth extents must meet certain size requirements as listed in the following table. All values are specified in elements.

CUDA array type	Valid extents {(width range in elements), (height range), (depth range)}
1D	{ (1,maxTexture1DMipmap), 0, 0 }

CUDA array type	Valid extents {(width range in elements), (height range), (depth range)}
2D	{ (1,maxTexture2DMipmap[0]), (1,maxTexture2DMipmap[1]), 0 }
3D	{ (1,maxTexture3D[0]), (1,maxTexture3D[1]), (1,maxTexture3D[2]) }
1D Layered	{ (1,maxTexture1DLayered[0]), 0, (1,maxTexture1DLayered[1]) }
2D Layered	{ (1,maxTexture2DLayered[0]), (1,maxTexture2DLayered[1]), (1,maxTexture2DLayered[2]) }
Cubemap	{ (1,maxTextureCubemap), (1,maxTextureCubemap), 6 }
Cubemap Layered	{ (1,maxTextureCubemapLayered[0]), (1,maxTextureCubemapLayered[0]), (1,maxTextureCubemapLayered[1]) }



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaMalloc3D](#), [cudaMalloc](#), [cudaMallocPitch](#), [cudaFree](#), [cudaFreeArray](#), [cudaMallocHost](#) ( C API), [cudaFreeHost](#), [cudaHostAlloc](#), [make\\_cudaExtent](#)

## cudaError\_t cudaMallocPitch (void \*\*devPtr, size\_t \*pitch, size\_t width, size\_t height)

Allocates pitched memory on the device.

### Parameters

#### devPtr

- Pointer to allocated pitched device memory

#### pitch

- Pitch for allocation

#### width

- Requested pitched allocation width (in bytes)

#### height

- Requested pitched allocation height

### Returns

[cudaSuccess](#), [cudaErrorMemoryAllocation](#)

## Description

Allocates at least `width` (in bytes) \* `height` bytes of linear memory on the device and returns in `*devPtr` a pointer to the allocated memory. The function may pad the allocation to ensure that corresponding pointers in any given row will continue to meet the alignment requirements for coalescing as the address is updated from row to row. The pitch returned in `*pitch` by `cudaMallocPitch()` is the width in bytes of the allocation. The intended usage of `pitch` is as a separate parameter of the allocation, used to compute addresses within the 2D array. Given the row and column of an array element of type `T`, the address is computed as:

```
T* pElement = (T*)((char*)BaseAddress + Row * pitch) + Column;
```

For allocations of 2D arrays, it is recommended that programmers consider performing pitch allocations using `cudaMallocPitch()`. Due to pitch alignment restrictions in the hardware, this is especially true if the application will be performing 2D memory copies between different regions of device memory (whether linear memory or CUDA arrays).



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaMalloc`, `cudaFree`, `cudaMallocArray`, `cudaFreeArray`, `cudaMallocHost` ( C API), `cudaFreeHost`, `cudaMalloc3D`, `cudaMalloc3DArray`, `cudaHostAlloc`

## `cudaError_t cudaMemcpy (void *dst, const void *src, size_t count, cudaMemcpyKind kind)`

Copies data between host and device.

### Parameters

#### **dst**

- Destination memory address

#### **src**

- Source memory address

#### **count**

- Size in bytes to copy

#### **kind**

- Type of transfer

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`, `cudaErrorInvalidMemcpyDirection`

## Description

Copies `count` bytes from the memory area pointed to by `src` to the memory area pointed to by `dst`, where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy. The memory areas may not overlap. Calling `cudaMemcpy()` with `dst` and `src` pointers that do not match the direction of the copy results in an undefined behavior.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits `synchronous` behavior for most use cases.

## See also:

`cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`, `cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`, `cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpy2D (void *dst, size_t dpitch, const void *src, size_t spitch, size_t width, size_t height, cudaMemcpyKind kind)`**

Copies data between host and device.

## Parameters

**`dst`**

- Destination memory address

**`dpitch`**

- Pitch of destination memory

**`src`**

- Source memory address

**`spitch`**

- Pitch of source memory

**`width`**

- Width of matrix transfer (columns in bytes)

**`height`**

- Height of matrix transfer (rows)

**kind**

- Type of transfer

**Returns**

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidPitchValue`,  
`cudaErrorInvalidDevicePointer`, `cudaErrorInvalidMemcpyDirection`

**Description**

Copies a matrix (`height` rows of `width` bytes each) from the memory area pointed to by `src` to the memory area pointed to by `dst`, where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy. `dpitch` and `spitch` are the widths in memory in bytes of the 2D arrays pointed to by `dst` and `src`, including any padding added to the end of each row. The memory areas may not overlap. `width` must not exceed either `dpitch` or `spitch`. Calling `cudaMemcpy2D()` with `dst` and `src` pointers that do not match the direction of the copy results in an undefined behavior. `cudaMemcpy2D()` returns an error if `dpitch` or `spitch` exceeds the maximum allowed.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaMemcpy`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,  
`cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`,  
`cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`,  
`cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`,  
`cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`,  
`cudaMemcpyFromSymbolAsync`

`cudaError_t cudaMemcpy2DArrayToArray`  
`(cudaArray_t dst, size_t wOffsetDst, size_t`  
`hOffsetDst, cudaArray_const_t src, size_t wOffsetSrc,`

## `size_t hOffsetSrc, size_t width, size_t height, cudaMemcpyKind kind)`

Copies data between host and device.

### Parameters

#### **dst**

- Destination memory address

#### **wOffsetDst**

- Destination starting X offset

#### **hOffsetDst**

- Destination starting Y offset

#### **src**

- Source memory address

#### **wOffsetSrc**

- Source starting X offset

#### **hOffsetSrc**

- Source starting Y offset

#### **width**

- Width of matrix transfer (columns in bytes)

#### **height**

- Height of matrix transfer (rows)

#### **kind**

- Type of transfer

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidMemcpyDirection`

### Description

Copies a matrix (`height` rows of `width` bytes each) from the CUDA array `srcArray` starting at the upper left corner (`wOffsetSrc`, `hOffsetSrc`) to the CUDA array `dst` starting at the upper left corner (`wOffsetDst`, `hOffsetDst`), where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy. `wOffsetDst + width` must not exceed the width of the CUDA array `dst`. `wOffsetSrc + width` must not exceed the width of the CUDA array `src`.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.



**See also:**

[cudaMemcpy](#), [cudaMemcpy2D](#), [cudaMemcpyToArray](#), [cudaMemcpy2DToArray](#),  
[cudaMemcpyFromArray](#), [cudaMemcpy2DFromArray](#), [cudaMemcpyArrayToArray](#),  
[cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#), [cudaMemcpyAsync](#),  
[cudaMemcpy2DAsync](#), [cudaMemcpyToArrayAsync](#), [cudaMemcpy2DToArrayAsync](#),  
[cudaMemcpyFromArrayAsync](#), [cudaMemcpy2DFromArrayAsync](#),  
[cudaMemcpyToSymbolAsync](#), [cudaMemcpyFromSymbolAsync](#)

**cudaError\_t cudaMemcpy2DAsync (void \*dst, size\_t dpitch, const void \*src, size\_t spitch, size\_t width, size\_t height, cudaMemcpyKind kind, cudaStream\_t stream)**

Copies data between host and device.

**Parameters**

**dst**

- Destination memory address

**dpitch**

- Pitch of destination memory

**src**

- Source memory address

**spitch**

- Pitch of source memory

**width**

- Width of matrix transfer (columns in bytes)

**height**

- Height of matrix transfer (rows)

**kind**

- Type of transfer

**stream**

- Stream identifier

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidPitchValue](#),  
[cudaErrorInvalidDevicePointer](#), [cudaErrorInvalidMemcpyDirection](#)

**Description**

Copies a matrix (`height` rows of `width` bytes each) from the memory area pointed to by `src` to the memory area pointed to by `dst`, where `kind` is one of [cudaMemcpyHostToHost](#), [cudaMemcpyHostToDevice](#), [cudaMemcpyDeviceToHost](#),

or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy. `dpitch` and `spitch` are the widths in memory in bytes of the 2D arrays pointed to by `dst` and `src`, including any padding added to the end of each row. The memory areas may not overlap. `width` must not exceed either `dpitch` or `spitch`. Calling `cudaMemcpy2DAsync()` with `dst` and `src` pointers that do not match the direction of the copy results in an undefined behavior. `cudaMemcpy2DAsync()` returns an error if `dpitch` or `spitch` is greater than the maximum allowed.

`cudaMemcpy2DAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyHostToDevice` or `cudaMemcpyDeviceToHost` and `stream` is non-zero, the copy may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits `asynchronous` behavior for most use cases.

#### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`, `cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`, `cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpy2DFromArray (void *dst, size_t dpitch, cudaArray_const_t src, size_t wOffset, size_t hOffset, size_t width, size_t height, cudaMemcpyKind kind)`**

Copies data between host and device.

#### Parameters

##### **`dst`**

- Destination memory address

##### **`dpitch`**

- Pitch of destination memory

##### **`src`**

- Source memory address

**wOffset**

- Source starting X offset

**hOffset**

- Source starting Y offset

**width**

- Width of matrix transfer (columns in bytes)

**height**

- Height of matrix transfer (rows)

**kind**

- Type of transfer

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidPitchValue](#), [cudaErrorInvalidMemcpyDirection](#)

**Description**

Copies a matrix (`height` rows of `width` bytes each) from the CUDA array `srcArray` starting at the upper left corner (`wOffset`, `hOffset`) to the memory area pointed to by `dst`, where `kind` is one of [cudaMemcpyHostToHost](#), [cudaMemcpyHostToDevice](#), [cudaMemcpyDeviceToHost](#), or [cudaMemcpyDeviceToDevice](#), and specifies the direction of the copy. `dpitch` is the width in memory in bytes of the 2D array pointed to by `dst`, including any padding added to the end of each row. `wOffset + width` must not exceed the width of the CUDA array `src`. `width` must not exceed `dpitch`. [cudaMemcpy2DFromArray\(\)](#) returns an error if `dpitch` exceeds the maximum allowed.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits [synchronous](#) behavior for most use cases.

**See also:**

[cudaMemcpy](#), [cudaMemcpy2D](#), [cudaMemcpyToArray](#), [cudaMemcpy2DToArray](#),  
[cudaMemcpyFromArray](#), [cudaMemcpyArrayToArray](#), [cudaMemcpy2DArrayToArray](#),  
[cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#), [cudaMemcpyAsync](#),  
[cudaMemcpy2DAsync](#), [cudaMemcpyToArrayAsync](#), [cudaMemcpy2DToArrayAsync](#),  
[cudaMemcpyFromArrayAsync](#), [cudaMemcpy2DFromArrayAsync](#),  
[cudaMemcpyToSymbolAsync](#), [cudaMemcpyFromSymbolAsync](#)

**[cudaError\\_t cudaMemcpy2DFromArrayAsync \(void  
\\*dst, size\\_t dpitch, cudaArray\\_const\\_t src, size\\_t](#)**

**wOffset, size\_t hOffset, size\_t width, size\_t height,  
cudaMemcpyKind kind, cudaStream\_t stream)**

Copies data between host and device.

### Parameters

**dst**

- Destination memory address

**dpitch**

- Pitch of destination memory

**src**

- Source memory address

**wOffset**

- Source starting X offset

**hOffset**

- Source starting Y offset

**width**

- Width of matrix transfer (columns in bytes)

**height**

- Height of matrix transfer (rows)

**kind**

- Type of transfer

**stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidPitchValue](#), [cudaErrorInvalidMemcpyDirection](#)

### Description

Copies a matrix (height rows of width bytes each) from the CUDA array `srcArray` starting at the upper left corner (`wOffset`, `hOffset`) to the memory area pointed to by `dst`, where `kind` is one of [cudaMemcpyHostToHost](#), [cudaMemcpyHostToDevice](#), [cudaMemcpyDeviceToHost](#), or [cudaMemcpyDeviceToDevice](#), and specifies the direction of the copy. `dpitch` is the width in memory in bytes of the 2D array pointed to by `dst`, including any padding added to the end of each row. `wOffset + width` must not exceed the width of the CUDA array `src`. `width` must not exceed `dpitch`. [cudaMemcpy2DFromArrayAsync\(\)](#) returns an error if `dpitch` exceeds the maximum allowed.

[cudaMemcpy2DFromArrayAsync\(\)](#) is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is [cudaMemcpyHostToDevice](#)

or `cudaMemcpyDeviceToHost` and `stream` is non-zero, the copy may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **asynchronous** behavior for most use cases.

#### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`, `cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`, `cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`, `cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpy2DToArray (cudaArray_t dst, size_t wOffset, size_t hOffset, const void *src, size_t spitch, size_t width, size_t height, cudaMemcpyKind kind)`**

Copies data between host and device.

#### Parameters

##### **dst**

- Destination memory address

##### **wOffset**

- Destination starting X offset

##### **hOffset**

- Destination starting Y offset

##### **src**

- Source memory address

##### **spitch**

- Pitch of source memory

##### **width**

- Width of matrix transfer (columns in bytes)

##### **height**

- Height of matrix transfer (rows)

##### **kind**

- Type of transfer

## Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`,  
`cudaErrorInvalidPitchValue`, `cudaErrorInvalidMemcpyDirection`

## Description

Copies a matrix (height rows of width bytes each) from the memory area pointed to by `src` to the CUDA array `dst` starting at the upper left corner (`wOffset`, `hOffset`) where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy. `spitch` is the width in memory in bytes of the 2D array pointed to by `src`, including any padding added to the end of each row. `wOffset + width` must not exceed the width of the CUDA array `dst`. `width` must not exceed `spitch`. `cudaMemcpy2DToArray()` returns an error if `spitch` exceeds the maximum allowed.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **synchronous** behavior for most use cases.

## See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpyFromArray`,  
`cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`,  
`cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`,  
`cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`,  
`cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`,  
`cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpy2DToArrayAsync (cudaArray_t dst, size_t wOffset, size_t hOffset, const void *src, size_t spitch, size_t width, size_t height, cudaMemcpyKind kind, cudaStream_t stream)`**

Copies data between host and device.

## Parameters

### **`dst`**

- Destination memory address

### **`wOffset`**

- Destination starting X offset

**hOffset**

- Destination starting Y offset

**src**

- Source memory address

**spitch**

- Pitch of source memory

**width**

- Width of matrix transfer (columns in bytes)

**height**

- Height of matrix transfer (rows)

**kind**

- Type of transfer

**stream**

- Stream identifier

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidPitchValue](#), [cudaErrorInvalidMemcpyDirection](#)

**Description**

Copies a matrix (`height` rows of `width` bytes each) from the memory area pointed to by `src` to the CUDA array `dst` starting at the upper left corner (`wOffset`, `hOffset`) where `kind` is one of [cudaMemcpyHostToHost](#), [cudaMemcpyHostToDevice](#), [cudaMemcpyDeviceToHost](#), or [cudaMemcpyDeviceToDevice](#), and specifies the direction of the copy. `spitch` is the width in memory in bytes of the 2D array pointed to by `src`, including any padding added to the end of each row. `wOffset + width` must not exceed the width of the CUDA array `dst`. `width` must not exceed `spitch`. [cudaMemcpy2DToArrayAsync\(\)](#) returns an error if `spitch` exceeds the maximum allowed.

[cudaMemcpy2DToArrayAsync\(\)](#) is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is [cudaMemcpyHostToDevice](#) or [cudaMemcpyDeviceToHost](#) and `stream` is non-zero, the copy may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits [asynchronous](#) behavior for most use cases.

See also:

[cudaMemcpy](#), [cudaMemcpy2D](#), [cudaMemcpyToArray](#), [cudaMemcpy2DToArray](#),  
[cudaMemcpyFromArray](#), [cudaMemcpy2DFromArray](#), [cudaMemcpyArrayToArray](#),  
[cudaMemcpy2DArrayToArray](#), [cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#),  
[cudaMemcpyAsync](#), [cudaMemcpy2DAsync](#), [cudaMemcpyToArrayAsync](#),  
[cudaMemcpyFromArrayAsync](#), [cudaMemcpy2DFromArrayAsync](#),  
[cudaMemcpyToSymbolAsync](#), [cudaMemcpyFromSymbolAsync](#)

## cudaError\_t cudaMemcpy3D (const cudaMemcpy3DParms \*p)

Copies data between 3D objects.

### Parameters

**p**  
 - 3D memory copy parameters

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidPitchValue](#), [cudaErrorInvalidMemcpyDirection](#)

### Description

```

struct cudaExtent {
    size_t width;
    size_t height;
    size_t depth;
};
struct cudaExtent
    make_cudaExtent(size_t w, size_t h, size_t d);

struct cudaPos {
    size_t x;
    size_t y;
    size_t z;
};
struct cudaPos
    make_cudaPos(size_t x, size_t y, size_t z);

struct cudaMemcpy3DParms {
    cudaArray_t
        srcArray;
    struct cudaPos
        srcPos;
    struct cudaPitchedPtr
        srcPtr;
    cudaArray_t
        dstArray;
    struct cudaPos
        dstPos;
    struct cudaPitchedPtr
        dstPtr;
    struct cudaExtent
        extent;
    enum cudaMemcpyKind
        kind;
};
  
```



```
};
```

`cudaMemcpy3D()` copies data between two 3D objects. The source and destination objects may be in either host memory, device memory, or a CUDA array. The source, destination, extent, and kind of copy performed is specified by the `cudaMemcpy3DParms` struct which should be initialized to zero before use:

```
cudaMemcpy3DParms myParms = {0};
```

The struct passed to `cudaMemcpy3D()` must specify one of `srcArray` or `srcPtr` and one of `dstArray` or `dstPtr`. Passing more than one non-zero source or destination will cause `cudaMemcpy3D()` to return an error.

The `srcPos` and `dstPos` fields are optional offsets into the source and destination objects and are defined in units of each object's elements. The element for a host or device pointer is assumed to be **unsigned char**. For CUDA arrays, positions must be in the range `[0, 2048)` for any dimension.

The `extent` field defines the dimensions of the transferred area in elements. If a CUDA array is participating in the copy, the extent is defined in terms of that array's elements. If no CUDA array is participating in the copy then the extents are defined in elements of **unsigned char**.

The `kind` field defines the direction of the copy. It must be one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`.

If the source and destination are both arrays, `cudaMemcpy3D()` will return an error if they do not have the same element size.

The source and destination object may not overlap. If overlapping source and destination objects are specified, undefined behavior will result.

The source object must lie entirely within the region defined by `srcPos` and `extent`. The destination object must lie entirely within the region defined by `dstPos` and `extent`.

`cudaMemcpy3D()` returns an error if the pitch of `srcPtr` or `dstPtr` exceeds the maximum allowed. The pitch of a `cudaPitchedPtr` allocated with `cudaMalloc3D()` will always be valid.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.

**See also:**

`cudaMalloc3D`, `cudaMalloc3DArray`, `cudaMemset3D`, `cudaMemcpy3DAsync`, `cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,

[cudaMemcpyFromArray](#), [cudaMemcpy2DFromArray](#), [cudaMemcpyArrayToArray](#),  
[cudaMemcpy2DArrayToArray](#), [cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#),  
[cudaMemcpyAsync](#), [cudaMemcpy2DAsync](#), [cudaMemcpyToArrayAsync](#),  
[cudaMemcpy2DToArrayAsync](#), [cudaMemcpyFromArrayAsync](#),  
[cudaMemcpy2DFromArrayAsync](#), [cudaMemcpyToSymbolAsync](#),  
[cudaMemcpyFromSymbolAsync](#), [make\\_cudaExtent](#), [make\\_cudaPos](#)

## cudaError\_t cudaMemcpy3DAsync (const cudaMemcpy3DParms \*p, cudaStream\_t stream)

Copies data between 3D objects.

### Parameters

**p**  
 - 3D memory copy parameters

**stream**  
 - Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidPitchValue](#), [cudaErrorInvalidMemcpyDirection](#)

### Description

```

struct cudaExtent {
    size_t width;
    size_t height;
    size_t depth;
};
struct cudaExtent
    make_cudaExtent(size_t w, size_t h, size_t d);

struct cudaPos {
    size_t x;
    size_t y;
    size_t z;
};
struct cudaPos
    make_cudaPos(size_t x, size_t y, size_t z);

struct cudaMemcpy3DParms {
    cudaArray_t
        srcArray;
    struct cudaPos
        srcPos;
    struct cudaPitchedPtr
        srcPtr;
    cudaArray_t
        dstArray;
    struct cudaPos
        dstPos;
    struct cudaPitchedPtr
        dstPtr;
    struct cudaExtent

```

```

        extent;
enum cudaMemcpyKind
        kind;
};

```

`cudaMemcpy3DAsync()` copies data between two 3D objects. The source and destination objects may be in either host memory, device memory, or a CUDA array. The source, destination, extent, and kind of copy performed is specified by the `cudaMemcpy3DParms` struct which should be initialized to zero before use:

```

[ cudaMemcpy3DParms myParms = {0};

```

The struct passed to `cudaMemcpy3DAsync()` must specify one of `srcArray` or `srcPtr` and one of `dstArray` or `dstPtr`. Passing more than one non-zero source or destination will cause `cudaMemcpy3DAsync()` to return an error.

The `srcPos` and `dstPos` fields are optional offsets into the source and destination objects and are defined in units of each object's elements. The element for a host or device pointer is assumed to be **unsigned char**. For CUDA arrays, positions must be in the range [0, 2048) for any dimension.

The `extent` field defines the dimensions of the transferred area in elements. If a CUDA array is participating in the copy, the extent is defined in terms of that array's elements. If no CUDA array is participating in the copy then the extents are defined in elements of **unsigned char**.

The `kind` field defines the direction of the copy. It must be one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`.

If the source and destination are both arrays, `cudaMemcpy3DAsync()` will return an error if they do not have the same element size.

The source and destination object may not overlap. If overlapping source and destination objects are specified, undefined behavior will result.

The source object must lie entirely within the region defined by `srcPos` and `extent`. The destination object must lie entirely within the region defined by `dstPos` and `extent`.

`cudaMemcpy3DAsync()` returns an error if the pitch of `srcPtr` or `dstPtr` exceeds the maximum allowed. The pitch of a `cudaPitchedPtr` allocated with `cudaMalloc3D()` will always be valid.

`cudaMemcpy3DAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyHostToDevice` or `cudaMemcpyDeviceToHost` and `stream` is non-zero, the copy may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **asynchronous** behavior for most use cases.

### See also:

[cudaMalloc3D](#), [cudaMalloc3DArray](#), [cudaMemset3D](#), [cudaMemcpy3D](#), [cudaMemcpy](#), [cudaMemcpy2D](#), [cudaMemcpyToArray](#), [cudaMemcpy2DToArray](#), [cudaMemcpyFromArray](#), [cudaMemcpy2DFromArray](#), [cudaMemcpyArrayToArray](#), [cudaMemcpy2DArrayToArray](#), [cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#), [cudaMemcpyAsync](#), [cudaMemcpy2DAsync](#), [cudaMemcpyToArrayAsync](#), [cudaMemcpy2DToArrayAsync](#), [cudaMemcpyFromArrayAsync](#), [cudaMemcpy2DFromArrayAsync](#), [cudaMemcpyToSymbolAsync](#), [cudaMemcpyFromSymbolAsync](#), [make\\_cudaExtent](#), [make\\_cudaPos](#)

## `cudaError_t cudaMemcpy3DPeer (const cudaMemcpy3DPeerParms *p)`

Copies memory between devices.

### Parameters

**p**

- Parameters for the memory copy

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevice](#)

### Description

Perform a 3D memory copy according to the parameters specified in p. See the definition of the [cudaMemcpy3DPeerParms](#) structure for documentation of its parameters.

Note that this function is synchronous with respect to the host only if the source or destination of the transfer is host memory. Note also that this copy is serialized with respect to all pending and future asynchronous work in to the current device, the copy's source device, and the copy's destination device (use [cudaMemcpy3DPeerAsync](#) to avoid this synchronization).



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.

**See also:**

[cudaMemcpy](#), [cudaMemcpyPeer](#), [cudaMemcpyAsync](#), [cudaMemcpyPeerAsync](#),  
[cudaMemcpy3DPeerAsync](#)

## **cudaError\_t cudaMemcpy3DPeerAsync (const cudaMemcpy3DPeerParms \*p, cudaStream\_t stream)**

Copies memory between devices asynchronously.

**Parameters**

**p**

- Parameters for the memory copy

**stream**

- Stream identifier

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevice](#)

**Description**

Perform a 3D memory copy according to the parameters specified in p. See the definition of the [cudaMemcpy3DPeerParms](#) structure for documentation of its parameters.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits [asynchronous](#) behavior for most use cases.

**See also:**

[cudaMemcpy](#), [cudaMemcpyPeer](#), [cudaMemcpyAsync](#), [cudaMemcpyPeerAsync](#),  
[cudaMemcpy3DPeerAsync](#)

## **cudaError\_t cudaMemcpyArrayToArray (cudaArray\_t dst, size\_t wOffsetDst, size\_t hOffsetDst, cudaArray\_const\_t**

`src, size_t wOffsetSrc, size_t hOffsetSrc, size_t count, cudaMemcpyKind kind)`

Copies data between host and device.

### Parameters

**dst**

- Destination memory address

**wOffsetDst**

- Destination starting X offset

**hOffsetDst**

- Destination starting Y offset

**src**

- Source memory address

**wOffsetSrc**

- Source starting X offset

**hOffsetSrc**

- Source starting Y offset

**count**

- Size in bytes to copy

**kind**

- Type of transfer

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidMemcpyDirection`

### Description

Copies `count` bytes from the CUDA array `src` starting at the upper left corner (`wOffsetSrc`, `hOffsetSrc`) to the CUDA array `dst` starting at the upper left corner (`wOffsetDst`, `hOffsetDst`) where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`, `cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`,

`cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`,  
`cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpyAsync (void *dst, const void *src, size_t count, cudaMemcpyKind kind, cudaStream_t stream)`**

Copies data between host and device.

### Parameters

**dst**

- Destination memory address

**src**

- Source memory address

**count**

- Size in bytes to copy

**kind**

- Type of transfer

**stream**

- Stream identifier

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`,  
`cudaErrorInvalidMemcpyDirection`

### Description

Copies `count` bytes from the memory area pointed to by `src` to the memory area pointed to by `dst`, where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy. The memory areas may not overlap. Calling `cudaMemcpyAsync()` with `dst` and `src` pointers that do not match the direction of the copy results in an undefined behavior.

`cudaMemcpyAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyHostToDevice` or `cudaMemcpyDeviceToHost` and the `stream` is non-zero, the copy may overlap with operations in other streams.



► Note that this function may also return error codes from previous, asynchronous launches.

► This function exhibits **asynchronous** behavior for most use cases.

#### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,  
`cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`,  
`cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`,  
`cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`,  
`cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpyFromArray (void *dst,  
 cudaArray_const_t src, size_t wOffset, size_t hOffset,  
 size_t count, cudaMemcpyKind kind)`**

Copies data between host and device.

#### Parameters

##### **dst**

- Destination memory address

##### **src**

- Source memory address

##### **wOffset**

- Source starting X offset

##### **hOffset**

- Source starting Y offset

##### **count**

- Size in bytes to copy

##### **kind**

- Type of transfer

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`,  
`cudaErrorInvalidMemcpyDirection`

#### Description

Copies `count` bytes from the CUDA array `src` starting at the upper left corner (`wOffset`, `hOffset`) to the memory area pointed to by `dst`, where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy.





- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.

### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,  
`cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`,  
`cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`,  
`cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`,  
`cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`,  
`cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpyFromArrayAsync (void *dst,  
 cudaArray_const_t src, size_t wOffset, size_t hOffset,  
 size_t count, cudaMemcpyKind kind, cudaStream_t  
 stream)`**

Copies data between host and device.

### Parameters

#### **dst**

- Destination memory address

#### **src**

- Source memory address

#### **wOffset**

- Source starting X offset

#### **hOffset**

- Source starting Y offset

#### **count**

- Size in bytes to copy

#### **kind**

- Type of transfer

#### **stream**

- Stream identifier

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`,  
`cudaErrorInvalidMemcpyDirection`

## Description

Copies `count` bytes from the CUDA array `src` starting at the upper left corner (`wOffset`, `hOffset`) to the memory area pointed to by `dst`, where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy.

`cudaMemcpyFromArrayAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyHostToDevice` or `cudaMemcpyDeviceToHost` and `stream` is non-zero, the copy may overlap with operations in other streams.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **asynchronous** behavior for most use cases.

## See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`, `cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`, `cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`, `cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

## `cudaError_t cudaMemcpyFromSymbol (void *dst, const void *symbol, size_t count, size_t offset, cudaMemcpyKind kind)`

Copies data from the given symbol on the device.

## Parameters

**dst**

- Destination memory address

**symbol**

- Device symbol address

**count**

- Size in bytes to copy

**offset**

- Offset from start of symbol in bytes

**kind**

- Type of transfer

## Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidSymbol`,  
`cudaErrorInvalidDevicePointer`, `cudaErrorInvalidMemcpyDirection`

## Description

Copies `count` bytes from the memory area pointed to by `offset` bytes from the start of symbol `symbol` to the memory area pointed to by `dst`. The memory areas may not overlap. `symbol` is a variable that resides in global or constant memory space. `kind` can be either `cudaMemcpyDeviceToHost` or `cudaMemcpyDeviceToDevice`.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.
- Use of a string naming a variable as the `symbol` parameter was deprecated in CUDA 4.1 and removed in CUDA 5.0.

## See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,  
`cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyAsync`,  
`cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`,  
`cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`,  
`cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpyFromSymbolAsync (void *dst, const void *symbol, size_t count, size_t offset, cudaMemcpyKind kind, cudaStream_t stream)`**

Copies data from the given symbol on the device.

## Parameters

### **`dst`**

- Destination memory address

### **`symbol`**

- Device symbol address

### **`count`**

- Size in bytes to copy

### **`offset`**

- Offset from start of symbol in bytes

**kind**

- Type of transfer

**stream**

- Stream identifier

**Returns**

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidSymbol`,  
`cudaErrorInvalidDevicePointer`, `cudaErrorInvalidMemcpyDirection`

**Description**

Copies `count` bytes from the memory area pointed to by `offset` bytes from the start of symbol `symbol` to the memory area pointed to by `dst`. The memory areas may not overlap. `symbol` is a variable that resides in global or constant memory space. `kind` can be either `cudaMemcpyDeviceToHost` or `cudaMemcpyDeviceToDevice`.

`cudaMemcpyFromSymbolAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyDeviceToHost` and `stream` is non-zero, the copy may overlap with operations in other streams.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits `asynchronous` behavior for most use cases.
- ▶ Use of a string naming a variable as the `symbol` parameter was deprecated in CUDA 4.1 and removed in CUDA 5.0.

**See also:**

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,  
`cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`,  
`cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`,  
`cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`,  
`cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`

## `cudaError_t cudaMemcpyPeer (void *dst, int dstDevice, const void *src, int srcDevice, size_t count)`

Copies memory between two devices.

### Parameters

#### **dst**

- Destination device pointer

#### **dstDevice**

- Destination device

#### **src**

- Source device pointer

#### **srcDevice**

- Source device

#### **count**

- Size of memory copy in bytes

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevice](#)

### Description

Copies memory from one device to memory on another device. `dst` is the base device pointer of the destination memory and `dstDevice` is the destination device. `src` is the base device pointer of the source memory and `srcDevice` is the source device. `count` specifies the number of bytes to copy.

Note that this function is asynchronous with respect to the host, but serialized with respect all pending and future asynchronous work in to the current device, `srcDevice`, and `dstDevice` (use [cudaMemcpyPeerAsync](#) to avoid this synchronization).



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits [synchronous](#) behavior for most use cases.

### See also:

[cudaMemcpy](#), [cudaMemcpyAsync](#), [cudaMemcpyPeerAsync](#), [cudaMemcpy3DPeerAsync](#)

```
cudaError_t cudaMemcpyPeerAsync (void *dst, int
dstDevice, const void *src, int srcDevice, size_t count,
cudaStream_t stream)
```

Copies memory between two devices asynchronously.

### Parameters

#### **dst**

- Destination device pointer

#### **dstDevice**

- Destination device

#### **src**

- Source device pointer

#### **srcDevice**

- Source device

#### **count**

- Size of memory copy in bytes

#### **stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevice](#)

### Description

Copies memory from one device to memory on another device. `dst` is the base device pointer of the destination memory and `dstDevice` is the destination device. `src` is the base device pointer of the source memory and `srcDevice` is the source device. `count` specifies the number of bytes to copy.

Note that this function is asynchronous with respect to the host and all work in other streams and other devices.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits [asynchronous](#) behavior for most use cases.

### See also:

[cudaMemcpy](#), [cudaMemcpyPeer](#), [cudaMemcpyAsync](#), [cudaMemcpy3DPeerAsync](#)

```
cudaError_t cudaMemcpyToArray (cudaArray_t dst,
size_t wOffset, size_t hOffset, const void *src, size_t
count, cudaMemcpyKind kind)
```

Copies data between host and device.

### Parameters

#### **dst**

- Destination memory address

#### **wOffset**

- Destination starting X offset

#### **hOffset**

- Destination starting Y offset

#### **src**

- Source memory address

#### **count**

- Size in bytes to copy

#### **kind**

- Type of transfer

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidMemcpyDirection](#)

### Description

Copies `count` bytes from the memory area pointed to by `src` to the CUDA array `dst` starting at the upper left corner (`wOffset`, `hOffset`), where `kind` is one of [cudaMemcpyHostToHost](#), [cudaMemcpyHostToDevice](#), [cudaMemcpyDeviceToHost](#), or [cudaMemcpyDeviceToDevice](#), and specifies the direction of the copy.



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits [synchronous](#) behavior for most use cases.

### See also:

[cudaMemcpy](#), [cudaMemcpy2D](#), [cudaMemcpy2DToArray](#),  
[cudaMemcpyFromArray](#), [cudaMemcpy2DFromArray](#), [cudaMemcpyArrayToArray](#),  
[cudaMemcpy2DArrayToArray](#), [cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#),  
[cudaMemcpyAsync](#), [cudaMemcpy2DAsync](#), [cudaMemcpyToArrayAsync](#),

`cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`,  
`cudaMemcpy2DFromArrayAsync`, `cudaMemcpyToSymbolAsync`,  
`cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpyToArrayAsync (cudaArray_t dst, size_t wOffset, size_t hOffset, const void *src, size_t count, cudaMemcpyKind kind, cudaStream_t stream)`**

Copies data between host and device.

### Parameters

**`dst`**

- Destination memory address

**`wOffset`**

- Destination starting X offset

**`hOffset`**

- Destination starting Y offset

**`src`**

- Source memory address

**`count`**

- Size in bytes to copy

**`kind`**

- Type of transfer

**`stream`**

- Stream identifier

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`,  
`cudaErrorInvalidMemcpyDirection`

### Description

Copies `count` bytes from the memory area pointed to by `src` to the CUDA array `dst` starting at the upper left corner (`wOffset`, `hOffset`), where `kind` is one of `cudaMemcpyHostToHost`, `cudaMemcpyHostToDevice`, `cudaMemcpyDeviceToHost`, or `cudaMemcpyDeviceToDevice`, and specifies the direction of the copy.

`cudaMemcpyToArrayAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyHostToDevice` or `cudaMemcpyDeviceToHost` and `stream` is non-zero, the copy may overlap with operations in other streams.





- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits [asynchronous](#) behavior for most use cases.

### See also:

[cudaMemcpy](#), [cudaMemcpy2D](#), [cudaMemcpyToArray](#), [cudaMemcpy2DToArray](#), [cudaMemcpyFromArray](#), [cudaMemcpy2DFromArray](#), [cudaMemcpyArrayToArray](#), [cudaMemcpy2DArrayToArray](#), [cudaMemcpyToSymbol](#), [cudaMemcpyFromSymbol](#), [cudaMemcpyAsync](#), [cudaMemcpy2DAsync](#), [cudaMemcpy2DToArrayAsync](#), [cudaMemcpyFromArrayAsync](#), [cudaMemcpy2DFromArrayAsync](#), [cudaMemcpyToSymbolAsync](#), [cudaMemcpyFromSymbolAsync](#)

## **cudaError\_t cudaMemcpyToSymbol (const void \*symbol, const void \*src, size\_t count, size\_t offset, cudaMemcpyKind kind)**

Copies data to the given symbol on the device.

### Parameters

#### **symbol**

- Device symbol address

#### **src**

- Source memory address

#### **count**

- Size in bytes to copy

#### **offset**

- Offset from start of symbol in bytes

#### **kind**

- Type of transfer

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidSymbol](#), [cudaErrorInvalidDevicePointer](#), [cudaErrorInvalidMemcpyDirection](#)

### Description

Copies `count` bytes from the memory area pointed to by `src` to the memory area pointed to by `offset` bytes from the start of symbol `symbol`. The memory areas may not overlap. `symbol` is a variable that resides in global or constant memory space. `kind` can be either [cudaMemcpyHostToDevice](#) or [cudaMemcpyDeviceToDevice](#).



- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits **synchronous** behavior for most use cases.
- Use of a string naming a variable as the `symbol` parameter was deprecated in CUDA 4.1 and removed in CUDA 5.0.

#### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`,  
`cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyArrayToArray`,  
`cudaMemcpy2DArrayToArray`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`,  
`cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`,  
`cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`,  
`cudaMemcpyToSymbolAsync`, `cudaMemcpyFromSymbolAsync`

**`cudaError_t cudaMemcpyToSymbolAsync (const void *symbol, const void *src, size_t count, size_t offset, cudaMemcpyKind kind, cudaStream_t stream)`**

Copies data to the given symbol on the device.

#### Parameters

##### **symbol**

- Device symbol address

##### **src**

- Source memory address

##### **count**

- Size in bytes to copy

##### **offset**

- Offset from start of symbol in bytes

##### **kind**

- Type of transfer

##### **stream**

- Stream identifier

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidSymbol`,  
`cudaErrorInvalidDevicePointer`, `cudaErrorInvalidMemcpyDirection`

#### Description

Copies `count` bytes from the memory area pointed to by `src` to the memory area pointed to by `offset` bytes from the start of symbol `symbol`. The memory areas may

not overlap. `symbol` is a variable that resides in global or constant memory space. `kind` can be either `cudaMemcpyHostToDevice` or `cudaMemcpyDeviceToDevice`.

`cudaMemcpyToSymbolAsync()` is asynchronous with respect to the host, so the call may return before the copy is complete. The copy can optionally be associated to a stream by passing a non-zero `stream` argument. If `kind` is `cudaMemcpyHostToDevice` and `stream` is non-zero, the copy may overlap with operations in other streams.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ This function exhibits **asynchronous** behavior for most use cases.
- ▶ Use of a string naming a variable as the `symbol` parameter was deprecated in CUDA 4.1 and removed in CUDA 5.0.

#### See also:

`cudaMemcpy`, `cudaMemcpy2D`, `cudaMemcpyToArray`, `cudaMemcpy2DToArray`, `cudaMemcpyFromArray`, `cudaMemcpy2DFromArray`, `cudaMemcpyFromArrayToArray`, `cudaMemcpy2DFromArrayToArray`, `cudaMemcpyToSymbol`, `cudaMemcpyFromSymbol`, `cudaMemcpyAsync`, `cudaMemcpy2DAsync`, `cudaMemcpyToArrayAsync`, `cudaMemcpy2DToArrayAsync`, `cudaMemcpyFromArrayAsync`, `cudaMemcpy2DFromArrayAsync`, `cudaMemcpyFromSymbolAsync`

## `cudaError_t cudaMemGetInfo (size_t *free, size_t *total)`

Gets free and total device memory.

### Parameters

#### `free`

- Returned free memory in bytes

#### `total`

- Returned total memory in bytes

### Returns

`cudaSuccess`, `cudaErrorInitializationError`, `cudaErrorInvalidValue`, `cudaErrorLaunchFailure`

### Description

Returns in `*free` and `*total` respectively, the free and total amount of memory available for allocation by the device in bytes.



Note that this function may also return error codes from previous, asynchronous launches.

## `cudaError_t cudaMemset (void *devPtr, int value, size_t count)`

Initializes or sets device memory to a value.

### Parameters

#### **devPtr**

- Pointer to device memory

#### **value**

- Value to set for each byte of specified memory

#### **count**

- Size in bytes to set

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`

### Description

Fills the first `count` bytes of the memory area pointed to by `devPtr` with the constant byte value `value`.

Note that this function is asynchronous with respect to the host unless `devPtr` refers to pinned host memory.



- ▶ Note that this function may also return error codes from previous, asynchronous launches.
- ▶ See also [memset synchronization details](#).

### See also:

[cudaMemset2D](#), [cudaMemset3D](#), [cudaMemsetAsync](#), [cudaMemset2DAsync](#), [cudaMemset3DAsync](#)

## `cudaError_t cudaMemset2D (void *devPtr, size_t pitch, int value, size_t width, size_t height)`

Initializes or sets device memory to a value.

### Parameters

#### **devPtr**

- Pointer to 2D device memory

#### **pitch**

- Pitch in bytes of 2D device memory

#### **value**

- Value to set for each byte of specified memory

#### **width**

- Width of matrix set (columns in bytes)

#### **height**

- Height of matrix set (rows)

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`

### Description

Sets to the specified value `value` a matrix (`height` rows of `width` bytes each) pointed to by `dstPtr`. `pitch` is the width in bytes of the 2D array pointed to by `dstPtr`, including any padding added to the end of each row. This function performs fastest when the pitch is one that has been passed back by `cudaMallocPitch()`.

Note that this function is asynchronous with respect to the host unless `devPtr` refers to pinned host memory.



- Note that this function may also return error codes from previous, asynchronous launches.
- See also [memset synchronization details](#).

### See also:

`cudaMemset`, `cudaMemset3D`, `cudaMemsetAsync`, `cudaMemset2DAsync`, `cudaMemset3DAsync`

```
cudaError_t cudaMemset2DAsync (void *devPtr,
size_t pitch, int value, size_t width, size_t height,
cudaStream_t stream)
```

Initializes or sets device memory to a value.

### Parameters

#### **devPtr**

- Pointer to 2D device memory

#### **pitch**

- Pitch in bytes of 2D device memory

#### **value**

- Value to set for each byte of specified memory

#### **width**

- Width of matrix set (columns in bytes)

#### **height**

- Height of matrix set (rows)

#### **stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#)

### Description

Sets to the specified value `value` a matrix (`height` rows of `width` bytes each) pointed to by `dstPtr`. `pitch` is the width in bytes of the 2D array pointed to by `dstPtr`, including any padding added to the end of each row. This function performs fastest when the pitch is one that has been passed back by [cudaMallocPitch\(\)](#).

[cudaMemset2DAsync\(\)](#) is asynchronous with respect to the host, so the call may return before the memset is complete. The operation can optionally be associated to a stream by passing a non-zero `stream` argument. If `stream` is non-zero, the operation may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.
- See also [memset synchronization details](#).

See also:

[cudaMemset](#), [cudaMemset2D](#), [cudaMemset3D](#), [cudaMemsetAsync](#),  
[cudaMemset3DAsync](#)

## `cudaError_t cudaMemset3D (cudaPitchedPtr pitchedDevPtr, int value, cudaExtent extent)`

Initializes or sets device memory to a value.

### Parameters

#### **pitchedDevPtr**

- Pointer to pitched device memory

#### **value**

- Value to set for each byte of specified memory

#### **extent**

- Size parameters for where to set device memory (`width` field in bytes)

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#)

### Description

Initializes each element of a 3D array to the specified value `value`. The object to initialize is defined by `pitchedDevPtr`. The `pitch` field of `pitchedDevPtr` is the width in memory in bytes of the 3D array pointed to by `pitchedDevPtr`, including any padding added to the end of each row. The `xsize` field specifies the logical width of each row in bytes, while the `ysize` field specifies the height of each 2D slice in rows.

The extents of the initialized region are specified as a width in bytes, a height in rows, and a depth in slices.

Extents with `width` greater than or equal to the `xsize` of `pitchedDevPtr` may perform significantly faster than extents narrower than the `xsize`. Secondly, extents with `height` equal to the `ysize` of `pitchedDevPtr` will perform faster than when the `height` is shorter than the `ysize`.

This function performs fastest when the `pitchedDevPtr` has been allocated by [cudaMalloc3D\(\)](#).

Note that this function is asynchronous with respect to the host unless `pitchedDevPtr` refers to pinned host memory.



- Note that this function may also return error codes from previous, asynchronous launches.
- See also [memset synchronization details](#).

See also:

[cudaMemset](#), [cudaMemset2D](#), [cudaMemsetAsync](#), [cudaMemset2DAsync](#),  
[cudaMemset3DAsync](#), [cudaMalloc3D](#), [make\\_cudaPitchedPtr](#), [make\\_cudaExtent](#)

## **cudaError\_t cudaMemset3DAsync (cudaPitchedPtr pitchedDevPtr, int value, cudaExtent extent, cudaStream\_t stream)**

Initializes or sets device memory to a value.

### **Parameters**

#### **pitchedDevPtr**

- Pointer to pitched device memory

#### **value**

- Value to set for each byte of specified memory

#### **extent**

- Size parameters for where to set device memory (width field in bytes)

#### **stream**

- Stream identifier

### **Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#)

### **Description**

Initializes each element of a 3D array to the specified value `value`. The object to initialize is defined by `pitchedDevPtr`. The `pitch` field of `pitchedDevPtr` is the width in memory in bytes of the 3D array pointed to by `pitchedDevPtr`, including any padding added to the end of each row. The `xsize` field specifies the logical width of each row in bytes, while the `ysize` field specifies the height of each 2D slice in rows.

The extents of the initialized region are specified as a width in bytes, a height in rows, and a depth in slices.

Extents with width greater than or equal to the `xsize` of `pitchedDevPtr` may perform significantly faster than extents narrower than the `xsize`. Secondly, extents with height equal to the `ysize` of `pitchedDevPtr` will perform faster than when the height is shorter than the `ysize`.

This function performs fastest when the `pitchedDevPtr` has been allocated by [cudaMalloc3D\(\)](#).

[cudaMemset3DAsync\(\)](#) is asynchronous with respect to the host, so the call may return before the memset is complete. The operation can optionally be associated to a stream by



passing a non-zero `stream` argument. If `stream` is non-zero, the operation may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.
- See also [memset synchronization details](#).

See also:

[cudaMemset](#), [cudaMemset2D](#), [cudaMemset3D](#), [cudaMemsetAsync](#),  
[cudaMemset2DAsync](#), [cudaMalloc3D](#), [make\\_cudaPitchedPtr](#), [make\\_cudaExtent](#)

## `cudaError_t cudaMemsetAsync (void *devPtr, int value, size_t count, cudaStream_t stream)`

Initializes or sets device memory to a value.

### Parameters

#### **devPtr**

- Pointer to device memory

#### **value**

- Value to set for each byte of specified memory

#### **count**

- Size in bytes to set

#### **stream**

- Stream identifier

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#)

### Description

Fills the first `count` bytes of the memory area pointed to by `devPtr` with the constant byte value `value`.

[cudaMemsetAsync\(\)](#) is asynchronous with respect to the host, so the call may return before the `memset` is complete. The operation can optionally be associated to a stream by passing a non-zero `stream` argument. If `stream` is non-zero, the operation may overlap with operations in other streams.



- Note that this function may also return error codes from previous, asynchronous launches.

► See also [memset synchronization details](#).

See also:

[cudaMemset](#), [cudaMemset2D](#), [cudaMemset3D](#), [cudaMemset2DAsync](#),  
[cudaMemset3DAsync](#)

## make\_cudaExtent (size\_t w, size\_t h, size\_t d)

Returns a [cudaExtent](#) based on input parameters.

### Parameters

- w**  
- Width in bytes
- h**  
- Height in elements
- d**  
- Depth in elements

### Returns

[cudaExtent](#) specified by w, h, and d

### Description

Returns a [cudaExtent](#) based on the specified input parameters w, h, and d.

See also:

[make\\_cudaPitchedPtr](#), [make\\_cudaPos](#)

## make\_cudaPitchedPtr (void \*d, size\_t p, size\_t xsz, size\_t ysz)

Returns a [cudaPitchedPtr](#) based on input parameters.

### Parameters

- d**  
- Pointer to allocated memory
- p**  
- Pitch of allocated memory in bytes
- xsz**  
- Logical width of allocation in elements
- ysz**  
- Logical height of allocation in elements

**Returns**

`cudaPitchedPtr` specified by `d`, `p`, `xsz`, and `ysz`

**Description**

Returns a `cudaPitchedPtr` based on the specified input parameters `d`, `p`, `xsz`, and `ysz`.

**See also:**

`make_cudaExtent`, `make_cudaPos`

## `make_cudaPos (size_t x, size_t y, size_t z)`

Returns a `cudaPos` based on input parameters.

**Parameters**

- x**  
- X position
- y**  
- Y position
- z**  
- Z position

**Returns**

`cudaPos` specified by `x`, `y`, and `z`

**Description**

Returns a `cudaPos` based on the specified input parameters `x`, `y`, and `z`.

**See also:**

`make_cudaExtent`, `make_cudaPitchedPtr`

## 2.8. Unified Addressing

This section describes the unified addressing functions of the CUDA runtime application programming interface.

**Overview**

CUDA devices can share a unified address space with the host. For these devices there is no distinction between a device pointer and a host pointer -- the same pointer value

may be used to access memory from the host program and from a kernel running on the device (with exceptions enumerated below).

### Supported Platforms

Whether or not a device supports unified addressing may be queried by calling `cudaGetDeviceProperties()` with the device property `cudaDeviceProp::unifiedAddressing`.

Unified addressing is automatically enabled in 64-bit processes on devices with compute capability greater than or equal to 2.0.

Unified addressing is not yet supported on Windows Vista or Windows 7 for devices that do not use the TCC driver model.

### Looking Up Information from Pointer Values

It is possible to look up information about the memory which backs a pointer value. For instance, one may want to know if a pointer points to host or device memory. As another example, in the case of device memory, one may want to know on which CUDA device the memory resides. These properties may be queried using the function `cudaPointerGetAttributes()`

Since pointers are unique, it is not necessary to specify information about the pointers specified to `cudaMemcpy()` and other copy functions. The copy direction `cudaMemcpyDefault` may be used to specify that the CUDA runtime should infer the location of the pointer from its value.

### Automatic Mapping of Host Allocated Host Memory

All host memory allocated through all devices using `cudaMallocHost()` and `cudaHostAlloc()` is always directly accessible from all devices that support unified addressing. This is the case regardless of whether or not the flags `cudaHostAllocPortable` and `cudaHostAllocMapped` are specified.

The pointer value through which allocated host memory may be accessed in kernels on all devices that support unified addressing is the same as the pointer value through which that memory is accessed on the host. It is not necessary to call `cudaHostGetDevicePointer()` to get the device pointer for these allocations.

Note that this is not the case for memory allocated using the flag `cudaHostAllocWriteCombined`, as discussed below.

### Direct Access of Peer Memory

Upon enabling direct access from a device that supports unified addressing to another peer device that supports unified addressing using `cudaDeviceEnablePeerAccess()` all memory allocated in the peer device using `cudaMalloc()` and `cudaMallocPitch()` will immediately be accessible by the current device. The device pointer value through which any peer's memory may be accessed in the current device is the same pointer value through which that memory may be accessed from the peer device.

## Exceptions, Disjoint Addressing

Not all memory may be accessed on devices through the same pointer value through which they are accessed on the host. These exceptions are host memory registered using `cudaHostRegister()` and host memory allocated using the flag `cudaHostAllocWriteCombined`. For these exceptions, there exists a distinct host and device address for the memory. The device address is guaranteed to not overlap any valid host pointer range and is guaranteed to have the same value across all devices that support unified addressing.

This device address may be queried using `cudaHostGetDevicePointer()` when a device using unified addressing is current. Either the host or the unified device pointer value may be used to refer to this memory in `cudaMemcpy()` and similar functions using the `cudaMemcpyDefault` memory direction.

## `cudaError_t cudaPointerGetAttributes` (`cudaPointerAttributes *attributes, const void *ptr`)

Returns attributes about a specified pointer.

### Parameters

#### `attributes`

- Attributes for the specified pointer

#### `ptr`

- Pointer to get attributes for

### Returns

`cudaSuccess`, `cudaErrorInvalidDevice`

### Description

Returns in `*attributes` the attributes of the pointer `ptr`.

The `cudaPointerAttributes` structure is defined as:

```
struct cudaPointerAttributes {
    enum cudaMemoryType
        memoryType;
    int device;
    void *devicePointer;
    void *hostPointer;
}
```

In this structure, the individual fields mean

- `memoryType` identifies the physical location of the memory associated with pointer `ptr`. It can be `cudaMemoryTypeHost` for host memory or `cudaMemoryTypeDevice` for device memory.

- ▶ **device** is the device against which `ptr` was allocated. If `ptr` has memory type `cudaMemoryTypeDevice` then this identifies the device on which the memory referred to by `ptr` physically resides. If `ptr` has memory type `cudaMemoryTypeHost` then this identifies the device which was current when the allocation was made (and if that device is deinitialized then this allocation will vanish with that device's state).
- ▶ **devicePointer** is the device pointer alias through which the memory referred to by `ptr` may be accessed on the current device. If the memory referred to by `ptr` cannot be accessed directly by the current device then this is `NULL`.
- ▶ **hostPointer** is the host pointer alias through which the memory referred to by `ptr` may be accessed on the host. If the memory referred to by `ptr` cannot be accessed directly by the host then this is `NULL`.

See also:

`cudaGetDeviceCount`, `cudaGetDevice`, `cudaSetDevice`, `cudaChooseDevice`

## 2.9. Peer Device Memory Access

This section describes the peer device memory access functions of the CUDA runtime application programming interface.

### `cudaError_t cudaDeviceCanAccessPeer (int *canAccessPeer, int device, int peerDevice)`

Queries if a device may directly access a peer device's memory.

#### Parameters

##### **canAccessPeer**

- Returned access capability

##### **device**

- Device from which allocations on `peerDevice` are to be directly accessed.

##### **peerDevice**

- Device on which the allocations to be directly accessed by `device` reside.

#### Returns

`cudaSuccess`, `cudaErrorInvalidDevice`

#### Description

Returns in `*canAccessPeer` a value of 1 if device `device` is capable of directly accessing memory from `peerDevice` and 0 otherwise. If direct access of

`peerDevice` from device is possible, then access may be enabled by calling `cudaDeviceEnablePeerAccess()`.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaDeviceEnablePeerAccess`, `cudaDeviceDisablePeerAccess`

## `cudaError_t cudaDeviceDisablePeerAccess (int peerDevice)`

Disables direct access to memory allocations on a peer device.

### Parameters

#### `peerDevice`

- Peer device to disable direct access to

### Returns

`cudaSuccess`, `cudaErrorPeerAccessNotEnabled`, `cudaErrorInvalidDevice`

### Description

Returns `cudaErrorPeerAccessNotEnabled` if direct access to memory on `peerDevice` has not yet been enabled from the current device.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaDeviceCanAccessPeer`, `cudaDeviceEnablePeerAccess`

## `cudaError_t cudaDeviceEnablePeerAccess (int peerDevice, unsigned int flags)`

Enables direct access to memory allocations on a peer device.

### Parameters

#### `peerDevice`

- Peer device to enable direct access to from the current device

#### `flags`

- Reserved for future use and must be set to 0

### Returns

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorPeerAccessAlreadyEnabled`, `cudaErrorInvalidValue`

### Description

On success, all allocations from `peerDevice` will immediately be accessible by the current device. They will remain accessible until access is explicitly disabled using `cudaDeviceDisablePeerAccess()` or either device is reset using `cudaDeviceReset()`.

Note that access granted by this call is unidirectional and that in order to access memory on the current device from `peerDevice`, a separate symmetric call to `cudaDeviceEnablePeerAccess()` is required.

Peer access is not supported in 32 bit applications.

Returns `cudaErrorInvalidDevice` if `cudaDeviceCanAccessPeer()` indicates that the current device cannot directly access memory from `peerDevice`.

Returns `cudaErrorPeerAccessAlreadyEnabled` if direct access of `peerDevice` from the current device has already been enabled.

Returns `cudaErrorInvalidValue` if `flags` is not 0.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaDeviceCanAccessPeer`, `cudaDeviceDisablePeerAccess`



## 2.10. OpenGL Interoperability

This section describes the OpenGL interoperability functions of the CUDA runtime application programming interface. Note that mapping of OpenGL resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

### enum cudaGLDeviceList

CUDA devices corresponding to the current OpenGL context

#### Values

**cudaGLDeviceListAll = 1**

The CUDA devices for all GPUs used by the current OpenGL context

**cudaGLDeviceListCurrentFrame = 2**

The CUDA devices for the GPUs used by the current OpenGL context in its currently rendering frame

**cudaGLDeviceListNextFrame = 3**

The CUDA devices for the GPUs to be used by the current OpenGL context in the next frame

**cudaError\_t cudaGLGetDevices (unsigned int \*pCudaDeviceCount, int \*pCudaDevices, unsigned int cudaDeviceCount, cudaGLDeviceList deviceList)**

Gets the CUDA devices associated with the current OpenGL context.

#### Parameters

**pCudaDeviceCount**

- Returned number of CUDA devices corresponding to the current OpenGL context

**pCudaDevices**

- Returned CUDA devices corresponding to the current OpenGL context

**cudaDeviceCount**

- The size of the output device array `pCudaDevices`

**deviceList**

- The set of devices to return. This set may be [cudaGLDeviceListAll](#) for all devices, [cudaGLDeviceListCurrentFrame](#) for the devices used to render the current frame (in SLI), or [cudaGLDeviceListNextFrame](#) for the devices used to render the next frame (in SLI).

**Returns**

`cudaSuccess`, `cudaErrorNoDevice`, `cudaErrorUnknown`

**Description**

Returns in `*pCudaDeviceCount` the number of CUDA-compatible devices corresponding to the current OpenGL context. Also returns in `*pCudaDevices` at most `cudaDeviceCount` of the CUDA-compatible devices corresponding to the current OpenGL context. If any of the GPUs being used by the current OpenGL context are not CUDA capable then the call will return `cudaErrorNoDevice`.



- ▶ This function is not supported on Mac OS X.
- ▶ Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaGraphicsUnregisterResource`, `cudaGraphicsMapResources`,  
`cudaGraphicsSubResourceGetMappedArray`, `cudaGraphicsResourceGetMappedPointer`

## `cudaError_t cudaGraphicsGLRegisterBuffer` (`cudaGraphicsResource **resource`, `GLuint buffer`, unsigned int flags)

Registers an OpenGL buffer object.

**Parameters****resource**

- Pointer to the returned object handle

**buffer**

- name of buffer object to be registered

**flags**

- Register flags

**Returns**

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`,  
`cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

## Description

Registers the buffer object specified by `buffer` for access by CUDA. A handle to the registered object is returned as `resource`. The register flags `flags` specify the intended usage, as follows:

- ▶ `cudaGraphicsRegisterFlagsNone`: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- ▶ `cudaGraphicsRegisterFlagsReadOnly`: Specifies that CUDA will not write to this resource.
- ▶ `cudaGraphicsRegisterFlagsWriteDiscard`: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaGraphicsUnregisterResource`, `cudaGraphicsMapResources`,  
`cudaGraphicsResourceGetMappedPointer`

## `cudaError_t cudaGraphicsGLRegisterImage` (`cudaGraphicsResource **resource`, `GLuint image`, `GLenum target`, unsigned int flags)

Register an OpenGL texture or renderbuffer object.

## Parameters

### **resource**

- Pointer to the returned object handle

### **image**

- name of texture or renderbuffer object to be registered

### **target**

- Identifies the type of object specified by `image`

### **flags**

- Register flags

## Returns

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`,  
`cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

## Description

Registers the texture or renderbuffer object specified by `image` for access by CUDA. A handle to the registered object is returned as `resource`.

`target` must match the type of the object, and must be one of `GL_TEXTURE_2D`, `GL_TEXTURE_RECTANGLE`, `GL_TEXTURE_CUBE_MAP`, `GL_TEXTURE_3D`, `GL_TEXTURE_2D_ARRAY`, or `GL_RENDERBUFFER`.

The register flags `flags` specify the intended usage, as follows:

- ▶ `cudaGraphicsRegisterFlagsNone`: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- ▶ `cudaGraphicsRegisterFlagsReadOnly`: Specifies that CUDA will not write to this resource.
- ▶ `cudaGraphicsRegisterFlagsWriteDiscard`: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.
- ▶ `cudaGraphicsRegisterFlagsSurfaceLoadStore`: Specifies that CUDA will bind this resource to a surface reference.
- ▶ `cudaGraphicsRegisterFlagsTextureGather`: Specifies that CUDA will perform texture gather operations on this resource.

The following image formats are supported. For brevity's sake, the list is abbreviated. For ex., `{GL_R, GL_RG} X {8, 16}` would expand to the following 4 formats `{GL_R8, GL_R16, GL_RG8, GL_RG16}` :

- ▶ `GL_RED, GL_RG, GL_RGBA, GL_LUMINANCE, GL_ALPHA, GL_LUMINANCE_ALPHA, GL_INTENSITY`
- ▶ `{GL_R, GL_RG, GL_RGBA} X {8, 16, 16F, 32F, 8UI, 16UI, 32UI, 8I, 16I, 32I}`
- ▶ `{GL_LUMINANCE, GL_ALPHA, GL_LUMINANCE_ALPHA, GL_INTENSITY} X {8, 16, 16F_ARB, 32F_ARB, 8UI_EXT, 16UI_EXT, 32UI_EXT, 8I_EXT, 16I_EXT, 32I_EXT}`

The following image classes are currently disallowed:

- ▶ Textures with borders
- ▶ Multisampled renderbuffers



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsUnregisterResource`, `cudaGraphicsMapResources`,  
`cudaGraphicsSubResourceGetMappedArray`

## `cudaError_t cudaWGLGetDevice (int *device, HGPUNV hGpu)`

Gets the CUDA device associated with hGpu.

### Parameters

#### **device**

- Returns the device associated with hGpu, or -1 if hGpu is not a compute device.

#### **hGpu**

- Handle to a GPU, as queried via `WGL_NV_gpu_affinity`

### Returns

`cudaSuccess`

### Description

Returns the CUDA device associated with a hGpu, if applicable.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`WGL_NV_gpu_affinity`

## 2.11. OpenGL Interoperability [DEPRECATED]

This section describes deprecated OpenGL interoperability functionality.

### `enum cudaGLMapFlags`

CUDA GL Map Flags

#### Values

**`cudaGLMapFlagsNone = 0`**

Default; Assume resource can be read/written

**`cudaGLMapFlagsReadOnly = 1`**

CUDA kernels will not write to this resource

**cudaGLMapFlagsWriteDiscard = 2**

CUDA kernels will only write to and will not read from this resource

## cudaError\_t cudaGLMapBufferObject (void \*\*devPtr, GLuint bufObj)

Maps a buffer object for access by CUDA.

### Parameters

#### devPtr

- Returned device pointer to CUDA object

#### bufObj

- Buffer object ID to map

### Returns

cudaSuccess, cudaErrorMapBufferObjectFailed

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Maps the buffer object of ID `bufObj` into the address space of CUDA and returns in `*devPtr` the base pointer of the resulting mapping. The buffer must have previously been registered by calling [cudaGLRegisterBufferObject\(\)](#). While a buffer is mapped by CUDA, any OpenGL operation which references the buffer will result in undefined behavior. The OpenGL context used to create the buffer, or another context from the same share group, must be bound to the current thread when this is called.

All streams in the current thread are synchronized with the current GL context.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsMapResources](#)

**cudaError\_t cudaGLMapBufferObjectAsync (void  
\*\*devPtr, GLuint bufObj, cudaStream\_t stream)**

Maps a buffer object for access by CUDA.

### Parameters

#### **devPtr**

- Returned device pointer to CUDA object

#### **bufObj**

- Buffer object ID to map

#### **stream**

- Stream to synchronize

### Returns

[cudaSuccess](#), [cudaErrorMapBufferObjectFailed](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Maps the buffer object of ID `bufObj` into the address space of CUDA and returns in `*devPtr` the base pointer of the resulting mapping. The buffer must have previously been registered by calling [cudaGLRegisterBufferObject\(\)](#). While a buffer is mapped by CUDA, any OpenGL operation which references the buffer will result in undefined behavior. The OpenGL context used to create the buffer, or another context from the same share group, must be bound to the current thread when this is called.

Stream /p stream is synchronized with the current GL context.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsMapResources](#)

## cudaError\_t cudaGLRegisterBufferObject (GLuint bufObj)

Registers a buffer object for access by CUDA.

### Parameters

#### bufObj

- Buffer object ID to register

### Returns

[cudaSuccess](#), [cudaErrorInitializationError](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Registers the buffer object of ID `bufObj` for access by CUDA. This function must be called before CUDA can map the buffer object. The OpenGL context used to create the buffer, or another context from the same share group, must be bound to the current thread when this is called.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsGLRegisterBuffer](#)

## cudaError\_t cudaGLSetBufferObjectMapFlags (GLuint bufObj, unsigned int flags)

Set usage flags for mapping an OpenGL buffer.

### Parameters

#### bufObj

- Registered buffer object to set flags for

#### flags

- Parameters for buffer mapping

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)



## Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Set flags for mapping the OpenGL buffer `bufObj`

Changes to flags will take effect the next time `bufObj` is mapped. The `flags` argument may be any of the following:

- ▶ **`cudaGLMapFlagsNone`**: Specifies no hints about how this buffer will be used. It is therefore assumed that this buffer will be read from and written to by CUDA kernels. This is the default value.
- ▶ **`cudaGLMapFlagsReadOnly`**: Specifies that CUDA kernels which access this buffer will not write to the buffer.
- ▶ **`cudaGLMapFlagsWriteDiscard`**: Specifies that CUDA kernels which access this buffer will not read from the buffer and will write over the entire contents of the buffer, so none of the data previously stored in the buffer will be preserved.

If `bufObj` has not been registered for use with CUDA, then **`cudaErrorInvalidResourceHandle`** is returned. If `bufObj` is presently mapped for access by CUDA, then **`cudaErrorUnknown`** is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

**`cudaGraphicsResourceSetMapFlags`**

## **`cudaError_t cudaGLSetGLDevice (int device)`**

Sets a CUDA device to use OpenGL interoperability.

### Parameters

**device**

- Device to use for OpenGL interoperability

### Returns

**`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorSetOnActiveProcess`**

## Description

**Deprecated** This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA device with an OpenGL context in order to achieve maximum interoperability performance.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaGraphicsGLRegisterBuffer](#), [cudaGraphicsGLRegisterImage](#)

## **cudaError\_t cudaGLUnmapBufferObject (GLuint bufObj)**

Unmaps a buffer object for access by CUDA.

#### Parameters

##### **bufObj**

- Buffer object to unmap

#### Returns

[cudaSuccess](#), [cudaErrorInvalidDevicePointer](#), [cudaErrorUnmapBufferObjectFailed](#)

#### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Unmaps the buffer object of ID `bufObj` for access by CUDA. When a buffer is unmapped, the base address returned by [cudaGLMapBufferObject\(\)](#) is invalid and subsequent references to the address result in undefined behavior. The OpenGL context used to create the buffer, or another context from the same share group, must be bound to the current thread when this is called.

All streams in the current thread are synchronized with the current GL context.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaGraphicsUnmapResources](#)

## cudaError\_t cudaGLUnmapBufferObjectAsync (GLuint bufObj, cudaStream\_t stream)

Unmaps a buffer object for access by CUDA.

### Parameters

#### bufObj

- Buffer object to unmap

#### stream

- Stream to synchronize

### Returns

[cudaSuccess](#), [cudaErrorInvalidDevicePointer](#), [cudaErrorUnmapBufferObjectFailed](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Unmaps the buffer object of ID `bufObj` for access by CUDA. When a buffer is unmapped, the base address returned by [cudaGLMapBufferObject\(\)](#) is invalid and subsequent references to the address result in undefined behavior. The OpenGL context used to create the buffer, or another context from the same share group, must be bound to the current thread when this is called.

Stream /p stream is synchronized with the current GL context.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsUnmapResources](#)

## cudaError\_t cudaGLUnregisterBufferObject (GLuint bufObj)

Unregisters a buffer object for access by CUDA.

### Parameters

#### bufObj

- Buffer object to unregister

**Returns**`cudaSuccess`**Description**

**Deprecated** This function is deprecated as of CUDA 3.0.

Unregisters the buffer object of ID `bufObj` for access by CUDA and releases any CUDA resources associated with the buffer. Once a buffer is unregistered, it may no longer be mapped by CUDA. The GL context used to create the buffer, or another context from the same share group, must be bound to the current thread when this is called.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**`cudaGraphicsUnregisterResource`

## 2.12. Direct3D 9 Interoperability

This section describes the Direct3D 9 interoperability functions of the CUDA runtime application programming interface. Note that mapping of Direct3D 9 resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

### enum cudaD3D9DeviceList

CUDA devices corresponding to a D3D9 device

**Values**

**cudaD3D9DeviceListAll = 1**

The CUDA devices for all GPUs used by a D3D9 device

**cudaD3D9DeviceListCurrentFrame = 2**

The CUDA devices for the GPUs used by a D3D9 device in its currently rendering frame

**cudaD3D9DeviceListNextFrame = 3**

The CUDA devices for the GPUs to be used by a D3D9 device in the next frame

## cudaError\_t cudaD3D9GetDevice (int \*device, const char \*pszAdapterName)

Gets the device number for an adapter.

### Parameters

#### device

- Returns the device corresponding to pszAdapterName

#### pszAdapterName

- D3D9 adapter to get device for

### Returns

cudaSuccess, cudaErrorInvalidValue, cudaErrorUnknown

### Description

Returns in \*device the CUDA-compatible device corresponding to the adapter name pszAdapterName obtained from EnumDisplayDevices or IDirect3D9::GetAdapterIdentifier(). If no device on the adapter with name pszAdapterName is CUDA-compatible then the call will fail.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

cudaD3D9SetDirect3DDevice, cudaGraphicsD3D9RegisterResource,

## cudaError\_t cudaD3D9GetDevices (unsigned int \*pCudaDeviceCount, int \*pCudaDevices, unsigned int cudaDeviceCount, IDirect3DDevice9 \*pD3D9Device, cudaD3D9DeviceList deviceList)

Gets the CUDA devices corresponding to a Direct3D 9 device.

### Parameters

#### pCudaDeviceCount

- Returned number of CUDA devices corresponding to pD3D9Device

#### pCudaDevices

- Returned CUDA devices corresponding to pD3D9Device

**cudaDeviceCount**

- The size of the output device array `pCudaDevices`

**pD3D9Device**

- Direct3D 9 device to query for CUDA devices

**deviceList**

- The set of devices to return. This set may be `cudaD3D9DeviceListAll` for all devices, `cudaD3D9DeviceListCurrentFrame` for the devices used to render the current frame (in SLI), or `cudaD3D9DeviceListNextFrame` for the devices used to render the next frame (in SLI).

**Returns**

`cudaSuccess`, `cudaErrorNoDevice`, `cudaErrorUnknown`

**Description**

Returns in `*pCudaDeviceCount` the number of CUDA-compatible devices corresponding to the Direct3D 9 device `pD3D9Device`. Also returns in `*pCudaDevices` at most `cudaDeviceCount` of the the CUDA-compatible devices corresponding to the Direct3D 9 device `pD3D9Device`.

If any of the GPUs being used to render `pDevice` are not CUDA capable then the call will return `cudaErrorNoDevice`.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaGraphicsUnregisterResource`, `cudaGraphicsMapResources`, `cudaGraphicsSubResourceGetMappedArray`, `cudaGraphicsResourceGetMappedPointer`

## **cudaError\_t cudaD3D9GetDirect3DDevice (IDirect3DDevice9 \*\*ppD3D9Device)**

Gets the Direct3D device against which the current CUDA context was created.

**Parameters****ppD3D9Device**

- Returns the Direct3D device for this thread

**Returns**

`cudaSuccess`, `cudaErrorUnknown`

## Description

Returns in `*ppD3D9Device` the Direct3D device against which this CUDA context was created in `cudaD3D9SetDirect3DDevice()`.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaD3D9SetDirect3DDevice`

## `cudaError_t cudaD3D9SetDirect3DDevice` (`IDirect3DDevice9 *pD3D9Device`, `int device`)

Sets the Direct3D 9 device to use for interoperability with a CUDA device.

## Parameters

### `pD3D9Device`

- Direct3D device to use for this thread

### `device`

- The CUDA device to use. This device must be among the devices returned when querying `cudaD3D9DeviceListAll` from `cudaD3D9GetDevices`, may be set to -1 to automatically select an appropriate CUDA device.

## Returns

`cudaSuccess`, `cudaErrorInitializationError`, `cudaErrorInvalidValue`,  
`cudaErrorSetOnActiveProcess`

## Description

Records `pD3D9Device` as the Direct3D 9 device to use for Direct3D 9 interoperability with the CUDA device `device` and sets `device` as the current device for the calling host thread.

If `device` has already been initialized then this call will fail with the error `cudaErrorSetOnActiveProcess`. In this case it is necessary to reset `device` using `cudaDeviceReset()` before Direct3D 9 interoperability on `device` may be enabled.

Successfully initializing CUDA interoperability with `pD3D9Device` will increase the internal reference count on `pD3D9Device`. This reference count will be decremented when `device` is reset using `cudaDeviceReset()`.

Note that this function is never required for correct functionality. Use of this function will result in accelerated interoperability only when the operating system is Windows

Vista or Windows 7, and the device `pD3DDevice` is not an `IDirect3DDevice9Ex`. In all other circumstances, this function is not necessary.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaD3D9GetDevice](#), [cudaGraphicsD3D9RegisterResource](#), [cudaDeviceReset](#)

## **cudaError\_t cudaGraphicsD3D9RegisterResource** (**cudaGraphicsResource \*\*resource**, **IDirect3DResource9 \*pD3DResource**, **unsigned int flags**)

Register a Direct3D 9 resource for access by CUDA.

### Parameters

#### **resource**

- Pointer to returned resource handle

#### **pD3DResource**

- Direct3D resource to register

#### **flags**

- Parameters for resource registration

### Returns

[cudaSuccess](#), [cudaErrorInvalidDevice](#), [cudaErrorInvalidValue](#),  
[cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### Description

Registers the Direct3D 9 resource `pD3DResource` for access by CUDA.

If this call is successful then the application will be able to map and unmap this resource until it is unregistered through [cudaGraphicsUnregisterResource\(\)](#). Also on success, this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through [cudaGraphicsUnregisterResource\(\)](#).

This call potentially has a high-overhead and should not be called every frame in interactive applications.

The type of `pD3DResource` must be one of the following.

- ▶ `IDirect3DVertexBuffer9`: may be accessed through a device pointer



- ▶ `IDirect3DIndexBuffer9`: may be accessed through a device pointer
- ▶ `IDirect3DSurface9`: may be accessed through an array. Only stand-alone objects of type `IDirect3DSurface9` may be explicitly shared. In particular, individual mipmap levels and faces of cube maps may not be registered directly. To access individual surfaces associated with a texture, one must register the base texture object.
- ▶ `IDirect3DBaseTexture9`: individual surfaces on this texture may be accessed through an array.

The `flags` argument may be used to specify additional parameters at register time. The valid values for this parameter are

- ▶ `cudaGraphicsRegisterFlagsNone`: Specifies no hints about how this resource will be used.
- ▶ `cudaGraphicsRegisterFlagsSurfaceLoadStore`: Specifies that CUDA will bind this resource to a surface reference.
- ▶ `cudaGraphicsRegisterFlagsTextureGather`: Specifies that CUDA will perform texture gather operations on this resource.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- ▶ The primary rendertarget may not be registered with CUDA.
- ▶ Resources allocated as shared may not be registered with CUDA.
- ▶ Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- ▶ Surfaces of depth or stencil formats cannot be shared.

A complete list of supported formats is as follows:

- ▶ `D3DFMT_L8`
- ▶ `D3DFMT_L16`
- ▶ `D3DFMT_A8R8G8B8`
- ▶ `D3DFMT_X8R8G8B8`
- ▶ `D3DFMT_G16R16`
- ▶ `D3DFMT_A8B8G8R8`
- ▶ `D3DFMT_A8`
- ▶ `D3DFMT_A8L8`
- ▶ `D3DFMT_Q8W8V8U8`
- ▶ `D3DFMT_V16U16`
- ▶ `D3DFMT_A16B16G16R16F`
- ▶ `D3DFMT_A16B16G16R16`
- ▶ `D3DFMT_R32F`
- ▶ `D3DFMT_G16R16F`
- ▶ `D3DFMT_A32B32G32R32F`

- ▶ `D3DFMT_G32R32F`
- ▶ `D3DFMT_R16F`

If `pD3DResource` is of incorrect type or is already registered, then `cudaErrorInvalidResourceHandle` is returned. If `pD3DResource` cannot be registered, then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaD3D9SetDirect3DDevice`, `cudaGraphicsUnregisterResource`,  
`cudaGraphicsMapResources`, `cudaGraphicsSubResourceGetMappedArray`,  
`cudaGraphicsResourceGetMappedPointer`

## 2.13. Direct3D 9 Interoperability [DEPRECATED]

This section describes deprecated Direct3D 9 interoperability functions.

### enum `cudaD3D9MapFlags`

CUDA D3D9 Map Flags

#### Values

**`cudaD3D9MapFlagsNone = 0`**

Default; Assume resource can be read/written

**`cudaD3D9MapFlagsReadOnly = 1`**

CUDA kernels will not write to this resource

**`cudaD3D9MapFlagsWriteDiscard = 2`**

CUDA kernels will only write to and will not read from this resource

### enum `cudaD3D9RegisterFlags`

CUDA D3D9 Register Flags

#### Values

**`cudaD3D9RegisterFlagsNone = 0`**

Default; Resource can be accessed through a void\*

**`cudaD3D9RegisterFlagsArray = 1`**

Resource can be accessed through a CUarray\*

## `cudaError_t cudaD3D9MapResources (int count, IDirect3DResource9 **ppResources)`

Map Direct3D resources for access by CUDA.

### Parameters

#### **count**

- Number of resources to map for CUDA

#### **ppResources**

- Resources to map for CUDA

### Returns

`cudaSuccess`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Maps the `count` Direct3D resources in `ppResources` for access by CUDA.

The resources in `ppResources` may be accessed in CUDA kernels until they are unmapped. Direct3D should not access any resources while they are mapped by CUDA. If an application does so, the results are undefined.

This function provides the synchronization guarantee that any Direct3D calls issued before `cudaD3D9MapResources()` will complete before any CUDA kernels issued after `cudaD3D9MapResources()` begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries then `cudaErrorInvalidResourceHandle` is returned. If any of `ppResources` are presently mapped for access by CUDA then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaGraphicsMapResources`

## cudaError\_t cudaD3D9RegisterResource (IDirect3DResource9 \*pResource, unsigned int flags)

Registers a Direct3D resource for access by CUDA.

### Parameters

#### pResource

- Resource to register

#### flags

- Parameters for resource registration

### Returns

cudaSuccess, cudaErrorInvalidValue, cudaErrorInvalidResourceHandle, cudaErrorUnknown

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Registers the Direct3D resource `pResource` for access by CUDA.

If this call is successful, then the application will be able to map and unmap this resource until it is unregistered through `cudaD3D9UnregisterResource()`. Also on success, this call will increase the internal reference count on `pResource`. This reference count will be decremented when this resource is unregistered through `cudaD3D9UnregisterResource()`.

This call potentially has a high-overhead and should not be called every frame in interactive applications.

The type of `pResource` must be one of the following.

- ▶ `IDirect3DVertexBuffer9`: No notes.
- ▶ `IDirect3DIndexBuffer9`: No notes.
- ▶ `IDirect3DSurface9`: Only stand-alone objects of type `IDirect3DSurface9` may be explicitly shared. In particular, individual mipmap levels and faces of cube maps may not be registered directly. To access individual surfaces associated with a texture, one must register the base texture object.
- ▶ `IDirect3DBaseTexture9`: When a texture is registered, all surfaces associated with all mipmap levels of all faces of the texture will be accessible to CUDA.

The `flags` argument specifies the mechanism through which CUDA will access the Direct3D resource. The following value is allowed:

- ▶ `cudaD3D9RegisterFlagsNone`: Specifies that CUDA will access this resource through a `void*`. The pointer, size, and pitch for each subresource of this

resource may be queried through `cudaD3D9ResourceGetMappedPointer()`, `cudaD3D9ResourceGetMappedSize()`, and `cudaD3D9ResourceGetMappedPitch()` respectively. This option is valid for all resource types.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations:

- ▶ The primary rendertarget may not be registered with CUDA.
- ▶ Resources allocated as shared may not be registered with CUDA.
- ▶ Any resources allocated in D3DPOOL\_SYSTEMMEM or D3DPOOL\_MANAGED may not be registered with CUDA.
- ▶ Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- ▶ Surfaces of depth or stencil formats cannot be shared.

If Direct3D interoperability is not initialized on this context, then `cudaErrorInvalidDevice` is returned. If `pResource` is of incorrect type (e.g. is a non-stand-alone `IDirect3DSurface9`) or is already registered, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` cannot be registered then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsD3D9RegisterResource`

## `cudaError_t cudaD3D9ResourceGetMappedArray` (`cudaArray **ppArray`, `IDirect3DResource9 *pResource`, `unsigned int face`, `unsigned int level`)

Get an array through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **ppArray**

- Returned array corresponding to subresource

#### **pResource**

- Mapped resource to access

#### **face**

- Face of resource to access

**level**

- Level of resource to access

**Returns**

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

**Description**

[Deprecated](#) This function is deprecated as of CUDA 3.0.

Returns in `*pArray` an array through which the subresource of the mapped Direct3D resource `pResource`, which corresponds to `face` and `level` may be accessed. The value set in `pArray` may change every time that `pResource` is mapped.

If `pResource` is not registered then [cudaErrorInvalidResourceHandle](#) is returned. If `pResource` was not registered with usage flags [cudaD3D9RegisterFlagsArray](#), then [cudaErrorInvalidResourceHandle](#) is returned. If `pResource` is not mapped, then [cudaErrorUnknown](#) is returned.

For usage requirements of `face` and `level` parameters, see [cudaD3D9ResourceGetMappedPointer\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cudaGraphicsSubResourceGetMappedArray](#)

**`cudaError_t cudaD3D9ResourceGetMappedPitch (size_t *pPitch, size_t *pPitchSlice, IDirect3DResource9 *pResource, unsigned int face, unsigned int level)`**

Get the pitch of a subresource of a Direct3D resource which has been mapped for access by CUDA.

**Parameters****pPitch**

- Returned pitch of subresource

**pPitchSlice**

- Returned Z-slice pitch of subresource

**pResource**

- Mapped resource to access

**face**

- Face of resource to access

**level**

- Level of resource to access

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#),  
[cudaErrorUnknown](#)

**Description**

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*pPitch` and `*pPitchSlice` the pitch and Z-slice pitch of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `face` and `level`. The values set in `pPitch` and `pPitchSlice` may change every time that `pResource` is mapped.

The pitch and Z-slice pitch values may be used to compute the location of a sample on a surface as follows.

For a 2D surface, the byte offset of the sample at position `x`, `y` from the base pointer of the surface is:

**`y * pitch + (bytes per pixel) * x`**

For a 3D surface, the byte offset of the sample at position `x`, `y`, `z` from the base pointer of the surface is:

**`z * slicePitch + y * pitch + (bytes per pixel) * x`**

Both parameters `pPitch` and `pPitchSlice` are optional and may be set to `NULL`.

If `pResource` is not of type `IDirect3DBaseTexture9` or one of its sub-types or if `pResource` has not been registered for use with CUDA, then [cudaErrorInvalidResourceHandle](#) is returned. If `pResource` was not registered with usage flags [cudaD3D9RegisterFlagsNone](#), then [cudaErrorInvalidResourceHandle](#) is returned. If `pResource` is not mapped for access by CUDA then [cudaErrorUnknown](#) is returned.

For usage requirements of `face` and `level` parameters, see [cudaD3D9ResourceGetMappedPointer\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaGraphicsResourceGetMappedPointer`

**`cudaError_t cudaD3D9ResourceGetMappedPointer (void **pPointer, IDirect3DResource9 *pResource, unsigned int face, unsigned int level)`**

Get a pointer through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

**Parameters****pPointer**

- Returned pointer corresponding to subresource

**pResource**

- Mapped resource to access

**face**

- Face of resource to access

**level**

- Level of resource to access

**Returns**

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

**Description**

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*pPointer` the base pointer of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `face` and `level`. The value set in `pPointer` may change every time that `pResource` is mapped.

If `pResource` is not registered, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` was not registered with usage flags `cudaD3D9RegisterFlagsNone`, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` is not mapped, then `cudaErrorUnknown` is returned.

If `pResource` is of type `IDirect3DCubeTexture9`, then `face` must one of the values enumerated by type `D3DCUBEMAP_FACES`. For all other types, `face` must be 0. If `face` is invalid, then `cudaErrorInvalidValue` is returned.

If `pResource` is of type `IDirect3DBaseTexture9`, then `level` must correspond to a valid mipmap level. Only mipmap level 0 is supported for now. For all other types `level` must be 0. If `level` is invalid, then `cudaErrorInvalidValue` is returned.





Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsResourceGetMappedPointer](#)

**cudaError\_t cudaD3D9ResourceGetMappedSize (size\_t \*pSize, IDirect3DResource9 \*pResource, unsigned int face, unsigned int level)**

Get the size of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pSize**

- Returned size of subresource

**pResource**

- Mapped resource to access

**face**

- Face of resource to access

**level**

- Level of resource to access

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in \*pSize the size of the subresource of the mapped Direct3D resource pResource, which corresponds to face and level. The value set in pSize may change every time that pResource is mapped.

If pResource has not been registered for use with CUDA then [cudaErrorInvalidResourceHandle](#) is returned. If pResource was not registered with usage flags [cudaD3D9RegisterFlagsNone](#), then [cudaErrorInvalidResourceHandle](#) is returned. If pResource is not mapped for access by CUDA then [cudaErrorUnknown](#) is returned.

For usage requirements of face and level parameters, see [cudaD3D9ResourceGetMappedPointer\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsResourceGetMappedPointer](#)

**cudaError\_t cudaD3D9ResourceGetSurfaceDimensions**  
(size\_t \*pWidth, size\_t \*pHeight, size\_t \*pDepth,  
IDirect3DResource9 \*pResource, unsigned int face,  
unsigned int level)

Get the dimensions of a registered Direct3D surface.

### Parameters

**pWidth**

- Returned width of surface

**pHeight**

- Returned height of surface

**pDepth**

- Returned depth of surface

**pResource**

- Registered resource to access

**face**

- Face of resource to access

**level**

- Level of resource to access

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#),

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in \*pWidth, \*pHeight, and \*pDepth the dimensions of the subresource of the mapped Direct3D resource pResource which corresponds to face and level.

Since anti-aliased surfaces may have multiple samples per pixel, it is possible that the dimensions of a resource will be an integer factor larger than the dimensions reported by the Direct3D runtime.

The parameters pWidth, pHeight, and pDepth are optional. For 2D surfaces, the value returned in \*pDepth will be 0.

If `pResource` is not of type `IDirect3DBaseTexture9` or `IDirect3DSurface9` or if `pResource` has not been registered for use with CUDA, then `cudaErrorInvalidResourceHandle` is returned.

For usage requirements of `face` and `level` parameters, see `cudaD3D9ResourceGetMappedPointer`.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsSubResourceGetMappedArray`

## `cudaError_t cudaD3D9ResourceSetMapFlags` (`IDirect3DResource9 *pResource`, unsigned int flags)

Set usage flags for mapping a Direct3D resource.

### Parameters

#### `pResource`

- Registered resource to set flags for

#### `flags`

- Parameters for resource mapping

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Set flags for mapping the Direct3D resource `pResource`.

Changes to flags will take effect the next time `pResource` is mapped. The `flags` argument may be any of the following:

- ▶ `cudaD3D9MapFlagsNone`: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA kernels. This is the default value.
- ▶ `cudaD3D9MapFlagsReadOnly`: Specifies that CUDA kernels which access this resource will not write to this resource.

- ▶ **cudaD3D9MapFlagsWriteDiscard**: Specifies that CUDA kernels which access this resource will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

If `pResource` has not been registered for use with CUDA, then **cudaErrorInvalidResourceHandle** is returned. If `pResource` is presently mapped for access by CUDA, then **cudaErrorUnknown** is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaInteropResourceSetMapFlags`

## **cudaError\_t cudaD3D9UnmapResources (int count, IDirect3DResource9 \*\*ppResources)**

Unmap Direct3D resources for access by CUDA.

### Parameters

#### **count**

- Number of resources to unmap for CUDA

#### **ppResources**

- Resources to unmap for CUDA

### Returns

**cudaSuccess**, **cudaErrorInvalidResourceHandle**, **cudaErrorUnknown**

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Unmaps the `count` Direct3D resources in `ppResources`.

This function provides the synchronization guarantee that any CUDA kernels issued before **cudaD3D9UnmapResources()** will complete before any Direct3D calls issued after **cudaD3D9UnmapResources()** begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries, then **cudaErrorInvalidResourceHandle** is returned. If any of `ppResources` are not presently mapped for access by CUDA then **cudaErrorUnknown** is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsUnmapResources](#)

## **cudaError\_t cudaD3D9UnregisterResource (IDirect3DResource9 \*pResource)**

Unregisters a Direct3D resource for access by CUDA.

### **Parameters**

#### **pResource**

- Resource to unregister

### **Returns**

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### **Description**

**Deprecated** This function is deprecated as of CUDA 3.0.

Unregisters the Direct3D resource `pResource` so it is not accessible by CUDA unless registered again.

If `pResource` is not registered, then [cudaErrorInvalidResourceHandle](#) is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsUnregisterResource](#)

## **2.14. Direct3D 10 Interoperability**

This section describes the Direct3D 10 interoperability functions of the CUDA runtime application programming interface. Note that mapping of Direct3D 10 resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

## enum cudaD3D10DeviceList

CUDA devices corresponding to a D3D10 device

### Values

**cudaD3D10DeviceListAll = 1**

The CUDA devices for all GPUs used by a D3D10 device

**cudaD3D10DeviceListCurrentFrame = 2**

The CUDA devices for the GPUs used by a D3D10 device in its currently rendering frame

**cudaD3D10DeviceListNextFrame = 3**

The CUDA devices for the GPUs to be used by a D3D10 device in the next frame

## cudaError\_t cudaD3D10GetDevice (int \*device, IDXGIAdapter \*pAdapter)

Gets the device number for an adapter.

### Parameters

**device**

- Returns the device corresponding to pAdapter

**pAdapter**

- D3D10 adapter to get device for

### Returns

cudaSuccess, cudaErrorInvalidValue, cudaErrorUnknown

### Description

Returns in \*device the CUDA-compatible device corresponding to the adapter pAdapter obtained from IDXGIFactory::EnumAdapters. This call will succeed only if a device on adapter pAdapter is CUDA-compatible.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

cudaGraphicsD3D10RegisterResource,

**cudaError\_t cudaD3D10GetDevices (unsigned int \*pCudaDeviceCount, int \*pCudaDevices, unsigned int cudaDeviceCount, ID3D10Device \*pD3D10Device, cudaD3D10DeviceList deviceList)**

Gets the CUDA devices corresponding to a Direct3D 10 device.

### Parameters

#### **pCudaDeviceCount**

- Returned number of CUDA devices corresponding to pD3D10Device

#### **pCudaDevices**

- Returned CUDA devices corresponding to pD3D10Device

#### **cudaDeviceCount**

- The size of the output device array pCudaDevices

#### **pD3D10Device**

- Direct3D 10 device to query for CUDA devices

#### **deviceList**

- The set of devices to return. This set may be [cudaD3D10DeviceListAll](#) for all devices, [cudaD3D10DeviceListCurrentFrame](#) for the devices used to render the current frame (in SLI), or [cudaD3D10DeviceListNextFrame](#) for the devices used to render the next frame (in SLI).

### Returns

[cudaSuccess](#), [cudaErrorNoDevice](#), [cudaErrorUnknown](#)

### Description

Returns in \*pCudaDeviceCount the number of CUDA-compatible devices corresponding to the Direct3D 10 device pD3D10Device. Also returns in \*pCudaDevices at most cudaDeviceCount of the the CUDA-compatible devices corresponding to the Direct3D 10 device pD3D10Device.

If any of the GPUs being used to render pDevice are not CUDA capable then the call will return [cudaErrorNoDevice](#).



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsUnregisterResource](#), [cudaGraphicsMapResources](#), [cudaGraphicsSubResourceGetMappedArray](#), [cudaGraphicsResourceGetMappedPointer](#)

## cudaError\_t cudaGraphicsD3D10RegisterResource (cudaGraphicsResource \*\*resource, ID3D10Resource \*pD3DResource, unsigned int flags)

Registers a Direct3D 10 resource for access by CUDA.

### Parameters

#### resource

- Pointer to returned resource handle

#### pD3DResource

- Direct3D resource to register

#### flags

- Parameters for resource registration

### Returns

cudaSuccess, cudaErrorInvalidDevice, cudaErrorInvalidValue,  
cudaErrorInvalidResourceHandle, cudaErrorUnknown

### Description

Registers the Direct3D 10 resource `pD3DResource` for access by CUDA.

If this call is successful, then the application will be able to map and unmap this resource until it is unregistered through `cudaGraphicsUnregisterResource()`. Also on success, this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through `cudaGraphicsUnregisterResource()`.

This call potentially has a high-overhead and should not be called every frame in interactive applications.

The type of `pD3DResource` must be one of the following.

- ▶ ID3D10Buffer: may be accessed via a device pointer
- ▶ ID3D10Texture1D: individual subresources of the texture may be accessed via arrays
- ▶ ID3D10Texture2D: individual subresources of the texture may be accessed via arrays
- ▶ ID3D10Texture3D: individual subresources of the texture may be accessed via arrays

The `flags` argument may be used to specify additional parameters at register time. The valid values for this parameter are

- ▶ `cudaGraphicsRegisterFlagsNone`: Specifies no hints about how this resource will be used.
- ▶ `cudaGraphicsRegisterFlagsSurfaceLoadStore`: Specifies that CUDA will bind this resource to a surface reference.



- ▶ `cudaGraphicsRegisterFlagsTextureGather`: Specifies that CUDA will perform texture gather operations on this resource.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- ▶ The primary rendertarget may not be registered with CUDA.
- ▶ Resources allocated as shared may not be registered with CUDA.
- ▶ Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- ▶ Surfaces of depth or stencil formats cannot be shared.

A complete list of supported DXGI formats is as follows. For compactness the notation `A_{B,C,D}` represents `A_B`, `A_C`, and `A_D`.

- ▶ `DXGI_FORMAT_A8_UNORM`
- ▶ `DXGI_FORMAT_B8G8R8A8_UNORM`
- ▶ `DXGI_FORMAT_B8G8R8X8_UNORM`
- ▶ `DXGI_FORMAT_R16_FLOAT`
- ▶ `DXGI_FORMAT_R16G16B16A16_{FLOAT,SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R16G16_{FLOAT,SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R16_{SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R32_FLOAT`
- ▶ `DXGI_FORMAT_R32G32B32A32_{FLOAT,SINT,UINT}`
- ▶ `DXGI_FORMAT_R32G32_{FLOAT,SINT,UINT}`
- ▶ `DXGI_FORMAT_R32_{SINT,UINT}`
- ▶ `DXGI_FORMAT_R8G8B8A8_{SINT,SNORM,UINT,UNORM,UNORM_SRGB}`
- ▶ `DXGI_FORMAT_R8G8_{SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R8_{SINT,SNORM,UINT,UNORM}`

If `pD3DResource` is of incorrect type or is already registered, then `cudaErrorInvalidResourceHandle` is returned. If `pD3DResource` cannot be registered, then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsUnregisterResource`, `cudaGraphicsMapResources`,  
`cudaGraphicsSubResourceGetMappedArray`, `cudaGraphicsResourceGetMappedPointer`

## 2.15. Direct3D 10 Interoperability [DEPRECATED]

This section describes deprecated Direct3D 10 interoperability functions.

### enum cudaD3D10MapFlags

CUDA D3D10 Map Flags

#### Values

**cudaD3D10MapFlagsNone = 0**

Default; Assume resource can be read/written

**cudaD3D10MapFlagsReadOnly = 1**

CUDA kernels will not write to this resource

**cudaD3D10MapFlagsWriteDiscard = 2**

CUDA kernels will only write to and will not read from this resource

### enum cudaD3D10RegisterFlags

CUDA D3D10 Register Flags

#### Values

**cudaD3D10RegisterFlagsNone = 0**

Default; Resource can be accessed through a void\*

**cudaD3D10RegisterFlagsArray = 1**

Resource can be accessed through a CUarray\*

### cudaError\_t cudaD3D10GetDirect3DDevice (ID3D10Device \*\*ppD3D10Device)

Gets the Direct3D device against which the current CUDA context was created.

#### Parameters

**ppD3D10Device**

- Returns the Direct3D device for this thread

#### Returns

[cudaSuccess](#), [cudaErrorUnknown](#)

#### Description

[Deprecated](#) This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA device with a D3D10 device in order to achieve maximum interoperability performance.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaD3D10SetDirect3DDevice](#)

## **cudaError\_t cudaD3D10MapResources (int count, ID3D10Resource \*\*ppResources)**

Maps Direct3D Resources for access by CUDA.

### Parameters

#### **count**

- Number of resources to map for CUDA

#### **ppResources**

- Resources to map for CUDA

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Maps the `count` Direct3D resources in `ppResources` for access by CUDA.

The resources in `ppResources` may be accessed in CUDA kernels until they are unmapped. Direct3D should not access any resources while they are mapped by CUDA. If an application does so, the results are undefined.

This function provides the synchronization guarantee that any Direct3D calls issued before [cudaD3D10MapResources\(\)](#) will complete before any CUDA kernels issued after [cudaD3D10MapResources\(\)](#) begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries then [cudaErrorInvalidResourceHandle](#) is returned. If any of `ppResources` are presently mapped for access by CUDA then [cudaErrorUnknown](#) is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsMapResources](#)

## **cudaError\_t cudaD3D10RegisterResource (ID3D10Resource \*pResource, unsigned int flags)**

Registers a Direct3D 10 resource for access by CUDA.

### **Parameters**

#### **pResource**

- Resource to register

#### **flags**

- Parameters for resource registration

### **Returns**

[cudaSuccess](#), [cudaErrorInvalidDevice](#), [cudaErrorInvalidValue](#),  
[cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### **Description**

**Deprecated** This function is deprecated as of CUDA 3.0.

Registers the Direct3D resource `pResource` for access by CUDA.

If this call is successful, then the application will be able to map and unmap this resource until it is unregistered through [cudaD3D10UnregisterResource\(\)](#). Also on success, this call will increase the internal reference count on `pResource`. This reference count will be decremented when this resource is unregistered through [cudaD3D10UnregisterResource\(\)](#).

This call potentially has a high-overhead and should not be called every frame in interactive applications.

The type of `pResource` must be one of the following:

- ▶ ID3D10Buffer: Cannot be used with `flags` set to `cudaD3D10RegisterFlagsArray`.
- ▶ ID3D10Texture1D: No restrictions.
- ▶ ID3D10Texture2D: No restrictions.
- ▶ ID3D10Texture3D: No restrictions.

The `flags` argument specifies the mechanism through which CUDA will access the Direct3D resource. The following values are allowed.

- ▶ `cudaD3D10RegisterFlagsNone`: Specifies that CUDA will access this resource through a `void*`. The pointer, size, and pitch for each subresource of this resource may be queried through `cudaD3D10ResourceGetMappedPointer()`, `cudaD3D10ResourceGetMappedSize()`, and `cudaD3D10ResourceGetMappedPitch()` respectively. This option is valid for all resource types.
- ▶ `cudaD3D10RegisterFlagsArray`: Specifies that CUDA will access this resource through a `CUarray` queried on a sub-resource basis through `cudaD3D10ResourceGetMappedArray()`. This option is only valid for resources of type `ID3D10Texture1D`, `ID3D10Texture2D`, and `ID3D10Texture3D`.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- ▶ The primary rendertarget may not be registered with CUDA.
- ▶ Resources allocated as shared may not be registered with CUDA.
- ▶ Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- ▶ Surfaces of depth or stencil formats cannot be shared.

If Direct3D interoperability is not initialized on this context then `cudaErrorInvalidDevice` is returned. If `pResource` is of incorrect type or is already registered then `cudaErrorInvalidResourceHandle` is returned. If `pResource` cannot be registered then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsD3D10RegisterResource`

## `cudaError_t cudaD3D10ResourceGetMappedArray (cudaArray **ppArray, ID3D10Resource *pResource, unsigned int subResource)`

Gets an array through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **ppArray**

- Returned array corresponding to subresource

#### **pResource**

- Mapped resource to access

#### **subResource**

- Subresource of pResource to access

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`,  
`cudaErrorUnknown`

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*ppArray` an array through which the subresource of the mapped Direct3D resource `pResource` which corresponds to `subResource` may be accessed. The value set in `ppArray` may change every time that `pResource` is mapped.

If `pResource` is not registered, then `cudaErrorInvalidResourceHandle` is returned.

If `pResource` was not registered with usage flags `cudaD3D10RegisterFlagsArray`, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` is not mapped then `cudaErrorUnknown` is returned.

For usage requirements of the `subResource` parameter, see `cudaD3D10ResourceGetMappedPointer()`.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaGraphicsSubResourceGetMappedArray`

## `cudaError_t cudaD3D10ResourceGetMappedPitch (size_t *pPitch, size_t *pPitchSlice, ID3D10Resource *pResource, unsigned int subResource)`

Gets the pitch of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **pPitch**

- Returned pitch of subresource

#### **pPitchSlice**

- Returned Z-slice pitch of subresource

#### **pResource**

- Mapped resource to access

#### **subResource**

- Subresource of pResource to access

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*pPitch` and `*pPitchSlice` the pitch and Z-slice pitch of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `subResource`. The values set in `pPitch` and `pPitchSlice` may change every time that `pResource` is mapped.

The pitch and Z-slice pitch values may be used to compute the location of a sample on a surface as follows.

For a 2D surface, the byte offset of the sample at position `x`, `y` from the base pointer of the surface is:

$$y * \text{pitch} + (\text{bytes per pixel}) * x$$

For a 3D surface, the byte offset of the sample at position `x`, `y`, `z` from the base pointer of the surface is:

$$z * \text{slicePitch} + y * \text{pitch} + (\text{bytes per pixel}) * x$$

Both parameters `pPitch` and `pPitchSlice` are optional and may be set to `NULL`.

If `pResource` is not of type `ID3D10Texture1D`, `ID3D10Texture2D`, or `ID3D10Texture3D`, or if `pResource` has not been registered for use with CUDA, then

`cudaErrorInvalidResourceHandle` is returned. If `pResource` was not registered with usage flags `cudaD3D10RegisterFlagsNone`, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` is not mapped for access by CUDA then `cudaErrorUnknown` is returned.

For usage requirements of the `subResource` parameter see `cudaD3D10ResourceGetMappedPointer()`.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsSubResourceGetMappedArray`

## `cudaError_t cudaD3D10ResourceGetMappedPointer (void **pPointer, ID3D10Resource *pResource, unsigned int subResource)`

Gets a pointer through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **pPointer**

- Returned pointer corresponding to subresource

#### **pResource**

- Mapped resource to access

#### **subResource**

- Subresource of `pResource` to access

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*pPointer` the base pointer of the subresource of the mapped Direct3D resource `pResource` which corresponds to `subResource`. The value set in `pPointer` may change every time that `pResource` is mapped.

If `pResource` is not registered, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` was not registered with usage flags `cudaD3D9RegisterFlagsNone`, then



`cudaErrorInvalidResourceHandle` is returned. If `pResource` is not mapped then `cudaErrorUnknown` is returned.

If `pResource` is of type `ID3D10Buffer` then `subResource` must be 0. If `pResource` is of any other type, then the value of `subResource` must come from the subresource calculation in `D3D10CalcSubResource()`.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsResourceGetMappedPointer`

## `cudaError_t cudaD3D10ResourceGetMappedSize (size_t *pSize, ID3D10Resource *pResource, unsigned int subResource)`

Gets the size of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

#### **pSize**

- Returned size of subresource

#### **pResource**

- Mapped resource to access

#### **subResource**

- Subresource of `pResource` to access

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*pSize` the size of the subresource of the mapped Direct3D resource `pResource` which corresponds to `subResource`. The value set in `pSize` may change every time that `pResource` is mapped.

If `pResource` has not been registered for use with CUDA then `cudaErrorInvalidHandle` is returned. If `pResource` was not registered with usage flags

`cudaD3D10RegisterFlagsNone`, then `cudaErrorInvalidResourceHandle` is returned. If `pResource` is not mapped for access by CUDA then `cudaErrorUnknown` is returned.

For usage requirements of the `subResource` parameter see `cudaD3D10ResourceGetMappedPointer()`.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsResourceGetMappedPointer`

**`cudaError_t cudaD3D10ResourceGetSurfaceDimensions`  
(`size_t *pWidth`, `size_t *pHeight`, `size_t *pDepth`,  
`ID3D10Resource *pResource`, `unsigned int subResource`)**

Gets the dimensions of a registered Direct3D surface.

#### Parameters

##### **`pWidth`**

- Returned width of surface

##### **`pHeight`**

- Returned height of surface

##### **`pDepth`**

- Returned depth of surface

##### **`pResource`**

- Registered resource to access

##### **`subResource`**

- Subresource of `pResource` to access

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`,

#### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Returns in `*pWidth`, `*pHeight`, and `*pDepth` the dimensions of the subresource of the mapped Direct3D resource `pResource` which corresponds to `subResource`.

Since anti-aliased surfaces may have multiple samples per pixel, it is possible that the dimensions of a resource will be an integer factor larger than the dimensions reported by the Direct3D runtime.

The parameters `pWidth`, `pHeight`, and `pDepth` are optional. For 2D surfaces, the value returned in `*pDepth` will be 0.

If `pResource` is not of type `ID3D10Texture1D`, `ID3D10Texture2D`, or `ID3D10Texture3D`, or if `pResource` has not been registered for use with CUDA, then `cudaErrorInvalidHandle` is returned.

For usage requirements of `subResource` parameters see [cudaD3D10ResourceGetMappedPointer\(\)](#).



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsSubResourceGetMappedArray](#)

## `cudaError_t cudaD3D10ResourceSetMapFlags` (`ID3D10Resource *pResource`, unsigned int flags)

Set usage flags for mapping a Direct3D resource.

### Parameters

#### `pResource`

- Registered resource to set flags for

#### flags

- Parameters for resource mapping

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#),

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Set usage flags for mapping the Direct3D resource `pResource`.

Changes to flags will take effect the next time `pResource` is mapped. The `flags` argument may be any of the following:

- [cudaD3D10MapFlagsNone](#): Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA kernels. This is the default value.

- ▶ `cudaD3D10MapFlagsReadOnly`: Specifies that CUDA kernels which access this resource will not write to this resource.
- ▶ `cudaD3D10MapFlagsWriteDiscard`: Specifies that CUDA kernels which access this resource will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

If `pResource` has not been registered for use with CUDA then `cudaErrorInvalidHandle` is returned. If `pResource` is presently mapped for access by CUDA then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsResourceSetMapFlags`

## `cudaError_t cudaD3D10SetDirect3DDevice` (`ID3D10Device *pD3D10Device, int device`)

Sets the Direct3D 10 device to use for interoperability with a CUDA device.

### Parameters

#### `pD3D10Device`

- Direct3D device to use for interoperability

#### `device`

- The CUDA device to use. This device must be among the devices returned when querying `cudaD3D10DeviceListAll` from `cudaD3D10GetDevices`, may be set to -1 to automatically select an appropriate CUDA device.

### Returns

`cudaSuccess`, `cudaErrorInitializationError`, `cudaErrorInvalidValue`,  
`cudaErrorSetOnActiveProcess`

### Description

**Deprecated** This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA device with a D3D10 device in order to achieve maximum interoperability performance.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaD3D10GetDevice](#), [cudaGraphicsD3D10RegisterResource](#), [cudaDeviceReset](#)

## **cudaError\_t cudaD3D10UnmapResources (int count, ID3D10Resource \*\*ppResources)**

Unmaps Direct3D resources.

### Parameters

#### **count**

- Number of resources to unmap for CUDA

#### **ppResources**

- Resources to unmap for CUDA

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Unmaps the `count` Direct3D resource in `ppResources`.

This function provides the synchronization guarantee that any CUDA kernels issued before [cudaD3D10UnmapResources\(\)](#) will complete before any Direct3D calls issued after [cudaD3D10UnmapResources\(\)](#) begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries, then [cudaErrorInvalidResourceHandle](#) is returned. If any of `ppResources` are not presently mapped for access by CUDA then [cudaErrorUnknown](#) is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsUnmapResources](#)

## cudaError\_t cudaD3D10UnregisterResource (ID3D10Resource \*pResource)

Unregisters a Direct3D resource.

### Parameters

#### pResource

- Resource to unregister

### Returns

[cudaSuccess](#), [cudaErrorInvalidResourceHandle](#), [cudaErrorUnknown](#)

### Description

**Deprecated** This function is deprecated as of CUDA 3.0.

Unregisters the Direct3D resource `resource` so it is not accessible by CUDA unless registered again.

If `pResource` is not registered, then [cudaErrorInvalidResourceHandle](#) is returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsUnregisterResource](#)

## 2.16. Direct3D 11 Interoperability

This section describes the Direct3D 11 interoperability functions of the CUDA runtime application programming interface. Note that mapping of Direct3D 11 resources is performed with the graphics API agnostic, resource mapping interface described in [Graphics Interoperability](#).

### enum cudaD3D11DeviceList

CUDA devices corresponding to a D3D11 device

#### Values

`cudaD3D11DeviceListAll = 1`

The CUDA devices for all GPUs used by a D3D11 device

**cudaD3D11DeviceListCurrentFrame = 2**

The CUDA devices for the GPUs used by a D3D11 device in its currently rendering frame

**cudaD3D11DeviceListNextFrame = 3**

The CUDA devices for the GPUs to be used by a D3D11 device in the next frame

## cudaError\_t cudaD3D11GetDevice (int \*device, IDXGIAdapter \*pAdapter)

Gets the device number for an adapter.

### Parameters

**device**

- Returns the device corresponding to pAdapter

**pAdapter**

- D3D11 adapter to get device for

### Returns

cudaSuccess, cudaErrorInvalidValue, cudaErrorUnknown

### Description

Returns in \*device the CUDA-compatible device corresponding to the adapter pAdapter obtained from IDXGIFactory::EnumAdapters. This call will succeed only if a device on adapter pAdapter is CUDA-compatible.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

cudaGraphicsUnregisterResource, cudaGraphicsMapResources,  
cudaGraphicsSubResourceGetMappedArray, cudaGraphicsResourceGetMappedPointer

## cudaError\_t cudaD3D11GetDevices (unsigned int \*pCudaDeviceCount, int \*pCudaDevices, unsigned

## int cudaDeviceCount, ID3D11Device \*pD3D11Device, cudaD3D11DeviceList deviceList)

Gets the CUDA devices corresponding to a Direct3D 11 device.

### Parameters

#### **pCudaDeviceCount**

- Returned number of CUDA devices corresponding to pD3D11Device

#### **pCudaDevices**

- Returned CUDA devices corresponding to pD3D11Device

#### **cudaDeviceCount**

- The size of the output device array pCudaDevices

#### **pD3D11Device**

- Direct3D 11 device to query for CUDA devices

#### **deviceList**

- The set of devices to return. This set may be [cudaD3D11DeviceListAll](#) for all devices, [cudaD3D11DeviceListCurrentFrame](#) for the devices used to render the current frame (in SLI), or [cudaD3D11DeviceListNextFrame](#) for the devices used to render the next frame (in SLI).

### Returns

[cudaSuccess](#), [cudaErrorNoDevice](#), [cudaErrorUnknown](#)

### Description

Returns in \*pCudaDeviceCount the number of CUDA-compatible devices corresponding to the Direct3D 11 device pD3D11Device. Also returns in \*pCudaDevices at most cudaDeviceCount of the the CUDA-compatible devices corresponding to the Direct3D 11 device pD3D11Device.

If any of the GPUs being used to render pDevice are not CUDA capable then the call will return [cudaErrorNoDevice](#).



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsUnregisterResource](#), [cudaGraphicsMapResources](#), [cudaGraphicsSubResourceGetMappedArray](#), [cudaGraphicsResourceGetMappedPointer](#)



## cudaError\_t cudaGraphicsD3D11RegisterResource (cudaGraphicsResource \*\*resource, ID3D11Resource \*pD3DResource, unsigned int flags)

Register a Direct3D 11 resource for access by CUDA.

### Parameters

#### resource

- Pointer to returned resource handle

#### pD3DResource

- Direct3D resource to register

#### flags

- Parameters for resource registration

### Returns

cudaSuccess, cudaErrorInvalidDevice, cudaErrorInvalidValue,  
cudaErrorInvalidResourceHandle, cudaErrorUnknown

### Description

Registers the Direct3D 11 resource pD3DResource for access by CUDA.

If this call is successful, then the application will be able to map and unmap this resource until it is unregistered through [cudaGraphicsUnregisterResource\(\)](#). Also on success, this call will increase the internal reference count on pD3DResource. This reference count will be decremented when this resource is unregistered through [cudaGraphicsUnregisterResource\(\)](#).

This call potentially has a high-overhead and should not be called every frame in interactive applications.

The type of pD3DResource must be one of the following.

- ▶ ID3D11Buffer: may be accessed via a device pointer
- ▶ ID3D11Texture1D: individual subresources of the texture may be accessed via arrays
- ▶ ID3D11Texture2D: individual subresources of the texture may be accessed via arrays
- ▶ ID3D11Texture3D: individual subresources of the texture may be accessed via arrays

The flags argument may be used to specify additional parameters at register time. The valid values for this parameter are

- ▶ [cudaGraphicsRegisterFlagsNone](#): Specifies no hints about how this resource will be used.
- ▶ [cudaGraphicsRegisterFlagsSurfaceLoadStore](#): Specifies that CUDA will bind this resource to a surface reference.

- ▶ `cudaGraphicsRegisterFlagsTextureGather`: Specifies that CUDA will perform texture gather operations on this resource.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- ▶ The primary rendertarget may not be registered with CUDA.
- ▶ Resources allocated as shared may not be registered with CUDA.
- ▶ Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- ▶ Surfaces of depth or stencil formats cannot be shared.

A complete list of supported DXGI formats is as follows. For compactness the notation `A_{B,C,D}` represents `A_B`, `A_C`, and `A_D`.

- ▶ `DXGI_FORMAT_A8_UNORM`
- ▶ `DXGI_FORMAT_B8G8R8A8_UNORM`
- ▶ `DXGI_FORMAT_B8G8R8X8_UNORM`
- ▶ `DXGI_FORMAT_R16_FLOAT`
- ▶ `DXGI_FORMAT_R16G16B16A16_{FLOAT,SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R16G16_{FLOAT,SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R16_{SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R32_FLOAT`
- ▶ `DXGI_FORMAT_R32G32B32A32_{FLOAT,SINT,UINT}`
- ▶ `DXGI_FORMAT_R32G32_{FLOAT,SINT,UINT}`
- ▶ `DXGI_FORMAT_R32_{SINT,UINT}`
- ▶ `DXGI_FORMAT_R8G8B8A8_{SINT,SNORM,UINT,UNORM,UNORM_SRGB}`
- ▶ `DXGI_FORMAT_R8G8_{SINT,SNORM,UINT,UNORM}`
- ▶ `DXGI_FORMAT_R8_{SINT,SNORM,UINT,UNORM}`

If `pD3DResource` is of incorrect type or is already registered, then `cudaErrorInvalidResourceHandle` is returned. If `pD3DResource` cannot be registered, then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsUnregisterResource`, `cudaGraphicsMapResources`,  
`cudaGraphicsSubResourceGetMappedArray`, `cudaGraphicsResourceGetMappedPointer`

## 2.17. Direct3D 11 Interoperability [DEPRECATED]

This section describes deprecated Direct3D 11 interoperability functions.

### `cudaError_t cudaD3D11GetDirect3DDevice` (`ID3D11Device **ppD3D11Device`)

Gets the Direct3D device against which the current CUDA context was created.

#### Parameters

##### `ppD3D11Device`

- Returns the Direct3D device for this thread

#### Returns

`cudaSuccess`, `cudaErrorUnknown`

#### Description

**Deprecated** This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA device with a D3D11 device in order to achieve maximum interoperability performance.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaD3D11SetDirect3DDevice`

### `cudaError_t cudaD3D11SetDirect3DDevice` (`ID3D11Device *pD3D11Device`, `int device`)

Sets the Direct3D 11 device to use for interoperability with a CUDA device.

#### Parameters

##### `pD3D11Device`

- Direct3D device to use for interoperability

**device**

- The CUDA device to use. This device must be among the devices returned when querying `cudaD3D11DeviceListAll` from `cudaD3D11GetDevices`, may be set to -1 to automatically select an appropriate CUDA device.

**Returns**

`cudaSuccess`, `cudaErrorInitializationError`, `cudaErrorInvalidValue`,  
`cudaErrorSetOnActiveProcess`

**Description**

**Deprecated** This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA device with a D3D11 device in order to achieve maximum interoperability performance.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaD3D11GetDevice`, `cudaGraphicsD3D11RegisterResource`, `cudaDeviceReset`

## 2.18. VDPAU Interoperability

This section describes the VDPAU interoperability functions of the CUDA runtime application programming interface.

**`cudaError_t cudaGraphicsVDPAURegisterOutputSurface`**  
**(`cudaGraphicsResource **resource`, `VdpOutputSurface`**  
**`vdpSurface`, `unsigned int flags`)**

Register a `VdpOutputSurface` object.

**Parameters****resource**

- Pointer to the returned object handle

**vdpSurface**

- VDPAU object to be registered

**flags**

- Map flags

## Returns

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`,  
`cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

## Description

Registers the `VdpOutputSurface` specified by `vdpSurface` for access by CUDA. A handle to the registered object is returned as `resource`. The surface's intended usage is specified using `flags`, as follows:

- ▶ `cudaGraphicsMapFlagsNone`: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- ▶ `cudaGraphicsMapFlagsReadOnly`: Specifies that CUDA will not write to this resource.
- ▶ `cudaGraphicsMapFlagsWriteDiscard`: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaVDPAUSetVDPAUDevice`, `cudaGraphicsUnregisterResource`,  
`cudaGraphicsSubResourceGetMappedArray`

## `cudaError_t cudaGraphicsVDPAURegisterVideoSurface` `(cudaGraphicsResource **resource, VdpVideoSurface` `vdpSurface, unsigned int flags)`

Register a `VdpVideoSurface` object.

## Parameters

### **resource**

- Pointer to the returned object handle

### **vdpSurface**

- VDPAU object to be registered

### **flags**

- Map flags

## Returns

`cudaSuccess`, `cudaErrorInvalidDevice`, `cudaErrorInvalidValue`,  
`cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

## Description

Registers the `VdpVideoSurface` specified by `vdpSurface` for access by CUDA. A handle to the registered object is returned as `resource`. The surface's intended usage is specified using `flags`, as follows:

- ▶ `cudaGraphicsMapFlagsNone`: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- ▶ `cudaGraphicsMapFlagsReadOnly`: Specifies that CUDA will not write to this resource.
- ▶ `cudaGraphicsMapFlagsWriteDiscard`: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaVDPAUSetVDPAUDevice`, `cudaGraphicsUnregisterResource`,  
`cudaGraphicsSubResourceGetMappedArray`

**`cudaError_t cudaVDPAUGetDevice (int *device,  
VdpDevice vdpDevice, VdpGetProcAddress  
*vdpGetProcAddress)`**

Gets the CUDA device associated with a `VdpDevice`.

## Parameters

### **`device`**

- Returns the device associated with `vdpDevice`, or -1 if the device associated with `vdpDevice` is not a compute device.

### **`vdpDevice`**

- A `VdpDevice` handle

### **`vdpGetProcAddress`**

- VDPAU's `VdpGetProcAddress` function pointer

**Returns**[cudaSuccess](#)**Description**

Returns the CUDA device associated with a `VdpDevice`, if applicable.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**[cudaVDPAUSetVDPAUDevice](#)

**`cudaError_t cudaVDPAUSetVDPAUDevice (int device, VdpDevice vdpDevice, VdpGetProcAddress *vdpGetProcAddress)`**

Sets a CUDA device to use VDPAU interoperability.

**Parameters****device**

- Device to use for VDPAU interoperability

**vdpDevice**

- The `VdpDevice` to interoperate with

**vdpGetProcAddress**

- VDPAU's `VdpGetProcAddress` function pointer

**Returns**

[cudaSuccess](#), [cudaErrorInvalidDevice](#), [cudaErrorSetOnActiveProcess](#)

**Description**

Records `vdpDevice` as the `VdpDevice` for VDPAU interoperability with the CUDA device `device` and sets `device` as the current device for the calling host thread.

If `device` has already been initialized then this call will fail with the error [cudaErrorSetOnActiveProcess](#). In this case it is necessary to reset `device` using [cudaDeviceReset\(\)](#) before VDPAU interoperability on `device` may be enabled.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

`cudaGraphicsVDPAURegisterVideoSurface`,  
`cudaGraphicsVDPAURegisterOutputSurface`, `cudaDeviceReset`

## 2.19. Graphics Interoperability

This section describes the graphics interoperability functions of the CUDA runtime application programming interface.

**`cudaError_t cudaGraphicsMapResources (int count, cudaGraphicsResource_t *resources, cudaStream_t stream)`**

Map graphics resources for access by CUDA.

### Parameters

**count**

- Number of resources to map

**resources**

- Resources to map for CUDA

**stream**

- Stream for synchronization

### Returns

`cudaSuccess`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

Maps the `count` graphics resources in `resources` for access by CUDA.

The resources in `resources` may be accessed by CUDA until they are unmapped. The graphics API from which `resources` were registered should not access any resources while they are mapped by CUDA. If an application does so, the results are undefined.

This function provides the synchronization guarantee that any graphics calls issued before `cudaGraphicsMapResources()` will complete before any subsequent CUDA work issued in `stream` begins.



If `resources` contains any duplicate entries then `cudaErrorInvalidResourceHandle` is returned. If any of `resources` are presently mapped for access by CUDA then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

`cudaGraphicsResourceGetMappedPointer`, `cudaGraphicsSubResourceGetMappedArray`, `cudaGraphicsUnmapResources`

## `cudaError_t` `cudaGraphicsResourceGetMappedMipmappedArray` (`cudaMipmappedArray_t *mipmappedArray`, `cudaGraphicsResource_t resource`)

Get a mipmapped array through which to access a mapped graphics resource.

### Parameters

#### **`mipmappedArray`**

- Returned mipmapped array through which `resource` may be accessed

#### **`resource`**

- Mapped resource to access

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`,  
`cudaErrorUnknown`

### Description

Returns in `*mipmappedArray` a mipmapped array through which the mapped graphics resource `resource` may be accessed. The value set in `mipmappedArray` may change every time that `resource` is mapped.

If `resource` is not a texture then it cannot be accessed via an array and `cudaErrorUnknown` is returned. If `resource` is not mapped then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsResourceGetMappedPointer](#)

## **cudaError\_t cudaGraphicsResourceGetMappedPointer (void \*\*devPtr, size\_t \*size, cudaGraphicsResource\_t resource)**

Get an device pointer through which to access a mapped graphics resource.

### **Parameters**

#### **devPtr**

- Returned pointer through which `resource` may be accessed

#### **size**

- Returned size of the buffer accessible starting at `*devPtr`

#### **resource**

- Mapped resource to access

### **Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidResourceHandle](#),  
[cudaErrorUnknown](#)

### **Description**

Returns in `*devPtr` a pointer through which the mapped graphics resource `resource` may be accessed. Returns in `*size` the size of the memory in bytes which may be accessed from that pointer. The value set in `devPtr` may change every time that `resource` is mapped.

If `resource` is not a buffer then it cannot be accessed via a pointer and [cudaErrorUnknown](#) is returned. If `resource` is not mapped then [cudaErrorUnknown](#) is returned. \*



Note that this function may also return error codes from previous, asynchronous launches.

See also:

[cudaGraphicsMapResources](#), [cudaGraphicsSubResourceGetMappedArray](#)

## cudaError\_t cudaGraphicsResourceSetMapFlags (cudaGraphicsResource\_t resource, unsigned int flags)

Set usage flags for mapping a graphics resource.

### Parameters

#### resource

- Registered resource to set flags for

#### flags

- Parameters for resource mapping

### Returns

cudaSuccess, cudaErrorInvalidValue, cudaErrorInvalidResourceHandle, cudaErrorUnknown,

### Description

Set flags for mapping the graphics resource `resource`.

Changes to `flags` will take effect the next time `resource` is mapped. The `flags` argument may be any of the following:

- ▶ `cudaGraphicsMapFlagsNone`: Specifies no hints about how `resource` will be used. It is therefore assumed that CUDA may read from or write to `resource`.
- ▶ `cudaGraphicsMapFlagsReadOnly`: Specifies that CUDA will not write to `resource`.
- ▶ `cudaGraphicsMapFlagsWriteDiscard`: Specifies CUDA will not read from `resource` and will write over the entire contents of `resource`, so none of the data previously stored in `resource` will be preserved.

If `resource` is presently mapped for access by CUDA then `cudaErrorUnknown` is returned. If `flags` is not one of the above values then `cudaErrorInvalidValue` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

[cudaGraphicsMapResources](#)

## `cudaError_t cudaGraphicsSubResourceGetMappedArray(cudaArray_t *array, cudaGraphicsResource_t resource, unsigned int arrayIndex, unsigned int mipLevel)`

Get an array through which to access a subresource of a mapped graphics resource.

### Parameters

#### **array**

- Returned array through which a subresource of `resource` may be accessed

#### **resource**

- Mapped resource to access

#### **arrayIndex**

- Array index for array textures or cubemap face index as defined by `cudaGraphicsCubeFace` for cubemap textures for the subresource to access

#### **mipLevel**

- Mipmap level for the subresource to access

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

Returns in `*array` an array through which the subresource of the mapped graphics resource `resource` which corresponds to array index `arrayIndex` and mipmap level `mipLevel` may be accessed. The value set in `array` may change every time that `resource` is mapped.

If `resource` is not a texture then it cannot be accessed via an array and `cudaErrorUnknown` is returned. If `arrayIndex` is not a valid array index for `resource` then `cudaErrorInvalidValue` is returned. If `mipLevel` is not a valid mipmap level for `resource` then `cudaErrorInvalidValue` is returned. If `resource` is not mapped then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaGraphicsResourceGetMappedPointer`

## `cudaError_t cudaGraphicsUnmapResources (int count, cudaGraphicsResource_t *resources, cudaStream_t stream)`

Unmap graphics resources.

### Parameters

#### **count**

- Number of resources to unmap

#### **resources**

- Resources to unmap

#### **stream**

- Stream for synchronization

### Returns

`cudaSuccess`, `cudaErrorInvalidResourceHandle`, `cudaErrorUnknown`

### Description

Unmaps the `count` graphics resources in `resources`.

Once unmapped, the resources in `resources` may not be accessed by CUDA until they are mapped again.

This function provides the synchronization guarantee that any CUDA work issued in `stream` before `cudaGraphicsUnmapResources()` will complete before any subsequently issued graphics work begins.

If `resources` contains any duplicate entries then `cudaErrorInvalidResourceHandle` is returned. If any of `resources` are not presently mapped for access by CUDA then `cudaErrorUnknown` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaGraphicsMapResources`

## cudaError\_t cudaGraphicsUnregisterResource (cudaGraphicsResource\_t resource)

Unregisters a graphics resource for access by CUDA.

### Parameters

#### resource

- Resource to unregister

### Returns

cudaSuccess, cudaErrorInvalidResourceHandle, cudaErrorUnknown

### Description

Unregisters the graphics resource `resource` so it is not accessible by CUDA unless registered again.

If `resource` is invalid then `cudaErrorInvalidResourceHandle` is returned.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

cudaGraphicsD3D9RegisterResource, cudaGraphicsD3D10RegisterResource,  
cudaGraphicsD3D11RegisterResource, cudaGraphicsGLRegisterBuffer,  
cudaGraphicsGLRegisterImage

## 2.20. Texture Reference Management

This section describes the low level texture reference management functions of the CUDA runtime application programming interface.

Some functions have overloaded C++ API template versions documented separately in the [C++ API Routines](#) module.

```
cudaError_t cudaBindTexture (size_t *offset, const
textureReference *texref, const void *devPtr, const
cudaChannelFormatDesc *desc, size_t size)
```

Binds a memory area to a texture.

### Parameters

#### offset

- Offset in bytes

#### texref

- Texture to bind

#### devPtr

- Memory area on device

#### desc

- Channel format

#### size

- Size of the memory area pointed to by devPtr

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#),  
[cudaErrorInvalidTexture](#)

### Description

Binds `size` bytes of the memory area pointed to by `devPtr` to the texture reference `texref`. `desc` describes how the memory is interpreted when fetching values from the texture. Any memory previously bound to `texref` is unbound.

Since the hardware enforces an alignment requirement on texture base addresses, [cudaBindTexture\(\)](#) returns in `*offset` a byte offset that must be applied to texture fetches in order to read from the desired memory. This offset must be divided by the texel size and passed to kernels that read from the texture so they can be applied to the `tex1Dfetch()` function. If the device memory pointer was returned from [cudaMalloc\(\)](#), the offset is guaranteed to be 0 and NULL may be passed as the `offset` parameter.

The total number of elements (or texels) in the linear address range cannot exceed [cudaDeviceProp::maxTexture1DLinear\[0\]](#). The number of elements is computed as  $(size / elementSize)$ , where `elementSize` is determined from `desc`.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cudaCreateChannelDesc](#) ( C API), [cudaGetChannelDesc](#), [cudaGetTextureReference](#), [cudaBindTexture](#) (C++ API), [cudaBindTexture2D](#) ( C API), [cudaBindTextureToArray](#) ( C API), [cudaUnbindTexture](#) ( C API), [cudaGetTextureAlignmentOffset](#) ( C API)

**cudaError\_t cudaBindTexture2D** (size\_t \*offset, const textureReference \*texref, const void \*devPtr, const cudaChannelFormatDesc \*desc, size\_t width, size\_t height, size\_t pitch)

Binds a 2D memory area to a texture.

**Parameters****offset**

- Offset in bytes

**texref**

- Texture reference to bind

**devPtr**

- 2D memory area on device

**desc**

- Channel format

**width**

- Width in texel units

**height**

- Height in texel units

**pitch**

- Pitch in bytes

**Returns**

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidDevicePointer](#), [cudaErrorInvalidTexture](#)

**Description**

Binds the 2D memory area pointed to by `devPtr` to the texture reference `texref`. The size of the area is constrained by `width` in texel units, `height` in texel units, and `pitch` in byte units. `desc` describes how the memory is interpreted when fetching values from the texture. Any memory previously bound to `texref` is unbound.

Since the hardware enforces an alignment requirement on texture base addresses, [cudaBindTexture2D\(\)](#) returns in `*offset` a byte offset that must be applied to texture fetches in order to read from the desired memory. This offset must be divided by the texel size and passed to kernels that read from the texture so they can be applied to the



`tex2D()` function. If the device memory pointer was returned from `cudaMalloc()`, the offset is guaranteed to be 0 and NULL may be passed as the `offset` parameter.

`width` and `height`, which are specified in elements (or texels), cannot exceed `cudaDeviceProp::maxTexture2DLinear[0]` and `cudaDeviceProp::maxTexture2DLinear[1]` respectively. `pitch`, which is specified in bytes, cannot exceed `cudaDeviceProp::maxTexture2DLinear[2]`.

The driver returns `cudaErrorInvalidValue` if `pitch` is not a multiple of `cudaDeviceProp::texturePitchAlignment`.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaCreateChannelDesc` ( C API), `cudaGetChannelDesc`, `cudaGetTextureReference`, `cudaBindTexture` ( C API), `cudaBindTexture2D` (C++ API), `cudaBindTexture2D` (C++ API, inherited channel descriptor), `cudaBindTextureToArray` ( C API), `cudaBindTextureToArray` ( C API), `cudaGetTextureAlignmentOffset` ( C API)

## `cudaError_t cudaBindTextureToArray (const textureReference *texref, cudaArray_const_t array, const cudaChannelFormatDesc *desc)`

Binds an array to a texture.

#### Parameters

##### **texref**

- Texture to bind

##### **array**

- Memory array on device

##### **desc**

- Channel format

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`, `cudaErrorInvalidTexture`

## Description

Binds the CUDA array `array` to the texture reference `texref`. `desc` describes how the memory is interpreted when fetching values from the texture. Any CUDA array previously bound to `texref` is unbound.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaCreateChannelDesc` ( C API), `cudaGetChannelDesc`, `cudaGetTextureReference`, `cudaBindTexture` ( C API), `cudaBindTexture2D` ( C API), `cudaBindTextureToArray` (C++ API), `cudaUnbindTexture` ( C API), `cudaGetTextureAlignmentOffset` ( C API)

## `cudaError_t cudaBindTextureToMipmappedArray (const textureReference *texref, cudaMipmappedArray_const_t mipmappedArray, const cudaChannelFormatDesc *desc)`

Binds a mipmapped array to a texture.

## Parameters

### **texref**

- Texture to bind

### **mipmappedArray**

- Memory mipmapped array on device

### **desc**

- Channel format

## Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorInvalidDevicePointer`, `cudaErrorInvalidTexture`

## Description

Binds the CUDA mipmapped array `mipmappedArray` to the texture reference `texref`. `desc` describes how the memory is interpreted when fetching values from the texture. Any CUDA mipmapped array previously bound to `texref` is unbound.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[cudaCreateChannelDesc \( C API\)](#), [cudaGetChannelDesc](#), [cudaGetTextureReference](#), [cudaBindTexture \( C API\)](#), [cudaBindTexture2D \( C API\)](#), [cudaBindTextureToArray \(C++ API\)](#), [cudaUnbindTexture \( C API\)](#), [cudaGetTextureAlignmentOffset \( C API\)](#)

## cudaCreateChannelDesc (int x, int y, int z, int w, cudaChannelFormatKind f)

Returns a channel descriptor using the specified format.

**Parameters**

- x**  
- X component
- y**  
- Y component
- z**  
- Z component
- w**  
- W component
- f**  
- Channel format

**Returns**

Channel descriptor with format `f`

**Description**

Returns a channel descriptor with format `f` and number of bits of each component `x`, `y`, `z`, and `w`. The [cudaChannelFormatDesc](#) is defined as:

```
struct cudaChannelFormatDesc {
    int x, y, z, w;
    enum cudaChannelFormatKind
        f;
};
```

where [cudaChannelFormatKind](#) is one of [cudaChannelFormatKindSigned](#), [cudaChannelFormatKindUnsigned](#), or [cudaChannelFormatKindFloat](#).

**See also:**

[cudaCreateChannelDesc \( C++ API\)](#), [cudaGetChannelDesc](#), [cudaGetTextureReference](#), [cudaBindTexture \( C API\)](#), [cudaBindTexture2D \( C API\)](#), [cudaBindTextureToArray \( C API\)](#), [cudaUnbindTexture \( C API\)](#), [cudaGetTextureAlignmentOffset \( C API\)](#)

## cudaError\_t cudaGetChannelDesc (cudaChannelFormatDesc \*desc, cudaArray\_const\_t array)

Get the channel descriptor of an array.

### Parameters

**desc**

- Channel format

**array**

- Memory array on device

### Returns

cudaSuccess, cudaErrorInvalidValue

### Description

Returns in \*desc the channel descriptor of the CUDA array array.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

cudaCreateChannelDesc ( C API), cudaGetTextureReference, cudaBindTexture ( C API), cudaBindTexture2D ( C API), cudaBindTextureToArray ( C API), cudaUnbindTexture ( C API), cudaGetTextureAlignmentOffset ( C API)

## cudaError\_t cudaGetTextureAlignmentOffset (size\_t \*offset, const textureReference \*texref)

Get the alignment offset of a texture.

### Parameters

**offset**

- Offset of texture reference in bytes

**texref**

- Texture to get offset of

### Returns

cudaSuccess, cudaErrorInvalidTexture, cudaErrorInvalidTextureBinding

## Description

Returns in `*offset` the offset that was returned when texture reference `texref` was bound.



Note that this function may also return error codes from previous, asynchronous launches.

## See also:

`cudaCreateChannelDesc` ( C API), `cudaGetChannelDesc`, `cudaGetTextureReference`, `cudaBindTexture` ( C API), `cudaBindTexture2D` ( C API), `cudaBindTextureToArray` ( C API), `cudaUnbindTexture` ( C API), `cudaGetTextureAlignmentOffset` (C++ API)

## `cudaError_t cudaGetTextureReference (const textureReference **texref, const void *symbol)`

Get the texture reference associated with a symbol.

## Parameters

### `texref`

- Texture reference associated with symbol

### `symbol`

- Texture to get reference for

## Returns

`cudaSuccess`, `cudaErrorInvalidTexture`

## Description

Returns in `*texref` the structure associated to the texture reference defined by symbol `symbol`.



- Note that this function may also return error codes from previous, asynchronous launches.
- Use of a string naming a variable as the `symbol` paramater was removed in CUDA 5.0.

## See also:

`cudaCreateChannelDesc` ( C API), `cudaGetChannelDesc`, `cudaGetTextureAlignmentOffset` ( C API), `cudaBindTexture` ( C API),

`cudaBindTexture2D` ( C API), `cudaBindTextureToArray` ( C API), `cudaUnbindTexture` ( C API)

## `cudaError_t cudaUnbindTexture (const textureReference *texref)`

Unbinds a texture.

### Parameters

**texref**

- Texture to unbind

### Returns

`cudaSuccess`

### Description

Unbinds the texture bound to `texref`.



Note that this function may also return error codes from previous, asynchronous launches.

### See also:

`cudaCreateChannelDesc` ( C API), `cudaGetChannelDesc`, `cudaGetTextureReference`, `cudaBindTexture` ( C API), `cudaBindTexture2D` ( C API), `cudaBindTextureToArray` ( C API), `cudaUnbindTexture` (C++ API), `cudaGetTextureAlignmentOffset` ( C API)

## 2.21. Surface Reference Management

This section describes the low level surface reference management functions of the CUDA runtime application programming interface.

Some functions have overloaded C++ API template versions documented separately in the [C++ API Routines](#) module.

**cudaError\_t cudaBindSurfaceToArray (const surfaceReference \*surfref, cudaArray\_const\_t array, const cudaChannelFormatDesc \*desc)**

Binds an array to a surface.

#### Parameters

##### **surfref**

- Surface to bind

##### **array**

- Memory array on device

##### **desc**

- Channel format

#### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#), [cudaErrorInvalidSurface](#)

#### Description

Binds the CUDA array `array` to the surface reference `surfref`. `desc` describes how the memory is interpreted when fetching values from the surface. Any CUDA array previously bound to `surfref` is unbound.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaBindSurfaceToArray \(C++ API\)](#), [cudaBindSurfaceToArray \(C++ API, inherited channel descriptor\)](#), [cudaGetSurfaceReference](#)

**cudaError\_t cudaGetSurfaceReference (const surfaceReference \*\*surfref, const void \*symbol)**

Get the surface reference associated with a symbol.

#### Parameters

##### **surfref**

- Surface reference associated with symbol

##### **symbol**

- Surface to get reference for

**Returns**

`cudaSuccess`, `cudaErrorInvalidSurface`

**Description**

Returns in `*surfref` the structure associated to the surface reference defined by symbol `symbol`.



- Note that this function may also return error codes from previous, asynchronous launches.
- Use of a string naming a variable as the `symbol` paramater was removed in CUDA 5.0.

**See also:**

`cudaBindSurfaceToArray` ( C API)

## 2.22. Texture Object Management

This section describes the low level texture object management functions of the CUDA runtime application programming interface. The texture object API is only supported on devices of compute capability 3.0 or higher.

```
cudaError_t cudaCreateTextureObject
(cudaTextureObject_t *pTexObject, const
cudaResourceDesc *pResDesc, const cudaTextureDesc
*pTexDesc, const cudaResourceViewDesc
*pResViewDesc)
```

Creates a texture object.

**Parameters****pTexObject**

- Texture object to create

**pResDesc**

- Resource descriptor

**pTexDesc**

- Texture descriptor

**pResViewDesc**

- Resource view descriptor



## Returns

`cudaSuccess`, `cudaErrorInvalidValue`

## Description

Creates a texture object and returns it in `pTexObject`. `pResDesc` describes the data to texture from. `pTexDesc` describes how the data should be sampled. `pResViewDesc` is an optional argument that specifies an alternate format for the data described by `pResDesc`, and also describes the subresource region to restrict access to when texturing. `pResViewDesc` can only be specified if the type of resource is a CUDA array or a CUDA mipmapped array.

Texture objects are only supported on devices of compute capability 3.0 or higher.

The `cudaResourceDesc` structure is defined as:

```

↑ struct cudaResourceDesc {
    enum cudaResourceType
    resType;

    union {
        struct {
            cudaArray_t
            array;
        } array;
        struct {
            cudaMipmappedArray_t
            mipmap;
        } mipmap;
        struct {
            void *devPtr;
            struct cudaChannelFormatDesc
            desc;
            size_t sizeInBytes;
        } linear;
        struct {
            void *devPtr;
            struct cudaChannelFormatDesc
            desc;
            size_t width;
            size_t height;
            size_t pitchInBytes;
        } pitch2D;
    } res;
};

```

where:

- `cudaResourceDesc::resType` specifies the type of resource to texture from. `CUresourceType` is defined as:

```

↑ enum cudaResourceType {
    cudaResourceTypeArray          = 0x00,
    cudaResourceTypeMipmappedArray = 0x01,
    cudaResourceTypeLinear         = 0x02,
    cudaResourceTypePitch2D        = 0x03
};

```

If `cudaResourceDesc::resType` is set to `cudaResourceTypeArray`, `cudaResourceDesc::res::array::array` must be set to a valid CUDA array handle.

If `cudaResourceDesc::resType` is set to `cudaResourceTypeMipmappedArray`, `cudaResourceDesc::res::mipmap::mipmap` must be set to a valid CUDA mipmapped array handle.

If `cudaResourceDesc::resType` is set to `cudaResourceTypeLinear`, `cudaResourceDesc::res::linear::devPtr` must be set to a valid device pointer, that is aligned to `cudaDeviceProp::textureAlignment`. `cudaResourceDesc::res::linear::desc` describes the format and the number of components per array element. `cudaResourceDesc::res::linear::sizeInBytes` specifies the size of the array in bytes. The total number of elements in the linear address range cannot exceed `cudaDeviceProp::maxTexture1DLinear`. The number of elements is computed as  $(\text{sizeInBytes} / \text{sizeof}(\text{desc}))$ .

If `cudaResourceDesc::resType` is set to `cudaResourceTypePitch2D`, `cudaResourceDesc::res::pitch2D::devPtr` must be set to a valid device pointer, that is aligned to `cudaDeviceProp::textureAlignment`. `cudaResourceDesc::res::pitch2D::desc` describes the format and the number of components per array element. `cudaResourceDesc::res::pitch2D::width` and `cudaResourceDesc::res::pitch2D::height` specify the width and height of the array in elements, and cannot exceed `cudaDeviceProp::maxTexture2DLinear[0]` and `cudaDeviceProp::maxTexture2DLinear[1]` respectively. `cudaResourceDesc::res::pitch2D::pitchInBytes` specifies the pitch between two rows in bytes and has to be aligned to `cudaDeviceProp::texturePitchAlignment`. Pitch cannot exceed `cudaDeviceProp::maxTexture2DLinear[2]`.

The `cudaTextureDesc` struct is defined as

```
↑ struct cudaTextureDesc {
    enum cudaTextureAddressMode
    addressMode[3];
    enum cudaTextureFilterMode
    filterMode;
    enum cudaTextureReadMode
    readMode;
    int sRGB;
    int normalizedCoords;
    unsigned int maxAnisotropy;
    enum cudaTextureFilterMode
    mipmapFilterMode;
    float mipmapLevelBias;
    float minMipmapLevelClamp;
    float maxMipmapLevelClamp;
};
```

where

- `cudaTextureDesc::addressMode` specifies the addressing mode for each dimension of the texture data. `cudaTextureAddressMode` is defined as:

```
↑ enum cudaTextureAddressMode {
    cudaAddressModeWrap = 0,
    cudaAddressModeClamp = 1,
    cudaAddressModeMirror = 2,
    cudaAddressModeBorder = 3
};
```

This is ignored if `cudaResourceDesc::resType` is `cudaResourceTypeLinear`. Also, if `cudaTextureDesc::normalizedCoords` is set to zero, `cudaAddressModeWrap` and `cudaAddressModeMirror` won't be supported and will be switched to `cudaAddressModeClamp`.

- `cudaTextureDesc::filterMode` specifies the filtering mode to be used when fetching from the texture. `cudaTextureFilterMode` is defined as:

```
enum cudaTextureFilterMode {
    cudaFilterModePoint    = 0,
    cudaFilterModeLinear   = 1
};
```

This is ignored if `cudaResourceDesc::resType` is `cudaResourceTypeLinear`.

- `cudaTextureDesc::readMode` specifies whether integer data should be converted to floating point or not. `cudaTextureReadMode` is defined as:

```
enum cudaTextureReadMode {
    cudaReadModeElementType    = 0,
    cudaReadModeNormalizedFloat = 1
};
```

Note that this applies only to 8-bit and 16-bit integer formats. 32-bit integer format would not be promoted, regardless of whether or not this `cudaTextureDesc::readMode` is set `cudaReadModeNormalizedFloat` is specified.

- `cudaTextureDesc::sRGB` specifies whether sRGB to linear conversion should be performed during texture fetch.
- `cudaTextureDesc::normalizedCoords` specifies whether the texture coordinates will be normalized or not.
- `cudaTextureDesc::maxAnisotropy` specifies the maximum anisotropy ratio to be used when doing anisotropic filtering. This value will be clamped to the range [1,16].
- `cudaTextureDesc::mipmapFilterMode` specifies the filter mode when the calculated mipmap level lies between two defined mipmap levels.
- `cudaTextureDesc::mipmapLevelBias` specifies the offset to be applied to the calculated mipmap level.
- `cudaTextureDesc::minMipmapLevelClamp` specifies the lower end of the mipmap level range to clamp access to.
- `cudaTextureDesc::maxMipmapLevelClamp` specifies the upper end of the mipmap level range to clamp access to.

The `cudaResourceViewDesc` struct is defined as

```
struct cudaResourceViewDesc {
    enum cudaResourceViewFormat
    format;
    size_t          width;
    size_t          height;
    size_t          depth;
    unsigned int    firstMipmapLevel;
```

```

        unsigned int    lastMipmapLevel;
        unsigned int    firstLayer;
        unsigned int    lastLayer;
    };

```

where:

- ▶ `cudaResourceViewDesc::format` specifies how the data contained in the CUDA array or CUDA mipmapped array should be interpreted. Note that this can incur a change in size of the texture data. If the resource view format is a block compressed format, then the underlying CUDA array or CUDA mipmapped array has to have a 32-bit unsigned integer format with 2 or 4 channels, depending on the block compressed format. For ex., BC1 and BC4 require the underlying CUDA array to have a 32-bit unsigned int with 2 channels. The other BC formats require the underlying resource to have the same 32-bit unsigned int format but with 4 channels.
- ▶ `cudaResourceViewDesc::width` specifies the new width of the texture data. If the resource view format is a block compressed format, this value has to be 4 times the original width of the resource. For non block compressed formats, this value has to be equal to that of the original resource.
- ▶ `cudaResourceViewDesc::height` specifies the new height of the texture data. If the resource view format is a block compressed format, this value has to be 4 times the original height of the resource. For non block compressed formats, this value has to be equal to that of the original resource.
- ▶ `cudaResourceViewDesc::depth` specifies the new depth of the texture data. This value has to be equal to that of the original resource.
- ▶ `cudaResourceViewDesc::firstMipmapLevel` specifies the most detailed mipmap level. This will be the new mipmap level zero. For non-mipmapped resources, this value has to be zero. `cudaTextureDesc::minMipmapLevelClamp` and `cudaTextureDesc::maxMipmapLevelClamp` will be relative to this value. For ex., if the firstMipmapLevel is set to 2, and a minMipmapLevelClamp of 1.2 is specified, then the actual minimum mipmap level clamp will be 3.2.
- ▶ `cudaResourceViewDesc::lastMipmapLevel` specifies the least detailed mipmap level. For non-mipmapped resources, this value has to be zero.
- ▶ `cudaResourceViewDesc::firstLayer` specifies the first layer index for layered textures. This will be the new layer zero. For non-layered resources, this value has to be zero.
- ▶ `cudaResourceViewDesc::lastLayer` specifies the last layer index for layered textures. For non-layered resources, this value has to be zero.

See also:

`cudaDestroyTextureObject`

## `cudaError_t cudaDestroyTextureObject (cudaTextureObject_t texObject)`

Destroys a texture object.

### Parameters

#### **texObject**

- Texture object to destroy

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Destroys the texture object specified by `texObject`.

### See also:

`cudaCreateTextureObject`

## `cudaError_t cudaGetTextureObjectResourceDesc (cudaResourceDesc *pResDesc, cudaTextureObject_t texObject)`

Returns a texture object's resource descriptor.

### Parameters

#### **pResDesc**

- Resource descriptor

#### **texObject**

- Texture object

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Returns the resource descriptor for the texture object specified by `texObject`.

### See also:

`cudaCreateTextureObject`

## `cudaError_t cudaGetTextureObjectResourceViewDesc (cudaResourceViewDesc *pResViewDesc, cudaTextureObject_t texObject)`

Returns a texture object's resource view descriptor.

### Parameters

#### **pResViewDesc**

- Resource view descriptor

#### **texObject**

- Texture object

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Returns the resource view descriptor for the texture object specified by `texObject`. If no resource view was specified, `cudaErrorInvalidValue` is returned.

### See also:

`cudaCreateTextureObject`

## `cudaError_t cudaGetTextureObjectTextureDesc (cudaTextureDesc *pTexDesc, cudaTextureObject_t texObject)`

Returns a texture object's texture descriptor.

### Parameters

#### **pTexDesc**

- Texture descriptor

#### **texObject**

- Texture object

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Returns the texture descriptor for the texture object specified by `texObject`.

See also:

[cudaCreateTextureObject](#)

## 2.23. Surface Object Management

This section describes the low level texture object management functions of the CUDA runtime application programming interface. The surface object API is only supported on devices of compute capability 3.0 or higher.

**cudaError\_t cudaCreateSurfaceObject**  
(**cudaSurfaceObject\_t \*pSurfObject**, **const**  
**cudaResourceDesc \*pResDesc**)

Creates a surface object.

### Parameters

**pSurfObject**

- Surface object to create

**pResDesc**

- Resource descriptor

### Returns

[cudaSuccess](#), [cudaErrorInvalidValue](#)

### Description

Creates a surface object and returns it in `pSurfObject`. `pResDesc` describes the data to perform surface load/stores on. `cudaResourceDesc::resType` must be `cudaResourceTypeArray` and `cudaResourceDesc::res::array::array` must be set to a valid CUDA array handle.

Surface objects are only supported on devices of compute capability 3.0 or higher.

See also:

[cudaDestroySurfaceObject](#)

## `cudaError_t cudaDestroySurfaceObject (cudaSurfaceObject_t surfObject)`

Destroys a surface object.

### Parameters

#### **surfObject**

- Surface object to destroy

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

Destroys the surface object specified by `surfObject`.

### See also:

`cudaCreateSurfaceObject`

## `cudaError_t cudaGetSurfaceObjectResourceDesc (cudaResourceDesc *pResDesc, cudaSurfaceObject_t surfObject)`

Returns a surface object's resource descriptor Returns the resource descriptor for the surface object specified by `surfObject`.

### Parameters

#### **pResDesc**

- Resource descriptor

#### **surfObject**

- Surface object

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

### Description

### See also:

`cudaCreateSurfaceObject`



## 2.24. Version Management

### `cudaError_t cudaDriverGetVersion (int *driverVersion)`

Returns the CUDA driver version.

#### Parameters

##### `driverVersion`

- Returns the CUDA driver version.

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

#### Description

Returns in `*driverVersion` the version number of the installed CUDA driver. If no driver is installed, then 0 is returned as the driver version (via `driverVersion`). This function automatically returns `cudaErrorInvalidValue` if the `driverVersion` argument is NULL.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

`cudaRuntimeGetVersion`

### `cudaError_t cudaRuntimeGetVersion (int *runtimeVersion)`

Returns the CUDA Runtime version.

#### Parameters

##### `runtimeVersion`

- Returns the CUDA Runtime version.

#### Returns

`cudaSuccess`, `cudaErrorInvalidValue`

**Description**

Returns in `*runtimeVersion` the version number of the installed CUDA Runtime. This function automatically returns `cudaErrorInvalidValue` if the `runtimeVersion` argument is NULL.

**See also:**

[cudaDriverGetVersion](#)

## 2.25. C++ API Routines

C++-style interface built on top of CUDA runtime API.

This section describes the C++ high level API functions of the CUDA runtime application programming interface. To use these functions, your application needs to be compiled with the `nvcc` compiler.

### `template < class T > cudaCreateChannelDesc (void)`

[C++ API] Returns a channel descriptor using the specified format

**Returns**

Channel descriptor with format `f`

**Description**

Returns a channel descriptor with format `f` and number of bits of each component `x`, `y`, `z`, and `w`. The `cudaChannelFormatDesc` is defined as:

```
↑ struct cudaChannelFormatDesc {
    int x, y, z, w;
    enum cudaChannelFormatKind
        f;
};
```

where `cudaChannelFormatKind` is one of `cudaChannelFormatKindSigned`, `cudaChannelFormatKindUnsigned`, or `cudaChannelFormatKindFloat`.

**See also:**

[cudaCreateChannelDesc \( Low level\)](#), [cudaGetChannelDesc](#), [cudaGetTextureReference](#), [cudaBindTexture \(High level\)](#), [cudaBindTexture \(High level, inherited channel descriptor\)](#), [cudaBindTexture2D \(High level\)](#), [cudaBindTextureToArray \(High level\)](#), [cudaBindTextureToArray \(High level, inherited channel descriptor\)](#), [cudaUnbindTexture \(High level\)](#), [cudaGetTextureAlignmentOffset \(High level\)](#)

## 2.26. Interactions with the CUDA Driver API

This section describes the interactions between the CUDA Driver API and the CUDA Runtime API

### Primary Contexts

There exists a one to one relationship between CUDA devices in the CUDA Runtime API and CUcontext s in the CUDA Driver API within a process. The specific context which the CUDA Runtime API uses for a device is called the device's primary context. From the perspective of the CUDA Runtime API, a device and its primary context are synonymous.

### Initialization and Tear-Down

CUDA Runtime API calls operate on the CUDA Driver API CUcontext which is current to to the calling host thread.

The function `cudaSetDevice()` makes the primary context for the specified device current to the calling thread by calling `cuCtxSetCurrent()`.

The CUDA Runtime API will automatically initialize the primary context for a device at the first CUDA Runtime API call which requires an active context. If no CUcontext is current to the calling thread when a CUDA Runtime API call which requires an active context is made, then the primary context for a device will be selected, made current to the calling thread, and initialized.

The context which the CUDA Runtime API initializes will be initialized using the parameters specified by the CUDA Runtime API functions `cudaSetDeviceFlags()`, `cudaD3D9SetDirect3DDevice()`, `cudaD3D10SetDirect3DDevice()`, `cudaD3D11SetDirect3DDevice()`, `cudaGLSetGLDevice()`, and `cudaVDPAUSetVDPAUDevice()`. Note that these functions will fail with `cudaErrorSetOnActiveProcess` if they are called when the primary context for the specified device has already been initialized. (or if the current device has already been initialized, in the case of `cudaSetDeviceFlags()`).

Primary contexts will remain active until they are explicitly deinitialized using `cudaDeviceReset()`. The function `cudaDeviceReset()` will deinitialize the primary context for the calling thread's current device immediately. The context will remain current to all of the threads that it was current to. The next CUDA Runtime API call on any thread which requires an active context will trigger the reinitialization of that device's primary context.

Note that there is no reference counting of the primary context's lifetime. It is recommended that the primary context not be deinitialized except just before exit or to recover from an unspecified launch failure.

## Context Interoperability

Note that the use of multiple CUcontext s per device within a single process will substantially degrade performance and is strongly discouraged. Instead, it is highly recommended that the implicit one-to-one device-to-context mapping for the process provided by the CUDA Runtime API be used.

If a non-primary CUcontext created by the CUDA Driver API is current to a thread then the CUDA Runtime API calls to that thread will operate on that CUcontext, with some exceptions listed below. Interoperability between data types is discussed in the following sections.

The function `cudaPointerGetAttributes()` will return the error `cudaErrorIncompatibleDriverContext` if the pointer being queried was allocated by a non-primary context. The function `cudaDeviceEnablePeerAccess()` and the rest of the peer access API may not be called when a non-primary CUcontext is current. To use the pointer query and peer access APIs with a context created using the CUDA Driver API, it is necessary that the CUDA Driver API be used to access these features.

All CUDA Runtime API state (e.g, global variables' addresses and values) travels with its underlying CUcontext. In particular, if a CUcontext is moved from one thread to another then all CUDA Runtime API state will move to that thread as well.

Please note that attaching to legacy contexts (those with a version of 3010 as returned by `cuCtxGetApiVersion()`) is not possible. The CUDA Runtime will return `cudaErrorIncompatibleDriverContext` in such cases.

### Interactions between CUstream and cudaStream\_t

The types CUstream and `cudaStream_t` are identical and may be used interchangeably.

### Interactions between CUEvent and cudaEvent\_t

The types CUEvent and `cudaEvent_t` are identical and may be used interchangeably.

### Interactions between CUarray and cudaArray\_t

The types CUarray and `struct cudaArray *` represent the same data type and may be used interchangeably by casting the two types between each other.

In order to use a CUarray in a CUDA Runtime API function which takes a `struct cudaArray *`, it is necessary to explicitly cast the CUarray to a `struct cudaArray *`.

In order to use a `struct cudaArray *` in a CUDA Driver API function which takes a CUarray, it is necessary to explicitly cast the `struct cudaArray *` to a CUarray .

### Interactions between CUgraphicsResource and cudaGraphicsResource\_t

The types CUgraphicsResource and `cudaGraphicsResource_t` represent the same data type and may be used interchangeably by casting the two types between each other.

In order to use a `CUgraphicsResource` in a CUDA Runtime API function which takes a `cudaGraphicsResource_t`, it is necessary to explicitly cast the `CUgraphicsResource` to a `cudaGraphicsResource_t`.

In order to use a `cudaGraphicsResource_t` in a CUDA Driver API function which takes a `CUgraphicsResource`, it is necessary to explicitly cast the `cudaGraphicsResource_t` to a `CUgraphicsResource`.

## 2.27. Profiler Control

This section describes the profiler control functions of the CUDA runtime application programming interface.

**`cudaError_t cudaProfilerInitialize (const char *configFile, const char *outputFile, cudaOutputMode_t outputMode)`**

Initialize the CUDA profiler.

### Parameters

#### **`configFile`**

- Name of the config file that lists the counters/options for profiling.

#### **`outputFile`**

- Name of the outputFile where the profiling results will be stored.

#### **`outputMode`**

- outputMode, can be `cudaKeyValuePair` OR `cudaCSV`.

### Returns

`cudaSuccess`, `cudaErrorInvalidValue`, `cudaErrorProfilerDisabled`

### Description

Using this API user can initialize the CUDA profiler by specifying the configuration file, output file and output file format. This API is generally used to profile different set of counters by looping the kernel launch. The `configFile` parameter can be used to select profiling options including profiler counters. Refer to the "Compute Command Line Profiler User Guide" for supported profiler options and counters.

Limitation: The CUDA profiler cannot be initialized with this API if another profiling tool is already active, as indicated by the `cudaErrorProfilerDisabled` return code.

Typical usage of the profiling APIs is as follows:

```
for each set of counters/options { cudaProfilerInitialize\(\); //Initialize profiling,set
the counters/options in the config file ... cudaProfilerStart\(\); // code to be profiled
cudaProfilerStop\(\); ... cudaProfilerStart\(\); // code to be profiled cudaProfilerStop\(\); ... }
```



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaProfilerStart](#), [cudaProfilerStop](#)

## [cudaError\\_t cudaProfilerStart \(void\)](#)

Enable profiling.

#### Returns

[cudaSuccess](#)

#### Description

Enables profile collection by the active profiling tool for the current context. If profiling is already enabled, then [cudaProfilerStart\(\)](#) has no effect.

[cudaProfilerStart](#) and [cudaProfilerStop](#) APIs are used to programmatically control the profiling granularity by allowing profiling to be done only on selective pieces of code.



Note that this function may also return error codes from previous, asynchronous launches.

#### See also:

[cudaProfilerInitialize](#), [cudaProfilerStop](#)

## [cudaError\\_t cudaProfilerStop \(void\)](#)

Disable profiling.

#### Returns

[cudaSuccess](#)

#### Description

Disables profile collection by the active profiling tool for the current context. If profiling is already disabled, then [cudaProfilerStop\(\)](#) has no effect.

`cudaProfilerStart` and `cudaProfilerStop` APIs are used to programmatically control the profiling granularity by allowing profiling to be done only on selective pieces of code.



Note that this function may also return error codes from previous, asynchronous launches.

**See also:**

[`cudaProfilerInitialize`](#), [`cudaProfilerStart`](#)

## 2.28. Data types used by CUDA Runtime

struct cudaChannelFormatDesc

struct cudaDeviceProp

struct cudaExtent

struct cudaFuncAttributes

struct cudaIpcEventHandle\_t

struct cudaIpcMemHandle\_t

struct cudaMemcpy3DParms

struct cudaMemcpy3DPeerParms

struct cudaPitchedPtr

struct cudaPointerAttributes

struct cudaPos

struct cudaResourceDesc

struct cudaResourceViewDesc

struct cudaTextureDesc

struct surfaceReference

struct textureReference

enum cudaChannelFormatKind

Channel format kind



## Values

**cudaChannelFormatKindSigned = 0**

Signed channel format

**cudaChannelFormatKindUnsigned = 1**

Unsigned channel format

**cudaChannelFormatKindFloat = 2**

Float channel format

**cudaChannelFormatKindNone = 3**

No channel format

## enum cudaComputeMode

CUDA device compute modes

### Values

**cudaComputeModeDefault = 0**

Default compute mode (Multiple threads can use [cudaSetDevice\(\)](#) with this device)

**cudaComputeModeExclusive = 1**

Compute-exclusive-thread mode (Only one thread in one process will be able to use [cudaSetDevice\(\)](#) with this device)

**cudaComputeModeProhibited = 2**

Compute-prohibited mode (No threads can use [cudaSetDevice\(\)](#) with this device)

**cudaComputeModeExclusiveProcess = 3**

Compute-exclusive-process mode (Many threads in one process will be able to use [cudaSetDevice\(\)](#) with this device)

## enum cudaDeviceAttr

CUDA device attributes

### Values

**cudaDevAttrMaxThreadsPerBlock = 1**

Maximum number of threads per block

**cudaDevAttrMaxBlockDimX = 2**

Maximum block dimension X

**cudaDevAttrMaxBlockDimY = 3**

Maximum block dimension Y

**cudaDevAttrMaxBlockDimZ = 4**

Maximum block dimension Z

**cudaDevAttrMaxGridDimX = 5**

Maximum grid dimension X

**cudaDevAttrMaxGridDimY = 6**

Maximum grid dimension Y

**cudaDevAttrMaxGridDimZ = 7**

Maximum grid dimension Z

**cudaDevAttrMaxSharedMemoryPerBlock = 8**

Maximum shared memory available per block in bytes

**cudaDevAttrTotalConstantMemory = 9**

Memory available on device for `__constant__` variables in a CUDA C kernel in bytes

**cudaDevAttrWarpSize = 10**

Warp size in threads

**cudaDevAttrMaxPitch = 11**

Maximum pitch in bytes allowed by memory copies

**cudaDevAttrMaxRegistersPerBlock = 12**

Maximum number of 32-bit registers available per block

**cudaDevAttrClockRate = 13**

Peak clock frequency in kilohertz

**cudaDevAttrTextureAlignment = 14**

Alignment requirement for textures

**cudaDevAttrGpuOverlap = 15**

Device can possibly copy memory and execute a kernel concurrently

**cudaDevAttrMultiProcessorCount = 16**

Number of multiprocessors on device

**cudaDevAttrKernelExecTimeout = 17**

Specifies whether there is a run time limit on kernels

**cudaDevAttrIntegrated = 18**

Device is integrated with host memory

**cudaDevAttrCanMapHostMemory = 19**

Device can map host memory into CUDA address space

**cudaDevAttrComputeMode = 20**

Compute mode (See [cudaComputeMode](#) for details)

**cudaDevAttrMaxTexture1DWidth = 21**

Maximum 1D texture width

**cudaDevAttrMaxTexture2DWidth = 22**

Maximum 2D texture width

**cudaDevAttrMaxTexture2DHeight = 23**

Maximum 2D texture height

**cudaDevAttrMaxTexture3DWidth = 24**

Maximum 3D texture width

**cudaDevAttrMaxTexture3DHeight = 25**

Maximum 3D texture height

**cudaDevAttrMaxTexture3DDepth = 26**

Maximum 3D texture depth

**cudaDevAttrMaxTexture2DLayeredWidth = 27**

Maximum 2D layered texture width

**cudaDevAttrMaxTexture2DLayeredHeight = 28**

Maximum 2D layered texture height  
**cudaDevAttrMaxTexture2DLayeredLayers = 29**  
 Maximum layers in a 2D layered texture  
**cudaDevAttrSurfaceAlignment = 30**  
 Alignment requirement for surfaces  
**cudaDevAttrConcurrentKernels = 31**  
 Device can possibly execute multiple kernels concurrently  
**cudaDevAttrEccEnabled = 32**  
 Device has ECC support enabled  
**cudaDevAttrPciBusId = 33**  
 PCI bus ID of the device  
**cudaDevAttrPciDeviceId = 34**  
 PCI device ID of the device  
**cudaDevAttrTccDriver = 35**  
 Device is using TCC driver model  
**cudaDevAttrMemoryClockRate = 36**  
 Peak memory clock frequency in kilohertz  
**cudaDevAttrGlobalMemoryBusWidth = 37**  
 Global memory bus width in bits  
**cudaDevAttrL2CacheSize = 38**  
 Size of L2 cache in bytes  
**cudaDevAttrMaxThreadsPerMultiProcessor = 39**  
 Maximum resident threads per multiprocessor  
**cudaDevAttrAsyncEngineCount = 40**  
 Number of asynchronous engines  
**cudaDevAttrUnifiedAddressing = 41**  
 Device shares a unified address space with the host  
**cudaDevAttrMaxTexture1DLayeredWidth = 42**  
 Maximum 1D layered texture width  
**cudaDevAttrMaxTexture1DLayeredLayers = 43**  
 Maximum layers in a 1D layered texture  
**cudaDevAttrMaxTexture2DGatherWidth = 45**  
 Maximum 2D texture width if cudaArrayTextureGather is set  
**cudaDevAttrMaxTexture2DGatherHeight = 46**  
 Maximum 2D texture height if cudaArrayTextureGather is set  
**cudaDevAttrMaxTexture3DWidthAlt = 47**  
 Alternate maximum 3D texture width  
**cudaDevAttrMaxTexture3DHeightAlt = 48**  
 Alternate maximum 3D texture height  
**cudaDevAttrMaxTexture3DDepthAlt = 49**  
 Alternate maximum 3D texture depth  
**cudaDevAttrPciDomainId = 50**  
 PCI domain ID of the device

**cudaDevAttrTexturePitchAlignment = 51**

Pitch alignment requirement for textures

**cudaDevAttrMaxTextureCubemapWidth = 52**

Maximum cubemap texture width/height

**cudaDevAttrMaxTextureCubemapLayeredWidth = 53**

Maximum cubemap layered texture width/height

**cudaDevAttrMaxTextureCubemapLayeredLayers = 54**

Maximum layers in a cubemap layered texture

**cudaDevAttrMaxSurface1DWidth = 55**

Maximum 1D surface width

**cudaDevAttrMaxSurface2DWidth = 56**

Maximum 2D surface width

**cudaDevAttrMaxSurface2DHeight = 57**

Maximum 2D surface height

**cudaDevAttrMaxSurface3DWidth = 58**

Maximum 3D surface width

**cudaDevAttrMaxSurface3DHeight = 59**

Maximum 3D surface height

**cudaDevAttrMaxSurface3DDepth = 60**

Maximum 3D surface depth

**cudaDevAttrMaxSurface1DLayeredWidth = 61**

Maximum 1D layered surface width

**cudaDevAttrMaxSurface1DLayeredLayers = 62**

Maximum layers in a 1D layered surface

**cudaDevAttrMaxSurface2DLayeredWidth = 63**

Maximum 2D layered surface width

**cudaDevAttrMaxSurface2DLayeredHeight = 64**

Maximum 2D layered surface height

**cudaDevAttrMaxSurface2DLayeredLayers = 65**

Maximum layers in a 2D layered surface

**cudaDevAttrMaxSurfaceCubemapWidth = 66**

Maximum cubemap surface width

**cudaDevAttrMaxSurfaceCubemapLayeredWidth = 67**

Maximum cubemap layered surface width

**cudaDevAttrMaxSurfaceCubemapLayeredLayers = 68**

Maximum layers in a cubemap layered surface

**cudaDevAttrMaxTexture1DLinearWidth = 69**

Maximum 1D linear texture width

**cudaDevAttrMaxTexture2DLinearWidth = 70**

Maximum 2D linear texture width

**cudaDevAttrMaxTexture2DLinearHeight = 71**

Maximum 2D linear texture height

**cudaDevAttrMaxTexture2DLinearPitch = 72**

Maximum 2D linear texture pitch in bytes

**cudaDevAttrMaxTexture2DMipmappedWidth = 73**

Maximum mipmapped 2D texture width

**cudaDevAttrMaxTexture2DMipmappedHeight = 74**

Maximum mipmapped 2D texture height

**cudaDevAttrComputeCapabilityMajor = 75**

Major compute capability version number

**cudaDevAttrComputeCapabilityMinor = 76**

Minor compute capability version number

**cudaDevAttrMaxTexture1DMipmappedWidth = 77**

Maximum mipmapped 1D texture width

**cudaDevAttrStreamPrioritiesSupported = 78**

Device supports stream priorities

## enum cudaError

CUDA error types

### Values

**cudaSuccess = 0**

The API call returned with no errors. In the case of query calls, this can also mean that the operation being queried is complete (see [cudaEventQuery\(\)](#) and [cudaStreamQuery\(\)](#)).

**cudaErrorMissingConfiguration = 1**

The device function being invoked (usually via [cudaLaunch\(\)](#)) was not previously configured via the [cudaConfigureCall\(\)](#) function.

**cudaErrorMemoryAllocation = 2**

The API call failed because it was unable to allocate enough memory to perform the requested operation.

**cudaErrorInitializationError = 3**

The API call failed because the CUDA driver and runtime could not be initialized.

**cudaErrorLaunchFailure = 4**

An exception occurred on the device while executing a kernel. Common causes include dereferencing an invalid device pointer and accessing out of bounds shared memory. The device cannot be used until [cudaThreadExit\(\)](#) is called. All existing device memory allocations are invalid and must be reconstructed if the program is to continue using CUDA.

**cudaErrorPriorLaunchFailure = 5**

This indicated that a previous kernel launch failed. This was previously used for device emulation of kernel launches. **Deprecated** This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**cudaErrorLaunchTimeout = 6**

This indicates that the device kernel took too long to execute. This can only occur if timeouts are enabled - see the device property [kernelExecTimeoutEnabled](#) for more information. The device cannot be used until [cudaThreadExit\(\)](#) is called. All existing device memory allocations are invalid and must be reconstructed if the program is to continue using CUDA.

#### **cudaErrorLaunchOutOfResources = 7**

This indicates that a launch did not occur because it did not have appropriate resources. Although this error is similar to [cudaErrorInvalidConfiguration](#), this error usually indicates that the user has attempted to pass too many arguments to the device kernel, or the kernel launch specifies too many threads for the kernel's register count.

#### **cudaErrorInvalidDeviceFunction = 8**

The requested device function does not exist or is not compiled for the proper device architecture.

#### **cudaErrorInvalidConfiguration = 9**

This indicates that a kernel launch is requesting resources that can never be satisfied by the current device. Requesting more shared memory per block than the device supports will trigger this error, as will requesting too many threads or blocks. See [cudaDeviceProp](#) for more device limitations.

#### **cudaErrorInvalidDevice = 10**

This indicates that the device ordinal supplied by the user does not correspond to a valid CUDA device.

#### **cudaErrorInvalidValue = 11**

This indicates that one or more of the parameters passed to the API call is not within an acceptable range of values.

#### **cudaErrorInvalidPitchValue = 12**

This indicates that one or more of the pitch-related parameters passed to the API call is not within the acceptable range for pitch.

#### **cudaErrorInvalidSymbol = 13**

This indicates that the symbol name/identifier passed to the API call is not a valid name or identifier.

#### **cudaErrorMapBufferObjectFailed = 14**

This indicates that the buffer object could not be mapped.

#### **cudaErrorUnmapBufferObjectFailed = 15**

This indicates that the buffer object could not be unmapped.

#### **cudaErrorInvalidHostPointer = 16**

This indicates that at least one host pointer passed to the API call is not a valid host pointer.

#### **cudaErrorInvalidDevicePointer = 17**

This indicates that at least one device pointer passed to the API call is not a valid device pointer.

#### **cudaErrorInvalidTexture = 18**

This indicates that the texture passed to the API call is not a valid texture.

**cudaErrorInvalidTextureBinding = 19**

This indicates that the texture binding is not valid. This occurs if you call `cudaGetTextureAlignmentOffset()` with an unbound texture.

**cudaErrorInvalidChannelDescriptor = 20**

This indicates that the channel descriptor passed to the API call is not valid. This occurs if the format is not one of the formats specified by `cudaChannelFormatKind`, or if one of the dimensions is invalid.

**cudaErrorInvalidMemcpyDirection = 21**

This indicates that the direction of the memcpy passed to the API call is not one of the types specified by `cudaMemcpyKind`.

**cudaErrorAddressOfConstant = 22**

This indicated that the user has taken the address of a constant variable, which was forbidden up until the CUDA 3.1 release. **Deprecated** This error return is deprecated as of CUDA 3.1. Variables in constant memory may now have their address taken by the runtime via `cudaGetSymbolAddress()`.

**cudaErrorTextureFetchFailed = 23**

This indicated that a texture fetch was not able to be performed. This was previously used for device emulation of texture operations. **Deprecated** This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**cudaErrorTextureNotBound = 24**

This indicated that a texture was not bound for access. This was previously used for device emulation of texture operations. **Deprecated** This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**cudaErrorSynchronizationError = 25**

This indicated that a synchronization operation had failed. This was previously used for some device emulation functions. **Deprecated** This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**cudaErrorInvalidFilterSetting = 26**

This indicates that a non-float texture was being accessed with linear filtering. This is not supported by CUDA.

**cudaErrorInvalidNormSetting = 27**

This indicates that an attempt was made to read a non-float texture as a normalized float. This is not supported by CUDA.

**cudaErrorMixedDeviceExecution = 28**

Mixing of device and device emulation code was not allowed. **Deprecated** This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**cudaErrorCudartUnloading = 29**

This indicates that a CUDA Runtime API call cannot be executed because it is being called during process shut down, at a point in time after CUDA driver has been unloaded.

**cudaErrorUnknown = 30**



This indicates that an unknown internal error has occurred.

#### **cudaErrorNotYetImplemented = 31**

This indicates that the API call is not yet implemented. Production releases of CUDA will never return this error. **Deprecated** This error return is deprecated as of CUDA 4.1.

#### **cudaErrorMemoryValueTooLarge = 32**

This indicated that an emulated device pointer exceeded the 32-bit address range. **Deprecated** This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

#### **cudaErrorInvalidResourceHandle = 33**

This indicates that a resource handle passed to the API call was not valid. Resource handles are opaque types like `cudaStream_t` and `cudaEvent_t`.

#### **cudaErrorNotReady = 34**

This indicates that asynchronous operations issued previously have not completed yet. This result is not actually an error, but must be indicated differently than `cudaSuccess` (which indicates completion). Calls that may return this value include `cudaEventQuery()` and `cudaStreamQuery()`.

#### **cudaErrorInsufficientDriver = 35**

This indicates that the installed NVIDIA CUDA driver is older than the CUDA runtime library. This is not a supported configuration. Users should install an updated NVIDIA display driver to allow the application to run.

#### **cudaErrorSetOnActiveProcess = 36**

This indicates that the user has called `cudaSetValidDevices()`, `cudaSetDeviceFlags()`, `cudaD3D9SetDirect3DDevice()`, `cudaD3D10SetDirect3DDevice()`, `cudaD3D11SetDirect3DDevice()`, or `cudaVDPAUSetVDPAUDevice()` after initializing the CUDA runtime by calling non-device management operations (allocating memory and launching kernels are examples of non-device management operations). This error can also be returned if using runtime/driver interoperability and there is an existing CUcontext active on the host thread.

#### **cudaErrorInvalidSurface = 37**

This indicates that the surface passed to the API call is not a valid surface.

#### **cudaErrorNoDevice = 38**

This indicates that no CUDA-capable devices were detected by the installed CUDA driver.

#### **cudaErrorECCUncorrectable = 39**

This indicates that an uncorrectable ECC error was detected during execution.

#### **cudaErrorSharedObjectSymbolNotFound = 40**

This indicates that a link to a shared object failed to resolve.

#### **cudaErrorSharedObjectInitFailed = 41**

This indicates that initialization of a shared object failed.

#### **cudaErrorUnsupportedLimit = 42**

This indicates that the `cudaLimit` passed to the API call is not supported by the active device.



**cudaErrorDuplicateVariableName = 43**

This indicates that multiple global or constant variables (across separate CUDA source files in the application) share the same string name.

**cudaErrorDuplicateTextureName = 44**

This indicates that multiple textures (across separate CUDA source files in the application) share the same string name.

**cudaErrorDuplicateSurfaceName = 45**

This indicates that multiple surfaces (across separate CUDA source files in the application) share the same string name.

**cudaErrorDevicesUnavailable = 46**

This indicates that all CUDA devices are busy or unavailable at the current time. Devices are often busy/unavailable due to use of [cudaComputeModeExclusive](#), [cudaComputeModeProhibited](#) or when long running CUDA kernels have filled up the GPU and are blocking new work from starting. They can also be unavailable due to memory constraints on a device that already has active CUDA work being performed.

**cudaErrorInvalidKernelImage = 47**

This indicates that the device kernel image is invalid.

**cudaErrorNoKernelImageForDevice = 48**

This indicates that there is no kernel image available that is suitable for the device. This can occur when a user specifies code generation options for a particular CUDA source file that do not include the corresponding device configuration.

**cudaErrorIncompatibleDriverContext = 49**

This indicates that the current context is not compatible with this the CUDA Runtime. This can only occur if you are using CUDA Runtime/Driver interoperability and have created an existing Driver context using the driver API. The Driver context may be incompatible either because the Driver context was created using an older version of the API, because the Runtime API call expects a primary driver context and the Driver context is not primary, or because the Driver context has been destroyed. Please see [Interactions](#) with the CUDA Driver API" for more information.

**cudaErrorPeerAccessAlreadyEnabled = 50**

This error indicates that a call to [cudaDeviceEnablePeerAccess\(\)](#) is trying to re-enable peer addressing on from a context which has already had peer addressing enabled.

**cudaErrorPeerAccessNotEnabled = 51**

This error indicates that [cudaDeviceDisablePeerAccess\(\)](#) is trying to disable peer addressing which has not been enabled yet via [cudaDeviceEnablePeerAccess\(\)](#).

**cudaErrorDeviceAlreadyInUse = 54**

This indicates that a call tried to access an exclusive-thread device that is already in use by a different thread.

**cudaErrorProfilerDisabled = 55**

This indicates profiler is not initialized for this run. This can happen when the application is running with external profiling tools like visual profiler.

**cudaErrorProfilerNotInitialized = 56**

**Deprecated** This error return is deprecated as of CUDA 5.0. It is no longer an error to attempt to enable/disable the profiling via `cudaProfilerStart` or `cudaProfilerStop` without initialization.

**cudaErrorProfilerAlreadyStarted = 57**

**Deprecated** This error return is deprecated as of CUDA 5.0. It is no longer an error to call `cudaProfilerStart()` when profiling is already enabled.

**cudaErrorProfilerAlreadyStopped = 58**

**Deprecated** This error return is deprecated as of CUDA 5.0. It is no longer an error to call `cudaProfilerStop()` when profiling is already disabled.

**cudaErrorAssert = 59**

An assert triggered in device code during kernel execution. The device cannot be used again until `cudaThreadExit()` is called. All existing allocations are invalid and must be reconstructed if the program is to continue using CUDA.

**cudaErrorTooManyPeers = 60**

This error indicates that the hardware resources required to enable peer access have been exhausted for one or more of the devices passed to `cudaEnablePeerAccess()`.

**cudaErrorHostMemoryAlreadyRegistered = 61**

This error indicates that the memory range passed to `cudaHostRegister()` has already been registered.

**cudaErrorHostMemoryNotRegistered = 62**

This error indicates that the pointer passed to `cudaHostUnregister()` does not correspond to any currently registered memory region.

**cudaErrorOperatingSystem = 63**

This error indicates that an OS call failed.

**cudaErrorPeerAccessUnsupported = 64**

This error indicates that P2P access is not supported across the given devices.

**cudaErrorLaunchMaxDepthExceeded = 65**

This error indicates that a device runtime grid launch did not occur because the depth of the child grid would exceed the maximum supported number of nested grid launches.

**cudaErrorLaunchFileScopedTex = 66**

This error indicates that a grid launch did not occur because the kernel uses file-scoped textures which are unsupported by the device runtime. Kernels launched via the device runtime only support textures created with the Texture Object API's.

**cudaErrorLaunchFileScopedSurf = 67**

This error indicates that a grid launch did not occur because the kernel uses file-scoped surfaces which are unsupported by the device runtime. Kernels launched via the device runtime only support surfaces created with the Surface Object API's.

**cudaErrorSyncDepthExceeded = 68**

This error indicates that a call to `cudaDeviceSynchronize` made from the device runtime failed because the call was made at grid depth greater than either the default (2 levels of grids) or user specified device limit `cudaLimitDevRuntimeSyncDepth`. To be able to synchronize on

launched grids at a greater depth successfully, the maximum nested depth at which `cudaDeviceSynchronize` will be called must be specified with the `cudaLimitDevRuntimeSyncDepth` limit to the `cudaDeviceSetLimit` api before the host-side launch of a kernel using the device runtime. Keep in mind that additional levels of sync depth require the runtime to reserve large amounts of device memory that cannot be used for user allocations.

#### **cudaErrorLaunchPendingCountExceeded = 69**

This error indicates that a device runtime grid launch failed because the launch would exceed the limit `cudaLimitDevRuntimePendingLaunchCount`. For this launch to proceed successfully, `cudaDeviceSetLimit` must be called to set the `cudaLimitDevRuntimePendingLaunchCount` to be higher than the upper bound of outstanding launches that can be issued to the device runtime. Keep in mind that raising the limit of pending device runtime launches will require the runtime to reserve device memory that cannot be used for user allocations.

#### **cudaErrorNotPermitted = 70**

This error indicates the attempted operation is not permitted.

#### **cudaErrorNotSupported = 71**

This error indicates the attempted operation is not supported on the current system or device.

#### **cudaErrorStartupFailure = 0x7f**

This indicates an internal startup failure in the CUDA runtime.

#### **cudaErrorApiFailureBase = 10000**

Any unhandled CUDA driver error is added to this value and returned via the runtime. Production releases of CUDA should not return such errors. **Deprecated**  
This error return is deprecated as of CUDA 4.1.

## enum cudaFuncCache

CUDA function cache configurations

### Values

#### **cudaFuncCachePreferNone = 0**

Default function cache configuration, no preference

#### **cudaFuncCachePreferShared = 1**

Prefer larger shared memory and smaller L1 cache

#### **cudaFuncCachePreferL1 = 2**

Prefer larger L1 cache and smaller shared memory

#### **cudaFuncCachePreferEqual = 3**

Prefer equal size L1 cache and shared memory

## enum cudaGraphicsCubeFace

CUDA graphics interop array indices for cube maps

**Values****cudaGraphicsCubeFacePositiveX = 0x00**

Positive X face of cubemap

**cudaGraphicsCubeFaceNegativeX = 0x01**

Negative X face of cubemap

**cudaGraphicsCubeFacePositiveY = 0x02**

Positive Y face of cubemap

**cudaGraphicsCubeFaceNegativeY = 0x03**

Negative Y face of cubemap

**cudaGraphicsCubeFacePositiveZ = 0x04**

Positive Z face of cubemap

**cudaGraphicsCubeFaceNegativeZ = 0x05**

Negative Z face of cubemap

## enum cudaGraphicsMapFlags

CUDA graphics interop map flags

**Values****cudaGraphicsMapFlagsNone = 0**

Default; Assume resource can be read/written

**cudaGraphicsMapFlagsReadOnly = 1**

CUDA will not write to this resource

**cudaGraphicsMapFlagsWriteDiscard = 2**

CUDA will only write to and will not read from this resource

## enum cudaGraphicsRegisterFlags

CUDA graphics interop register flags

**Values****cudaGraphicsRegisterFlagsNone = 0**

Default

**cudaGraphicsRegisterFlagsReadOnly = 1**

CUDA will not write to this resource

**cudaGraphicsRegisterFlagsWriteDiscard = 2**

CUDA will only write to and will not read from this resource

**cudaGraphicsRegisterFlagsSurfaceLoadStore = 4**

CUDA will bind this resource to a surface reference

**cudaGraphicsRegisterFlagsTextureGather = 8**

CUDA will perform texture gather operations on this resource

## enum cudaLimit

CUDA Limits

### Values

**cudaLimitStackSize = 0x00**

GPU thread stack size

**cudaLimitPrintfFifoSize = 0x01**

GPU printf/fprintf FIFO size

**cudaLimitMallocHeapSize = 0x02**

GPU malloc heap size

**cudaLimitDevRuntimeSyncDepth = 0x03**

GPU device runtime synchronize depth

**cudaLimitDevRuntimePendingLaunchCount = 0x04**

GPU device runtime pending launch count

## enum cudaMemcpyKind

CUDA memory copy types

### Values

**cudaMemcpyHostToHost = 0**

Host -> Host

**cudaMemcpyHostToDevice = 1**

Host -> Device

**cudaMemcpyDeviceToHost = 2**

Device -> Host

**cudaMemcpyDeviceToDevice = 3**

Device -> Device

**cudaMemcpyDefault = 4**

Default based unified virtual address space

## enum cudaMemoryType

CUDA memory types

### Values

**cudaMemoryTypeHost = 1**

Host memory

**cudaMemoryTypeDevice = 2**

Device memory

## enum cudaOutputMode

CUDA Profiler Output modes

### Values

**cudaKeyValuePair = 0x00**

Output mode Key-Value pair format.

**cudaCSV = 0x01**

Output mode Comma separated values format.

## enum cudaResourceType

CUDA resource types

### Values

**cudaResourceTypeArray = 0x00**

Array resource

**cudaResourceTypeMipmappedArray = 0x01**

Mipmapped array resource

**cudaResourceTypeLinear = 0x02**

Linear resource

**cudaResourceTypePitch2D = 0x03**

Pitch 2D resource

## enum cudaResourceViewFormat

CUDA texture resource view formats

### Values

**cudaResViewFormatNone = 0x00**

No resource view format (use underlying resource format)

**cudaResViewFormatUnsignedChar1 = 0x01**

1 channel unsigned 8-bit integers

**cudaResViewFormatUnsignedChar2 = 0x02**

2 channel unsigned 8-bit integers

**cudaResViewFormatUnsignedChar4 = 0x03**

4 channel unsigned 8-bit integers

**cudaResViewFormatSignedChar1 = 0x04**

1 channel signed 8-bit integers

**cudaResViewFormatSignedChar2 = 0x05**

2 channel signed 8-bit integers

**cudaResViewFormatSignedChar4 = 0x06**

4 channel signed 8-bit integers  
**cudaResViewFormatUnsignedShort1 = 0x07**  
 1 channel unsigned 16-bit integers  
**cudaResViewFormatUnsignedShort2 = 0x08**  
 2 channel unsigned 16-bit integers  
**cudaResViewFormatUnsignedShort4 = 0x09**  
 4 channel unsigned 16-bit integers  
**cudaResViewFormatSignedShort1 = 0x0a**  
 1 channel signed 16-bit integers  
**cudaResViewFormatSignedShort2 = 0x0b**  
 2 channel signed 16-bit integers  
**cudaResViewFormatSignedShort4 = 0x0c**  
 4 channel signed 16-bit integers  
**cudaResViewFormatUnsignedInt1 = 0x0d**  
 1 channel unsigned 32-bit integers  
**cudaResViewFormatUnsignedInt2 = 0x0e**  
 2 channel unsigned 32-bit integers  
**cudaResViewFormatUnsignedInt4 = 0x0f**  
 4 channel unsigned 32-bit integers  
**cudaResViewFormatSignedInt1 = 0x10**  
 1 channel signed 32-bit integers  
**cudaResViewFormatSignedInt2 = 0x11**  
 2 channel signed 32-bit integers  
**cudaResViewFormatSignedInt4 = 0x12**  
 4 channel signed 32-bit integers  
**cudaResViewFormatHalf1 = 0x13**  
 1 channel 16-bit floating point  
**cudaResViewFormatHalf2 = 0x14**  
 2 channel 16-bit floating point  
**cudaResViewFormatHalf4 = 0x15**  
 4 channel 16-bit floating point  
**cudaResViewFormatFloat1 = 0x16**  
 1 channel 32-bit floating point  
**cudaResViewFormatFloat2 = 0x17**  
 2 channel 32-bit floating point  
**cudaResViewFormatFloat4 = 0x18**  
 4 channel 32-bit floating point  
**cudaResViewFormatUnsignedBlockCompressed1 = 0x19**  
 Block compressed 1  
**cudaResViewFormatUnsignedBlockCompressed2 = 0x1a**  
 Block compressed 2  
**cudaResViewFormatUnsignedBlockCompressed3 = 0x1b**  
 Block compressed 3

**cudaResViewFormatUnsignedBlockCompressed4 = 0x1c**

Block compressed 4 unsigned

**cudaResViewFormatSignedBlockCompressed4 = 0x1d**

Block compressed 4 signed

**cudaResViewFormatUnsignedBlockCompressed5 = 0x1e**

Block compressed 5 unsigned

**cudaResViewFormatSignedBlockCompressed5 = 0x1f**

Block compressed 5 signed

**cudaResViewFormatUnsignedBlockCompressed6H = 0x20**

Block compressed 6 unsigned half-float

**cudaResViewFormatSignedBlockCompressed6H = 0x21**

Block compressed 6 signed half-float

**cudaResViewFormatUnsignedBlockCompressed7 = 0x22**

Block compressed 7

## enum cudaSharedMemConfig

CUDA shared memory configuration

### Values

**cudaSharedMemBankSizeDefault = 0**

**cudaSharedMemBankSizeFourByte = 1**

**cudaSharedMemBankSizeEightByte = 2**

## enum cudaSurfaceBoundaryMode

CUDA Surface boundary modes

### Values

**cudaBoundaryModeZero = 0**

Zero boundary mode

**cudaBoundaryModeClamp = 1**

Clamp boundary mode

**cudaBoundaryModeTrap = 2**

Trap boundary mode

## enum cudaSurfaceFormatMode

CUDA Surface format modes

### Values

**cudaFormatModeForced = 0**

Forced format mode



**cudaFormatModeAuto = 1**

Auto format mode

## enum cudaTextureAddressMode

CUDA texture address modes

### Values

**cudaAddressModeWrap = 0**

Wrapping address mode

**cudaAddressModeClamp = 1**

Clamp to edge address mode

**cudaAddressModeMirror = 2**

Mirror address mode

**cudaAddressModeBorder = 3**

Border address mode

## enum cudaTextureFilterMode

CUDA texture filter modes

### Values

**cudaFilterModePoint = 0**

Point filter mode

**cudaFilterModeLinear = 1**

Linear filter mode

## enum cudaTextureReadMode

CUDA texture read modes

### Values

**cudaReadModeElementType = 0**

Read texture as specified element type

**cudaReadModeNormalizedFloat = 1**

Read texture as normalized float

## typedef cudaArray \*cudaArray\_const\_t

CUDA array (as source copy argument)

```
typedef cudaArray *cudaArray_t
```

CUDA array

```
typedef cudaError_t
```

CUDA Error types

```
typedef struct CUevent_st *cudaEvent_t
```

CUDA event types

```
typedef cudaGraphicsResource *cudaGraphicsResource_t
```

CUDA graphics resource types

```
typedef cudaMipmappedArray  
*cudaMipmappedArray_const_t
```

CUDA mipmapped array (as source argument)

```
typedef cudaMipmappedArray *cudaMipmappedArray_t
```

CUDA mipmapped array

```
typedef cudaOutputMode_t
```

CUDA output file modes

```
typedef struct CUstream_st *cudaStream_t
```

CUDA stream

```
typedef unsigned long long cudaSurfaceObject_t
```

CUDA Surface object

```
typedef unsigned long long cudaTextureObject_t
```

CUDA texture object

```
typedef struct CUuuid_st cudaUUID_t
```

CUDA UUID types

## **#define CUDA\_IPC\_HANDLE\_SIZE 64**

CUDA IPC Handle Size

## **#define cudaArrayCubemap 0x04**

Must be set in cudaMalloc3DArray to create a cubemap CUDA array

## **#define cudaArrayDefault 0x00**

Default CUDA array allocation flag

## **#define cudaArrayLayered 0x01**

Must be set in cudaMalloc3DArray to create a layered CUDA array

## **#define cudaArraySurfaceLoadStore 0x02**

Must be set in cudaMallocArray or cudaMalloc3DArray in order to bind surfaces to the CUDA array

## **#define cudaArrayTextureGather 0x08**

Must be set in cudaMallocArray or cudaMalloc3DArray in order to perform texture gather operations on the CUDA array

## **#define cudaDeviceBlockingSync 0x04**

**Deprecated** This flag was deprecated as of CUDA 4.0 and replaced with `cudaDeviceScheduleBlockingSync`.

Device flag - Use blocking synchronization

## **#define cudaDeviceLmemResizeToMax 0x10**

Device flag - Keep local memory allocation after launch

## **#define cudaDeviceMapHost 0x08**

Device flag - Support mapped pinned allocations

## **#define cudaDeviceMask 0x1f**

Device flags mask

## **#define cudaDevicePropDontCare**

Empty device properties

## **#define cudaDeviceScheduleAuto 0x00**

Device flag - Automatic scheduling

## **#define cudaDeviceScheduleBlockingSync 0x04**

Device flag - Use blocking synchronization

## **#define cudaDeviceScheduleMask 0x07**

Device schedule flags mask

## **#define cudaDeviceScheduleSpin 0x01**

Device flag - Spin default scheduling

## **#define cudaDeviceScheduleYield 0x02**

Device flag - Yield default scheduling

## **#define cudaEventBlockingSync 0x01**

Event uses blocking synchronization

## **#define cudaEventDefault 0x00**

Default event flag

## **#define cudaEventDisableTiming 0x02**

Event will not record timing data

## **#define cudaEventInterprocess 0x04**

Event is suitable for interprocess use. cudaEventDisableTiming must be set

## **#define cudaHostAllocDefault 0x00**

Default page-locked allocation flag

**#define cudaHostAllocMapped 0x02**

Map allocation into device space

**#define cudaHostAllocPortable 0x01**

Pinned memory accessible by all CUDA contexts

**#define cudaHostAllocWriteCombined 0x04**

Write-combined memory

**#define cudaHostRegisterDefault 0x00**

Default host memory registration flag

**#define cudaHostRegisterMapped 0x02**

Map registered memory into device space

**#define cudaHostRegisterPortable 0x01**

Pinned memory accessible by all CUDA contexts

**#define cudalpcMemLazyEnablePeerAccess 0x01**

Automatically enable peer access between remote devices as needed

**#define cudaPeerAccessDefault 0x00**

Default peer addressing enable flag

**#define cudaStreamDefault 0x00**

Default stream flag

**#define cudaStreamNonBlocking 0x01**

Stream does not synchronize with stream 0 (the NULL stream)

# Chapter 3.

## DATA STRUCTURES

Here are the data structures with brief descriptions:

- `cudaChannelFormatDesc`
- `cudaDeviceProp`
- `cudaExtent`
- `cudaFuncAttributes`
- `cudaIpcEventHandle_t`
- `cudaIpcMemHandle_t`
- `cudaMemcpy3DParms`
- `cudaMemcpy3DPeerParms`
- `cudaPitchedPtr`
- `cudaPointerAttributes`
- `cudaPos`
- `cudaResourceDesc`
- `cudaResourceViewDesc`
- `cudaTextureDesc`
- `surfaceReference`
- `textureReference`

### 3.1. `cudaChannelFormatDesc` Struct Reference

CUDA Channel format descriptor

`enum cudaChannelFormatKind`  
`cudaChannelFormatDesc::f`

#### Description

Channel format kind

## int cudaChannelFormatDesc::w

### Description

w

## int cudaChannelFormatDesc::x

### Description

x

## int cudaChannelFormatDesc::y

### Description

y

## int cudaChannelFormatDesc::z

### Description

z

## 3.2. cudaDeviceProp Struct Reference

CUDA device properties

## int cudaDeviceProp::asyncEngineCount

### Description

Number of asynchronous engines

## int cudaDeviceProp::canMapHostMemory

### Description

Device can map host memory with cudaHostAlloc/cudaHostGetDevicePointer

## `int cudaDeviceProp::clockRate`

### **Description**

Clock frequency in kilohertz

## `int cudaDeviceProp::computeMode`

### **Description**

Compute mode (See `cudaComputeMode`)

## `int cudaDeviceProp::concurrentKernels`

### **Description**

Device can possibly execute multiple kernels concurrently

## `int cudaDeviceProp::deviceOverlap`

### **Description**

Device can concurrently copy memory and execute a kernel. Deprecated. Use instead `asyncEngineCount`.

## `int cudaDeviceProp::ECCEnabled`

### **Description**

Device has ECC support enabled

## `int cudaDeviceProp::integrated`

### **Description**

Device is integrated as opposed to discrete

## `int cudaDeviceProp::kernelExecTimeoutEnabled`

### **Description**

Specified whether there is a run time limit on kernels



## `int cudaDeviceProp::l2CacheSize`

### **Description**

Size of L2 cache in bytes

## `int cudaDeviceProp::major`

### **Description**

Major compute capability

## `int cudaDeviceProp::maxGridSize`

### **Description**

Maximum size of each dimension of a grid

## `int cudaDeviceProp::maxSurface1D`

### **Description**

Maximum 1D surface size

## `int cudaDeviceProp::maxSurface1DLayered`

### **Description**

Maximum 1D layered surface dimensions

## `int cudaDeviceProp::maxSurface2D`

### **Description**

Maximum 2D surface dimensions

## `int cudaDeviceProp::maxSurface2DLayered`

### **Description**

Maximum 2D layered surface dimensions

## `int cudaDeviceProp::maxSurface3D`

### **Description**

Maximum 3D surface dimensions

## `int cudaDeviceProp::maxSurfaceCubemap`

### **Description**

Maximum Cubemap surface dimensions

## `int cudaDeviceProp::maxSurfaceCubemapLayered`

### **Description**

Maximum Cubemap layered surface dimensions

## `int cudaDeviceProp::maxTexture1D`

### **Description**

Maximum 1D texture size

## `int cudaDeviceProp::maxTexture1DLayered`

### **Description**

Maximum 1D layered texture dimensions

## `int cudaDeviceProp::maxTexture1DLinear`

### **Description**

Maximum size for 1D textures bound to linear memory

## `int cudaDeviceProp::maxTexture1DMipmap`

### **Description**

Maximum 1D mipmapped texture size

## `int cudaDeviceProp::maxTexture2D`

### **Description**

Maximum 2D texture dimensions

## `int cudaDeviceProp::maxTexture2DGather`

### **Description**

Maximum 2D texture dimensions if texture gather operations have to be performed

## `int cudaDeviceProp::maxTexture2DLayered`

### **Description**

Maximum 2D layered texture dimensions

## `int cudaDeviceProp::maxTexture2DLinear`

### **Description**

Maximum dimensions (width, height, pitch) for 2D textures bound to pitched memory

## `int cudaDeviceProp::maxTexture2DMipmap`

### **Description**

Maximum 2D mipmapped texture dimensions

## `int cudaDeviceProp::maxTexture3D`

### **Description**

Maximum 3D texture dimensions

## `int cudaDeviceProp::maxTexture3DAlt`

### **Description**

Maximum alternate 3D texture dimensions

## `int cudaDeviceProp::maxTextureCubemap`

### **Description**

Maximum Cubemap texture dimensions

## `int cudaDeviceProp::maxTextureCubemapLayered`

### **Description**

Maximum Cubemap layered texture dimensions

## `int cudaDeviceProp::maxThreadsDim`

### **Description**

Maximum size of each dimension of a block

## `int cudaDeviceProp::maxThreadsPerBlock`

### **Description**

Maximum number of threads per block

## `int cudaDeviceProp::maxThreadsPerMultiProcessor`

### **Description**

Maximum resident threads per multiprocessor

## `int cudaDeviceProp::memoryBusWidth`

### **Description**

Global memory bus width in bits

## `int cudaDeviceProp::memoryClockRate`

### **Description**

Peak memory clock frequency in kilohertz

## `size_t cudaDeviceProp::memPitch`

### **Description**

Maximum pitch in bytes allowed by memory copies

## `int cudaDeviceProp::minor`

### **Description**

Minor compute capability

## `int cudaDeviceProp::multiProcessorCount`

### **Description**

Number of multiprocessors on device

## `char cudaDeviceProp::name`

### **Description**

ASCII string identifying device

## `int cudaDeviceProp::pciBusID`

### **Description**

PCI bus ID of the device

## `int cudaDeviceProp::pciDeviceID`

### **Description**

PCI device ID of the device

## `int cudaDeviceProp::pciDomainID`

### **Description**

PCI domain ID of the device

## `int cudaDeviceProp::regsPerBlock`

### **Description**

32-bit registers available per block

## `size_t cudaDeviceProp::sharedMemPerBlock`

### **Description**

Shared memory available per block in bytes

## `int cudaDeviceProp::streamPrioritiesSupported`

### **Description**

Device supports stream priorities

## `size_t cudaDeviceProp::surfaceAlignment`

### **Description**

Alignment requirements for surfaces

## `int cudaDeviceProp::tccDriver`

### **Description**

1 if device is a Tesla device using TCC driver, 0 otherwise

## `size_t cudaDeviceProp::textureAlignment`

### **Description**

Alignment requirement for textures

## `size_t cudaDeviceProp::texturePitchAlignment`

### **Description**

Pitch alignment requirement for texture references bound to pitched memory

## `size_t cudaDeviceProp::totalConstMem`

### Description

Constant memory available on device in bytes

## `size_t cudaDeviceProp::totalGlobalMem`

### Description

Global memory available on device in bytes

## `int cudaDeviceProp::unifiedAddressing`

### Description

Device shares a unified address space with the host

## `int cudaDeviceProp::warpSize`

### Description

Warp size in threads

## 3.3. cudaExtent Struct Reference

CUDA extent

**See also:**

[`make\_cudaExtent`](#)

## `size_t cudaExtent::depth`

### Description

Depth in elements

## `size_t cudaExtent::height`

### Description

Height in elements

## `size_t cudaExtent::width`

### Description

Width in elements when referring to array memory, in bytes when referring to linear memory

## 3.4. `cudaFuncAttributes` Struct Reference

CUDA function attributes

## `int cudaFuncAttributes::binaryVersion`

### Description

The binary architecture version for which the function was compiled. This value is the major binary version \* 10 + the minor binary version, so a binary version 1.3 function would return the value 13.

## `size_t cudaFuncAttributes::constSizeBytes`

### Description

The size in bytes of user-allocated constant memory required by this function.

## `size_t cudaFuncAttributes::localSizeBytes`

### Description

The size in bytes of local memory used by each thread of this function.

## `int cudaFuncAttributes::maxThreadsPerBlock`

### Description

The maximum number of threads per block, beyond which a launch of the function would fail. This number depends on both the function and the device on which the function is currently loaded.



## `int cudaFuncAttributes::numRegs`

### Description

The number of registers used by each thread of this function.

## `int cudaFuncAttributes::ptxVersion`

### Description

The PTX virtual architecture version for which the function was compiled. This value is the major PTX version \* 10 + the minor PTX version, so a PTX version 1.3 function would return the value 13.

## `size_t cudaFuncAttributes::sharedSizeBytes`

### Description

The size in bytes of statically-allocated shared memory per block required by this function. This does not include dynamically-allocated shared memory requested by the user at runtime.

## 3.5. `cudaIpcEventHandle_t` Struct Reference

CUDA IPC event handle

## 3.6. `cudaIpcMemHandle_t` Struct Reference

CUDA IPC memory handle

## 3.7. `cudaMemcpy3DParms` Struct Reference

CUDA 3D memory copying parameters

## `cudaArray_t cudaMemcpy3DParms::dstArray`

### Description

Destination memory address

**struct cudaPos cudaMemcpy3DParms::dstPos**

**Description**

Destination position offset

**struct cudaPitchedPtr cudaMemcpy3DParms::dstPtr**

**Description**

Pitched destination memory address

**struct cudaExtent cudaMemcpy3DParms::extent**

**Description**

Requested memory copy size

**enum cudaMemcpyKind cudaMemcpy3DParms::kind**

**Description**

Type of transfer

**cudaArray\_t cudaMemcpy3DParms::srcArray**

**Description**

Source memory address

**struct cudaPos cudaMemcpy3DParms::srcPos**

**Description**

Source position offset

**struct cudaPitchedPtr cudaMemcpy3DParms::srcPtr**

**Description**

Pitched source memory address

## 3.8. cudaMemcpy3DPeerParms Struct Reference

CUDA 3D cross-device memory copying parameters

`cudaArray_t cudaMemcpy3DPeerParms::dstArray`

### Description

Destination memory address

`int cudaMemcpy3DPeerParms::dstDevice`

### Description

Destination device

`struct cudaPos cudaMemcpy3DPeerParms::dstPos`

### Description

Destination position offset

`struct cudaPitchedPtr cudaMemcpy3DPeerParms::dstPtr`

### Description

Pitched destination memory address

`struct cudaExtent cudaMemcpy3DPeerParms::extent`

### Description

Requested memory copy size

`cudaArray_t cudaMemcpy3DPeerParms::srcArray`

### Description

Source memory address

## int cudaMemcpy3DPeerParms::srcDevice

### Description

Source device

## struct cudaPos cudaMemcpy3DPeerParms::srcPos

### Description

Source position offset

## struct cudaPitchedPtr cudaMemcpy3DPeerParms::srcPtr

### Description

Pitched source memory address

## 3.9. cudaPitchedPtr Struct Reference

CUDA Pitched memory pointer

### See also:

[make\\_cudaPitchedPtr](#)

## size\_t cudaPitchedPtr::pitch

### Description

Pitch of allocated memory in bytes

## void \*cudaPitchedPtr::ptr

### Description

Pointer to allocated memory

## size\_t cudaPitchedPtr::xsize

### Description

Logical width of allocation in elements

## size\_t cudaPitchedPtr::ysize

### Description

Logical height of allocation in elements

## 3.10. cudaPointerAttributes Struct Reference

CUDA pointer attributes

### int cudaPointerAttributes::device

#### Description

The device against which the memory was allocated or registered. If the memory type is `cudaMemoryTypeDevice` then this identifies the device on which the memory referred physically resides. If the memory type is `cudaMemoryTypeHost` then this identifies the device which was current when the memory was allocated or registered (and if that device is deinitialized then this allocation will vanish with that device's state).

### void \*cudaPointerAttributes::devicePointer

#### Description

The address which may be dereferenced on the current device to access the memory or NULL if no such address exists.

### void \*cudaPointerAttributes::hostPointer

#### Description

The address which may be dereferenced on the host to access the memory or NULL if no such address exists.

## enum cudaMemoryType cudaPointerAttributes::memoryType

#### Description

The physical location of the memory, `cudaMemoryTypeHost` or `cudaMemoryTypeDevice`.

## 3.11. cudaPos Struct Reference

CUDA 3D position

**See also:**

[make\\_cudaPos](#)

`size_t cudaPos::x`

**Description**

x

`size_t cudaPos::y`

**Description**

y

`size_t cudaPos::z`

**Description**

z

## 3.12. cudaResourceDesc Struct Reference

CUDA resource descriptor

`cudaArray_t cudaResourceDesc::array`

**Description**

CUDA array

`struct cudaChannelFormatDesc cudaResourceDesc::desc`

**Description**

Channel descriptor

`void *cudaResourceDesc::devPtr`

**Description**

Device pointer

`size_t cudaResourceDesc::height`

**Description**

Height of the array in elements

`cudaMipmappedArray_t cudaResourceDesc::mipmap`

**Description**

CUDA mipmapped array

`size_t cudaResourceDesc::pitchInBytes`

**Description**

Pitch between two rows in bytes

`enumcudaResourceType cudaResourceDesc::resType`

**Description**

Resource type

`size_t cudaResourceDesc::sizeInBytes`

**Description**

Size in bytes

`size_t cudaResourceDesc::width`

**Description**

Width of the array in elements

## 3.13. cudaResourceViewDesc Struct Reference

CUDA resource view descriptor

`size_t cudaResourceViewDesc::depth`

### Description

Depth of the resource view

`unsigned int cudaResourceViewDesc::firstLayer`

### Description

First layer index

`unsigned int cudaResourceViewDesc::firstMipmapLevel`

### Description

First defined mipmap level

`enum cudaResourceViewFormat  
cudaResourceViewDesc::format`

### Description

Resource view format

`size_t cudaResourceViewDesc::height`

### Description

Height of the resource view

`unsigned int cudaResourceViewDesc::lastLayer`

### Description

Last layer index



## unsigned int cudaResourceViewDesc::lastMipmapLevel

### Description

Last defined mipmap level

## size\_t cudaResourceViewDesc::width

### Description

Width of the resource view

## 3.14. cudaTextureDesc Struct Reference

CUDA texture descriptor

## enum cudaTextureAddressMode cudaTextureDesc::addressMode

### Description

Texture address mode for up to 3 dimensions

## enum cudaTextureFilterMode cudaTextureDesc::filterMode

### Description

Texture filter mode

## unsigned int cudaTextureDesc::maxAnisotropy

### Description

Limit to the anisotropy ratio

## float cudaTextureDesc::maxMipmapLevelClamp

### Description

Upper end of the mipmap level range to clamp access to

## float cudaTextureDesc::minMipmapLevelClamp

### Description

Lower end of the mipmap level range to clamp access to

## enum cudaTextureFilterMode cudaTextureDesc::mipmapFilterMode

### Description

Mipmap filter mode

## float cudaTextureDesc::mipmapLevelBias

### Description

Offset applied to the supplied mipmap level

## int cudaTextureDesc::normalizedCoords

### Description

Indicates whether texture reads are normalized or not

## enum cudaTextureReadMode cudaTextureDesc::readMode

### Description

Texture read mode

## int cudaTextureDesc::sRGB

### Description

Perform sRGB->linear conversion during texture read

## 3.15. surfaceReference Struct Reference

CUDA Surface reference

```
struct cudaChannelFormatDesc  
surfaceReference::channelDesc
```

**Description**

Channel descriptor for surface reference

## 3.16. textureReference Struct Reference

CUDA texture reference

```
enum cudaTextureAddressMode  
textureReference::addressMode
```

**Description**

Texture address mode for up to 3 dimensions

```
struct cudaChannelFormatDesc  
textureReference::channelDesc
```

**Description**

Channel descriptor for the texture reference

```
enum cudaTextureFilterMode  
textureReference::filterMode
```

**Description**

Texture filter mode

```
unsigned int textureReference::maxAnisotropy
```

**Description**

Limit to the anisotropy ratio

## `float textureReference::maxMipmapLevelClamp`

### **Description**

Upper end of the mipmap level range to clamp access to

## `float textureReference::minMipmapLevelClamp`

### **Description**

Lower end of the mipmap level range to clamp access to

## `enum cudaTextureFilterMode textureReference::mipmapFilterMode`

### **Description**

Mipmap filter mode

## `float textureReference::mipmapLevelBias`

### **Description**

Offset applied to the supplied mipmap level

## `int textureReference::normalized`

### **Description**

Indicates whether texture reads are normalized or not

## `int textureReference::sRGB`

### **Description**

Perform sRGB->linear conversion during texture read

## Chapter 4. DATA FIELDS

Here is a list of all documented struct and union fields with links to the struct/union documentation for each field:

### A

#### **addressMode**

- [textureReference](#)
- [cudaTextureDesc](#)

#### **array**

- [cudaResourceDesc](#)

#### **asyncEngineCount**

- [cudaDeviceProp](#)

### B

#### **binaryVersion**

- [cudaFuncAttributes](#)

### C

#### **canMapHostMemory**

- [cudaDeviceProp](#)

#### **channelDesc**

- [surfaceReference](#)
- [textureReference](#)

#### **clockRate**

- [cudaDeviceProp](#)

#### **computeMode**

- [cudaDeviceProp](#)

#### **concurrentKernels**

- [cudaDeviceProp](#)

#### **constSizeBytes**

- [cudaFuncAttributes](#)

**D****depth**

cudaExtent  
 cudaResourceViewDesc

**desc**

cudaResourceDesc

**device**

cudaPointerAttributes

**deviceOverlap**

cudaDeviceProp

**devicePointer**

cudaPointerAttributes

**devPtr**

cudaResourceDesc

**dstArray**

cudaMemcpy3DParms  
 cudaMemcpy3DPeerParms

**dstDevice**

cudaMemcpy3DPeerParms

**dstPos**

cudaMemcpy3DPeerParms  
 cudaMemcpy3DParms

**dstPtr**

cudaMemcpy3DPeerParms  
 cudaMemcpy3DParms

**E****ECCEnabled**

cudaDeviceProp

**extent**

cudaMemcpy3DPeerParms  
 cudaMemcpy3DParms

**F****f**

cudaChannelFormatDesc

**filterMode**

textureReference  
 cudaTextureDesc

**firstLayer**

cudaResourceViewDesc

**firstMipmapLevel**

cudaResourceViewDesc

**format**

[cudaResourceViewDesc](#)

**H****height**

[cudaExtent](#)

[cudaResourceDesc](#)

[cudaResourceViewDesc](#)

**hostPointer**

[cudaPointerAttributes](#)

**I****integrated**

[cudaDeviceProp](#)

**K****kernelExecTimeoutEnabled**

[cudaDeviceProp](#)

**kind**

[cudaMemcpy3DParms](#)

**L****l2CacheSize**

[cudaDeviceProp](#)

**lastLayer**

[cudaResourceViewDesc](#)

**lastMipmapLevel**

[cudaResourceViewDesc](#)

**localSizeBytes**

[cudaFuncAttributes](#)

**M****major**

[cudaDeviceProp](#)

**maxAnisotropy**

[textureReference](#)

[cudaTextureDesc](#)

**maxGridSize**

[cudaDeviceProp](#)

**maxMipmapLevelClamp**

[textureReference](#)

[cudaTextureDesc](#)

**maxSurface1D**  
    cudaDeviceProp

**maxSurface1DLayered**  
    cudaDeviceProp

**maxSurface2D**  
    cudaDeviceProp

**maxSurface2DLayered**  
    cudaDeviceProp

**maxSurface3D**  
    cudaDeviceProp

**maxSurfaceCubemap**  
    cudaDeviceProp

**maxSurfaceCubemapLayered**  
    cudaDeviceProp

**maxTexture1D**  
    cudaDeviceProp

**maxTexture1DLayered**  
    cudaDeviceProp

**maxTexture1DLinear**  
    cudaDeviceProp

**maxTexture1DMipmap**  
    cudaDeviceProp

**maxTexture2D**  
    cudaDeviceProp

**maxTexture2DGather**  
    cudaDeviceProp

**maxTexture2DLayered**  
    cudaDeviceProp

**maxTexture2DLinear**  
    cudaDeviceProp

**maxTexture2DMipmap**  
    cudaDeviceProp

**maxTexture3D**  
    cudaDeviceProp

**maxTexture3DAlt**  
    cudaDeviceProp

**maxTextureCubemap**  
    cudaDeviceProp

**maxTextureCubemapLayered**  
    cudaDeviceProp

**maxThreadsDim**  
    cudaDeviceProp



**maxThreadsPerBlock**  
     [cudaFuncAttributes](#)  
     [cudaDeviceProp](#)  
**maxThreadsPerMultiProcessor**  
     [cudaDeviceProp](#)  
**memoryBusWidth**  
     [cudaDeviceProp](#)  
**memoryClockRate**  
     [cudaDeviceProp](#)  
**memoryType**  
     [cudaPointerAttributes](#)  
**memPitch**  
     [cudaDeviceProp](#)  
**minMipmapLevelClamp**  
     [cudaTextureDesc](#)  
     [textureReference](#)  
**minor**  
     [cudaDeviceProp](#)  
**mipmap**  
     [cudaResourceDesc](#)  
**mipmapFilterMode**  
     [cudaTextureDesc](#)  
     [textureReference](#)  
**mipmapLevelBias**  
     [textureReference](#)  
     [cudaTextureDesc](#)  
**multiProcessorCount**  
     [cudaDeviceProp](#)

**N**  
**name**  
     [cudaDeviceProp](#)  
**normalized**  
     [textureReference](#)  
**normalizedCoords**  
     [cudaTextureDesc](#)  
**numRegs**  
     [cudaFuncAttributes](#)

**P**  
**pciBusID**  
     [cudaDeviceProp](#)

**pciDeviceID**  
     cudaDeviceProp  
**pciDomainID**  
     cudaDeviceProp  
**pitch**  
     cudaPitchedPtr  
**pitchInBytes**  
     cudaResourceDesc  
**ptr**  
     cudaPitchedPtr  
**ptxVersion**  
     cudaFuncAttributes

**R**  
**readMode**  
     cudaTextureDesc  
**regsPerBlock**  
     cudaDeviceProp  
**resType**  
     cudaResourceDesc

**S**  
**sharedMemPerBlock**  
     cudaDeviceProp  
**sharedSizeBytes**  
     cudaFuncAttributes  
**sizeInBytes**  
     cudaResourceDesc  
**srcArray**  
     cudaMemcpy3DParms  
     cudaMemcpy3DPeerParms  
**srcDevice**  
     cudaMemcpy3DPeerParms  
**srcPos**  
     cudaMemcpy3DPeerParms  
     cudaMemcpy3DParms  
**srcPtr**  
     cudaMemcpy3DParms  
     cudaMemcpy3DPeerParms  
**sRGB**  
     textureReference  
     cudaTextureDesc

**streamPrioritiesSupported**

cudaDeviceProp

**surfaceAlignment**

cudaDeviceProp

**T****tccDriver**

cudaDeviceProp

**textureAlignment**

cudaDeviceProp

**texturePitchAlignment**

cudaDeviceProp

**totalConstMem**

cudaDeviceProp

**totalGlobalMem**

cudaDeviceProp

**U****unifiedAddressing**

cudaDeviceProp

**W****w**

cudaChannelFormatDesc

**warpSize**

cudaDeviceProp

**width**

cudaResourceDesc

cudaExtent

cudaResourceViewDesc

**X****x**

cudaChannelFormatDesc

cudaPos

**xsize**

cudaPitchedPtr

**Y****y**

cudaChannelFormatDesc

cudaPos

**ysize**`cudaPitchedPtr`**Z****z**`cudaChannelFormatDesc``cudaPos`

## Chapter 5. DEPRECATED LIST

**Global `cudaThreadExit`**

**Global `cudaThreadGetCacheConfig`**

**Global `cudaThreadGetLimit`**

**Global `cudaThreadSetCacheConfig`**

**Global `cudaThreadSetLimit`**

**Global `cudaThreadSynchronize`**

**Global `cudaGLMapBufferObject`**

This function is deprecated as of CUDA 3.0.

**Global `cudaGLMapBufferObjectAsync`**

This function is deprecated as of CUDA 3.0.

**Global `cudaGLRegisterBufferObject`**

This function is deprecated as of CUDA 3.0.

**Global `cudaGLSetBufferObjectMapFlags`**

This function is deprecated as of CUDA 3.0.

**Global `cudaGLSetGLDevice`**

This function is deprecated as of CUDA 5.0.

**Global `cudaGLUnmapBufferObject`**

This function is deprecated as of CUDA 3.0.

**Global `cudaGLUnmapBufferObjectAsync`**

This function is deprecated as of CUDA 3.0.

**Global `cudaGLUnregisterBufferObject`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9MapResources`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9RegisterResource`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9ResourceGetMappedArray`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9ResourceGetMappedPitch`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9ResourceGetMappedPointer`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9ResourceGetMappedSize`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9ResourceGetSurfaceDimensions`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9ResourceSetMapFlags`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9UnmapResources`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D9UnregisterResource`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10GetDirect3DDevice`**

This function is deprecated as of CUDA 5.0.

**Global `cudaD3D10MapResources`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10RegisterResource`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10ResourceGetMappedArray`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10ResourceGetMappedPitch`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10ResourceGetMappedPointer`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10ResourceGetMappedSize`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10ResourceGetSurfaceDimensions`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10ResourceSetMapFlags`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10SetDirect3DDevice`**

This function is deprecated as of CUDA 5.0.

**Global `cudaD3D10UnmapResources`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D10UnregisterResource`**

This function is deprecated as of CUDA 3.0.

**Global `cudaD3D11GetDirect3DDevice`**

This function is deprecated as of CUDA 5.0.

**Global `cudaD3D11SetDirect3DDevice`**

This function is deprecated as of CUDA 5.0.



**Global `cudaErrorPriorLaunchFailure`**

This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**Global `cudaErrorAddressOfConstant`**

This error return is deprecated as of CUDA 3.1. Variables in constant memory may now have their address taken by the runtime via `cudaGetSymbolAddress()`.

**Global `cudaErrorTextureFetchFailed`**

This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**Global `cudaErrorTextureNotBound`**

This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**Global `cudaErrorSynchronizationError`**

This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**Global `cudaErrorMixedDeviceExecution`**

This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**Global `cudaErrorNotYetImplemented`**

This error return is deprecated as of CUDA 4.1.

**Global `cudaErrorMemoryValueTooLarge`**

This error return is deprecated as of CUDA 3.1. Device emulation mode was removed with the CUDA 3.1 release.

**Global `cudaErrorProfilerNotInitialized`**

This error return is deprecated as of CUDA 5.0. It is no longer an error to attempt to enable/disable the profiling via `cudaProfilerStart` or `cudaProfilerStop` without initialization.

**Global `cudaErrorProfilerAlreadyStarted`**

This error return is deprecated as of CUDA 5.0. It is no longer an error to call `cudaProfilerStart()` when profiling is already enabled.

**Global `cudaErrorProfilerAlreadyStopped`**

This error return is deprecated as of CUDA 5.0. It is no longer an error to call `cudaProfilerStop()` when profiling is already disabled.

**Global `cudaErrorApiFailureBase`**

This error return is deprecated as of CUDA 4.1.

**Global `cudaDeviceBlockingSync`**

This flag was deprecated as of CUDA 4.0 and replaced with `cudaDeviceScheduleBlockingSync`.

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